Identifying electronic platforms to increase safety at sea in the Australian commercial fishing fleet

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

Foreword

This report is dedicated to all the men and women who go to sea as part of the Australian fishing industry. Too many of these people lose their lives in pursuit of their profession. They leave behind family, loved ones and friends. Their passing is also keenly felt by all fishers across the country. The report also goes out to the departed.

Birds and Ships

The birds are singing in your eyes today
Sweet flowers blossom in your smile
The wind and sun are in the words you say
Where might your lonesome lover be?
Birds may be singing in my eyes this day
Sweet flowers blossoms when I smile
But my soul is stormy
And my heart grows wild
My sweetheart rides a ship on the sea
Well, my soul is stormy and my heart grows wild
Where might my lonesome lover be?

Songwriters: Billy Bragg / Woody Guthrie

Acknowledgements

This research has been funded by the Fisheries Research and Development Corporation without which it may never had occurred. The research involved consultation with several government agencies including the Australian Maritime Safety Authority, the Australian Fisheries Management Authority, and the Bureau of Meteorology. I would like to acknowledge the expertise that these agencies brought to the project. The views contained in this report are those of the author and not attributable to, or associated with any stakeholder.

Input was also provided from members of the Australian fishing industry, both as individuals but also as part of larger entities such as companies of Professional Fisher Associations. Thank you to all those who contributed.

There is no doubt in my mind that this project would not have eventuated without the significant energy put into it by the families and friends of those lost at sea from the tragedies which befell the *FV Returner* and the *FV Dianne*, and from the survivor of the *FV Dianne* tragedy.

It is impossible to convey the profound grief felt by these people over the loss of their loved ones. But it is an enormous statement of character these people have channelled this grief in a direction which seeks to ensure that no one else must suffer in a similar manner to themselves. I feel very grateful to have been taken into their confidence, to hear their stories, to be invited to memorial services and to visit coastal memorials installed in the honour of their loved ones. I would like to sincerely thank each and every one of those people.

The families also expressed confidence in my ability to deliver constructive and beneficial outcomes. I hope I have met these expectations. Geoff Diver.

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Abbreviations

AFMA – Australian Fisheries management Authority

AIS – Automatic Identification System

ALC – Automatic Location Communicator

AMSA – Australian Maritime Safety Authority

BoM – Bureau of Meteorology

COSPAS-SARSAT – Translated from Russian “COsmicheskaya Sisteyama Poiska Avariynich Sudov and meaning “Space System for Search of Distress Vessels”, and “Search and Rescue Satellite-Aided Tracking”)

DSC – Digital selective calling

EPIRB – Emergency Position Indicating Radio Beacon

GEOSAR – Geostationary orbit search and rescue (with reference to satellite orbits)

GNSS – Global Navigation Satellite System

LEOSAR – Low earth orbit search and rescue (with reference to satellite orbits)

MEOSAR – Medium altitude orbit search and rescue

NSCV – National Standard for Commercial Vessels

MOB – Man Overboard

MMSI – Maritime Mobile Service Identity

PFD – Personal Flotation Device

PLB – Personal Locator Beacon

RCC – Rescue Coordination Centre

SAR – Search and rescue

SEND – Satellite Emergency Notification Device

SMS – Safety Management System

SOLAS – (Convention for) Safety of Life At Sea

UHF – Ultra High Frequency

VHF – Very High Frequency

VMS – Vessel Monitoring System

Executive Summary

This project has its genesis in the tragic loss of life at sea within the Australian fishing industry. In recent years there have been a number of instances where vessels have been lost causing the deaths of a significant number of fishers. In some cases, the vessels were lost before the crew could activate the vessel's Emergency Positioning Radio Beacon (EPIRB). EPIRB forms the basis for the formal search and rescue (SAR) agencies in Australia, and the absence of an EPIRB signal can significantly diminish the effectiveness of a search and rescue mission.

Recognising this, the purpose of this report was to examine other electronic platforms typically found on fishing vessels and to investigate if these could be incorporated into a process, policy, or procedure which could increase the maritime safety of the Australian fishing fleet.

This research was conducted with the full cooperation and support of the families of those lost at sea, and a sole survivor from a catastrophic loss of a vessel off Queensland. The research also involved consultation with key commonwealth government agencies such as the Australian Fisheries Management Authority, the Australian Maritime Safety Agency, and the Bureau of Meteorology.

The formal Objectives of the report were:

1. To identify an electronic platform which can accurately and automatically receive a signal from Australian fishing vessels wherever they operate to determine in a timely manner if the vessel is still able to receive and transmit a signal
2. To determine a protocol for timely action if a signal has been deemed to be lost
3. To identify an electronic platform which can alert skippers of heightened risks from fast developing, or fast changing weather and sea conditions
4. To make recommendations for the integration of these platforms into regulation through Australian maritime and fisheries jurisdictions

Maintaining safety at sea requires a multi-faceted and complex system including coordinating vessel integrity and the carriage of the correct equipment, the provision of accurate information on weather and sea conditions, the training of the crew and managing their actions at sea.

Providing a swift and professional response when a vessel is in distress requires a similarly complex system of an alert being issued by the vessel, the capacity of the SAR authorities to be able to accurately pinpoint the location of the vessel in a timely manner, and having the necessary interagency structures to launch a rescue mission.

Australian commercial fishing vessels are required by law to carry a range of electronic platforms before they go to sea. Depending on the size, survey classification and fishery of activity of the vessel, the minimum requirements usually include:

- Emergency position indicating radio beacons (EPIRB)
- Very high frequency (VHF) radio transmitters and/or High Frequency (HF) radio

Additional equipment often found on the modern fishing vessel includes:

- Vessel monitoring systems (VMS)
- Automatic Identifier Systems (AIS)
- Personal locator beacons (PLB)
- "Man Overboard" (MOB) systems
- Satellite Emergency Notification Device (SEND)
- Mobile telephones
- Satellite telephones

- Internet access via satellite

In analysing these electronic platforms, this report has concluded that EPIRB should remain the primary distress signalling platform for Australian fishing vessels. EPIRB signals are monitored globally by dedicated SAR authorities which have the expertise and resources to triage the initial distress signal, and coordinate a SAR mission.

EPIRBs can be purchased as manually activated models, water activated, or as float free units which deploy automatically if the unit is immersed in between 1 and 4 metres of water.

The National Standard for Commercial Vessels (NSCV) has been updated with “float free” EPIRBs now becoming mandatory on some vessels by January 1, 2021.

Where mandated in Australia, a VMS is used as a fisheries management compliance tool, not as a maritime safety device. The report found that VMS is not a suitable primary distress signalling platform. The principle reasons behind this finding include:

- Not all Australian fisheries management agencies mandate VMS units which have email communication or in built distress signalling capabilities
- VMS units will lose signal if the ship loses power
- There are often delays in the transmission of the VMS signal from the satellite earth station to the end user
- VMS may continue to transmit in emergency situations such as a fire, or a ship running aground and braking up.

PLB transmit on the same frequency as EPIRBs. They can transmit for 24 hours but do not float vertically. PLB should be attached to the upper section of a life jacket with a lanyard to ensure they don’t float away from the user. The report found PLB increase the safety of the individual user, but not the vessel as a whole.

SEND have a range of technical characteristics which make them a less suitable sea safety platform than PLB. Of note, these devices:

- May require battery changes, possibly while the user is in the water;
- Would need to be re-activated by the user after a battery change;
- Require the user to maintain an individual contract with a satellite provider;
- Are not directly monitored by Australia’s SAR authorities.

Similar to PLB and SEND, MOB systems increase individual crew safety but not the safety of the vessel as a whole. MOB systems immediately alert the parent vessel a crew member has gone overboard which should shorten the window of time that person is in the water. As with PLB and SEND, MOB systems are only effective if the crew wear the device on deck, and have it tethered to their clothing.

The Automatic Identification System was also found not to be a suitable substitute for EPIRBs. Automatic Identification System units can be switched off by the Master of a vessel.

Communication means such as radio, email and satellite phones would all lose functionality if the vessel lost power. Mobile phones would only be of use if the vessel is in range of a provider’s signal. An emergency “Triple zero” call can be made on an Australian phone and will be picked up by any mobile phone carrier. This requires the vessel in distress to be within range of a mobile phone tower.

The report found the Bureau of Meteorology provides a wide array of services of use to mariners. It is likely some of these are not widely known throughout the Australian fishing

industry. The main services of use to the industry are discussed in the report and recommendations on how best to disseminate this knowledge to the Australian fishing industry are made.

The report also discusses other safety issues such as the development of a safety management system, and other quantitative risk assessment processes. FRDC projects 2017-046 *"What's stopping you from protecting yourself and your mates? Identifying barriers to the adoption of safe work practises in the small-scale wild catch commercial fishing industry", and* 2017-194 "*SeSAFE - delivering industry safety through electronic learning*" are mentioned in the discussion section of this report as they have relevance for identifying some of the at sea risks likely to appear in fishing operations, and the development of training options for industry, respectively.

The implications from the report's findings include (among others):

- There are a number of recommendations which will require liaison between the Australian fishing industry and government agencies. Some of these agencies already have formal consultation bodies designed specifically to work with the industry;
- There are a number of recommendations which are aimed solely at industry. These recommendations can be taken up as initiatives "for industry, by industry"
- There seem to be no significant impediments to achieving substantial progress on the findings of the report.

The report makes 14 recommendations which are listed below, and in the body of the report.

Recommendations

Recommendation 1. It is recommended the Australian fishing industry and/or the entire maritime community develop a campaign raising awareness of the benefits of float free EPIRB and encourage vessel owners to install such units in a timely manner.

This campaign could also include highlighting the safety benefits to individual crew members available through PLB, SEND and MOB systems, and the limitations of each in using either as a distress signalling platform.

Recommendation 2. It is recommended AMSA and manufacturers on float free EPIRBs continue developing detailed installation instructions to mitigate the probability of a float free EPIRB becoming entangled in the vessel's structure in the case of maritime emergencies such as a vessel overturning.

Recommendation 3. It is recommended the Australian fishing industry and or the wider maritime community develop a campaign nominating a specific date at which EPIRB or PLB owners should review and update the contact details registered against their beacon serial number.

Recommendation 4. It is recommended that the Australian fishing industry, AMSA and State and Commonwealth fisheries agencies work towards an annual risk based audit which correlates the contact details held by AMSA and the various fisheries management agencies for fishing vessels. It is not a recommendation of this report that the audit cover all vessels fitted with VMS and EPIRB every year. This recommendation will require the involvement of both AMSA and State and Commonwealth fisheries agencies and it is noted that legal privacy requirements may limit the exchange of such information between the two agencies.

Recommendation 5. It is recommended that the Australian fishing industry ensure that all crew on a vessel are formally made aware of the location and activation method of all EPIRB or PLB on board as part of their occupational health and safety (OHS) induction when they join the vessel. The same process should be undertaken for all passengers (scientists, observers etc.) who go to sea on a vessel.

Recommendation 6. It is recommended that Australian fisheries management agencies pass on information on the loss of a VMS signal, and the last known position to the relevant SAR authority under a formal protocol including timeframes for each action.

Recommendation 7. It is recommended that Australian fisheries management agencies investigate mechanisms to automate an alert system which can notify the relevant officer of the loss of a VMS signal out of hours, and link the immediate actions to Recommendation 6.

Recommendation 8. It is recommended the Australian fishing industry investigate the formation of an industry funded VMS platform to operate on a subscriber basis to spread satellite polling costs. This recommendation is tempered by the fact vessels would need to purchase their own VMS units, and such a platform would need to be staffed and resourced and may be open to professional liability claims should it be promoted as a formal sea safety entity.

The Australian fishing industry should also continue to monitor the prospect of owners being able to access the fishery management agency's VMS signal for their vessel without paying for satellite monitoring costs, and to take advantage of such an outcome if or when it becomes available.

Recommendation 9. It is recommended the Australian fishing industry develop an information package on protocols between vessels and shore based representatives which integrate AIS into sea safety initiatives with an emphasis on protocols to attempt to differentiate between a

loss of signal as a result of a maritime emergency or due to manual switch off of the AIS, or a technical fault.

Recommendation 10. It is recommended the Australian fishing industry encourage its members to develop induction packages for their crew which include the location of radios, email facilities, satellite phones, and fixed mobile phones. The induction could also include knowledge of the monitored VHF digital selective calling (DSC) emergency channels on VHF radio, and that triple zero can be called from any Australian mobile phone if it is in range of any phone carrier. Induction should also involve crew members being informed of who the trained radio operators on-board are.

Recommendation 11. It is recommended the Australian fishing industry, in conjunction with the BoM, consider developing an information package on the various services offered by the BoM and the technical terms used by the BoM for marine forecasts and warnings. It is recommended this module be available to all crews and shore based representatives to enable them to be able to contribute to sea safety decision making if there are concerns with weather and sea conditions while at sea.

Recommendation 12. It is recommended the Australian fishing industry urge vessel operators and owners to develop a data driven risk based decision making matrix based on the definitions of BoM terminology and specific to the vessel size, area of operation, fishing gear etc. It is recommended that all crew on-board are made aware of the matrix and understand it.

Recommendation 13. It is recommended the Australian fishing industry continue to work with AMSA and the BoM in designing a system of determining and transmitting information on rapidly deteriorating, localised weather events.

Recommendation 14. It is recommended the Australian fishing industry promote a positive safety culture within the industry. The use of SeSAFE modules can address fishery or area specific safety issues and these modules be made available as part of the normal induction and training packages for crew.

Keywords

Safety at sea, search and rescue, fishing industry, emergency position indicating radio beacon, EPIRB, Personal locator beacon, vessel monitoring system, electronic platforms.

Introduction

Maintaining safety at sea requires a multi-faceted and complex system including coordinating vessel integrity and the carriage of the correct equipment, the provision of accurate information on weather and sea conditions, the training of the crew and managing their actions at sea. Providing a swift and professional response when a vessel is in distress requires a similarly complex system of an alert being issued by the vessel, the capacity of the search and rescue (SAR) authorities to be able to accurately pinpoint the location of the vessel in a timely manner, and having the necessary interagency structures to launch a SAR mission.

Australian commercial fishing vessels are required by law to carry a range of electronic platforms before they go to sea. Depending on the size, survey classification and fishery of activity of the vessel, the minimum requirements usually include:

- Emergency position indicating radio beacons (EPIRB)
- Very high frequency (VHF) radio and/or High Frequency (HF) radio

Additional equipment often found on the modern fishing vessel includes:

- Vessel monitoring systems (VMS)
- Automatic Identifier Systems (AIS)
- Personal locator beacons (PLB)
- "Man Overboard" (MOB) systems
- Satellite Emergency Notification Device (SEND)
- Mobile telephones
- Satellite telephones
- Internet access via satellite

Despite this, a number of Australian fishing vessels have sunk at sea resulting in the loss of life of crew members. Two such vessels were the *FV Dianne* which was lost off Queensland in 2017, and the *FV Returner* which sunk off Western Australia in 2015. Both vessels sank without the crew activating any of the emergency systems known to be on-board at the time. In the case of the *Returner*, a series of events identified by the Western Australian Coroner led to there being a delay of 5 days between when all forms of electronic signal were lost, and a formal SAR mission was commenced. Some of these events were raised by various Coroners who made recommendations centred on the sharing of information between fisheries management and SAR agencies. Recommendations for the sharing of information have since been taken up in Western Australia.

There is no doubt that interagency cooperation exists in Australia, and that there is an appetite to continually refine ways in which this can be built upon to increase safety at sea. This was clearly and publicly shown in the manner which several agencies adopted the recommendations of the Western Australian Coroner following the inquest into the loss of the *Returner,* and has been amply demonstrated by the cooperation of the various agencies consulted as part of this research.

Despite having its origins partly in the loss of the *FV Dianne* and the *FV Returner*, this report cites neither as case studies, although it does draw on the observations of the families of those lost, and the survivor of one of the tragedies. The report does examine the suite of mandatory and voluntary electronic platforms available to the Australian fishing industry and how these might be configured to best serve the safety of those at sea. The key players in such a configuration may include the:

- Shore based representatives and families of vessel crew
- Skippers and crews themselves
- Australian Maritime Safety Authority (AMSA)
- Commonwealth and State and Territory fisheries management agencies around the country
- Bureau of Meteorology (BoM)

- State and Territory police and emergency services
- Voluntary coast guard radio operators

The report details some basic principles which the reader needs to be aware of in order to understand the sections of the report which follow. The *Basic Principles* section is followed by a technical overview of *Electronic Platforms,* which are either mandated for Australian fishing vessels, or can be carried voluntarily. It is important to note that the extent of the electronic platforms carried on a fishing vessel through regulation is dependent on the survey class of the vessel. The survey class is largely determined by the vessel size and its area of operation. The technical detail of survey requirements for each vessel class are too complex to present in a report such as this. As a result, this section deals with all the key electronic platforms but specifically identifies equipment which is voluntary across all survey classes. The integration of these platforms into sea safety regimes is presented in the *Discussion* section of this report which also presents the *Recommendations* in the context of the discussion surrounding each facet investigated.

Objectives

The formal objectives of this project were to:

1. To identify an electronic platform which can accurately and automatically receive a signal from Australian fishing vessels wherever they operate to determine in a timely manner if the vessel is still able to receive and transmit a signal.
2. To determine a protocol for timely action if a signal has been deemed to be lost
3. To identify an electronic platform which can alert skippers of heightened risks from fast developing, or fast changing weather and sea conditions
4. To make recommendations for the integration of these platforms into regulation through Australian maritime and fisheries jurisdictions

Method

This research was conducted with the full cooperation and support of the families of those lost at sea, and a sole survivor from a catastrophic loss of a vessel off Queensland, and the families of those who perished in the loss of a fishing vessel off Western Australia.

The research also involved consultation with key Commonwealth government agencies such as the AMSA, Australian Fisheries Management Authority (AFMA) and the BoM. A range of technology suppliers were also approached for technical and logistic input. These included the makers of safety equipment, and providers of other technologies such as software and satellite systems. Members of the Australian Fishing industry were also consulted.

This information was then synthesised by the author and reviewed by a number of stakeholders.

The views contained in this report are those of the author and not attributable to, or associated with any stakeholder.

Results

Basic Principles

Search and Rescue

Search and rescue (SAR) functions refer to the specific activities of terrestrial, aviation and maritime responses to distress signals. International SAR activities are coordinated through the International Convention on Maritime Search and Rescue which was adopted on 27 April 1979 and came into force on 22 June 1985.

The convention further codified treaties such as the International Convention for the Safety of Life at Sea (SOLAS), which had previously required vessels at sea to respond to distress signals, and formally linked existing SAR organisations in member countries.

Once a distress signal is detected, it is relayed to the member nation responsible for SAR missions in that area. AMSA are the official SAR agency for the Australian zone shown in Fig. 1.

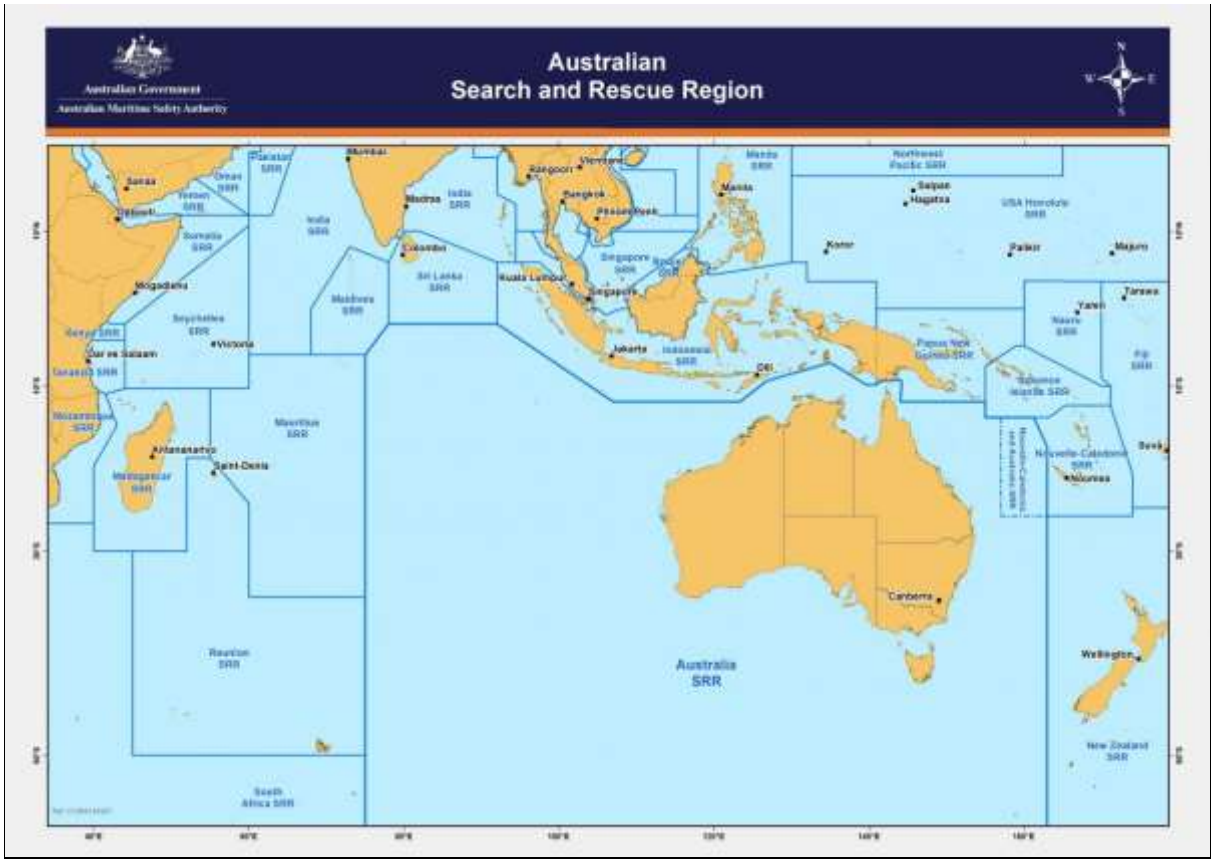

Figure 1*. Australian Search and Rescue Region. Reproduced with the permission of AMSA.*

In broad terms, mounting a SAR mission can involve:

- Transmitting the location of the distress calls to aircraft, ships and terrestrial craft in the vicinity of the distress signal;
- Coordinating activities with other agencies with SAR capability such as State and Territory police services, Borderforce and the armed services

- Coordinating the movement of “assets” such as agency owned and aircraft, ships and terrestrial vehicles
- Liaison with medical facilities and services.

COSPASS/SARSAT

The COSPAS-SARSAT satellite system (translated from Russian “COsmicheskaya Sisteyama Poiska Avariynich Sudov and meaning “Space System for Search of Distress Vessels”, and “Search and Rescue Satellite-Aided Tracking”) is an international SAR network formed under the SOLAS convention and is used by the 44 nation member nations – including Australia.

The system covers maritime, terrestrial and aircraft distress signals. A system overview is shown below in Figure 2. The COSPAS-SARSAT forms a major part of the Global Maritime Distress and Safety System (GMDSS).

The general SAR satellite configuration is a combination of low earth orbit search and rescue (LEOSAR) satellites, geostationary orbit search and rescue (GEOSAR) satellites within the medium-altitude Earth Orbit Search and Rescue system (MEOSAR). The system is shown below in Figure 2. By and large the SAR satellite coverage extends to about 80^{o} north and 80^{o} south.

Figure 2. COSPAS-SARSAT System. Source www.COSPAS-SARSAT.int

Global Maritime Distress Signalling System

The Global Maritime Distress Signalling System (GMDSS) is the maritime component of the COSPAS-SARSAT system with an overview of the system shown in Figure 3. GMDSS is mandatory on vessels over 300 gross tonnage on international voyages. A number of crew in such vessels must complete certificates of competency as a radio operator. Measures such as this safeguard the integrity of the GMDSS.

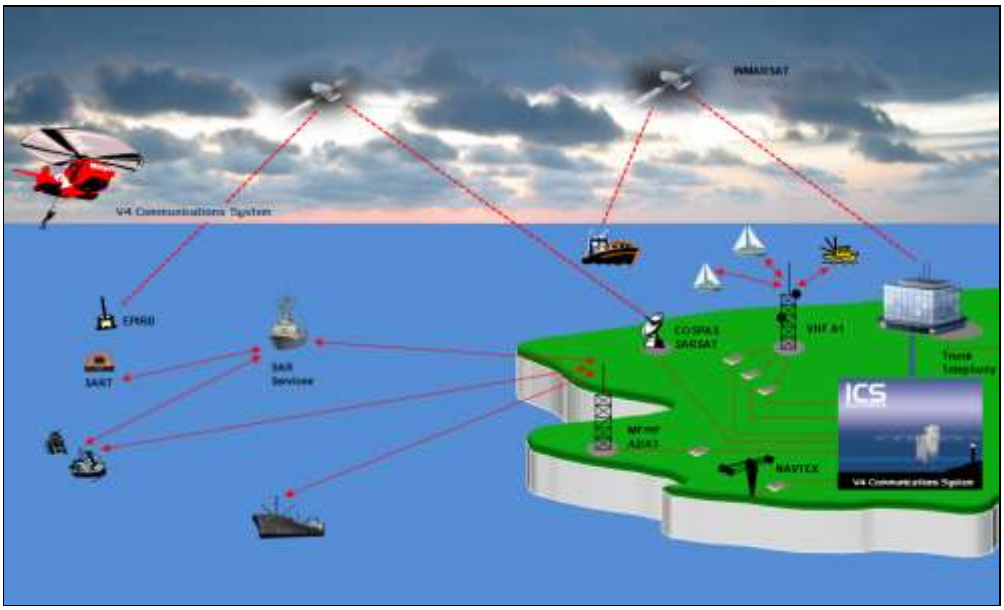

Figure 3. GMDSS Overview. © Asha Institute of Maritime Technology

Formal distress signals are presently carried by the Inmarsat-C satellite system. The Inmarsat coverage zones are shown in Figure 4. The Inmarsat system uses “earth stations” to relay satellite signals to the end user. As a result, any technical difficulties at the earth station, or in communications between the earth station and the end user can result in a time delay which may be as long as several hours.

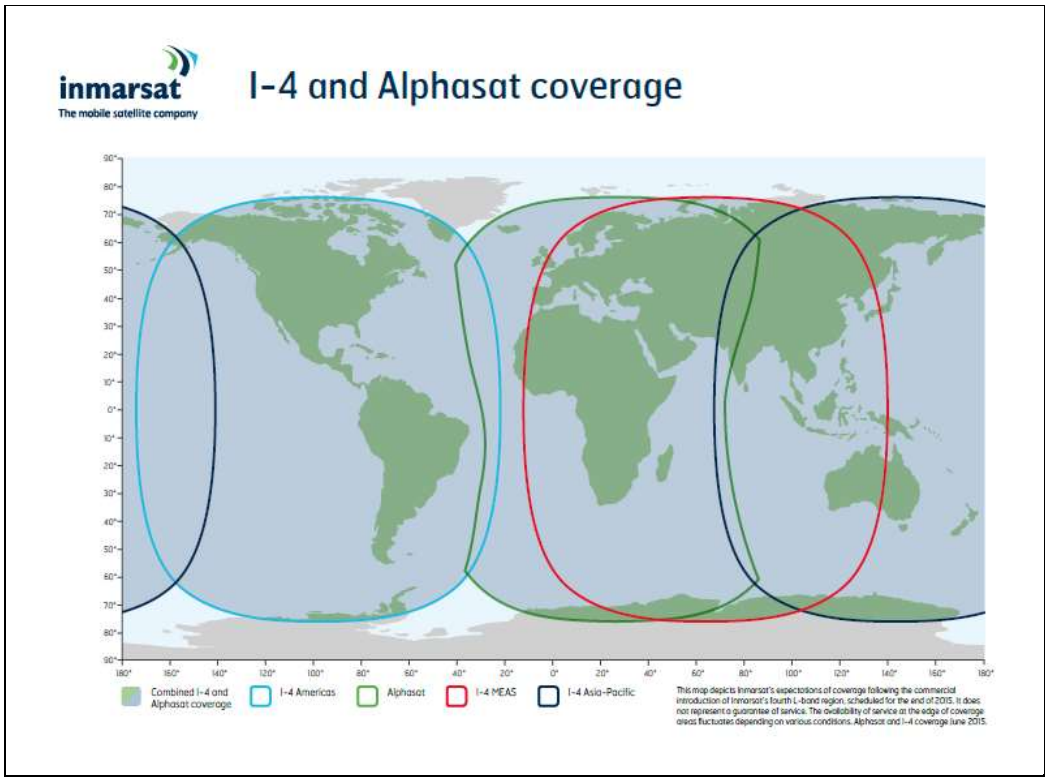

Figure 4. Inmarsat Maritime I-4 and Alphasat Coverage Areas. © Inmarsat

Electronic Platforms

Vessel Monitoring Systems

In the context of the Australian fishing industry, Vessel Monitoring Systems (VMS) is used by government fisheries management agencies to track vessels at sea for reasons of compliance with fisheries and other regulations such as marine reserves. Australian fisheries management agencies do not consider VMS to be a sea safety platform. AFMA hosts the principle fisheries VMS platform in Australia, sometimes also on behalf of the State and Territory fisheries agencies. An overview of the VMS is shown in Figure 5.

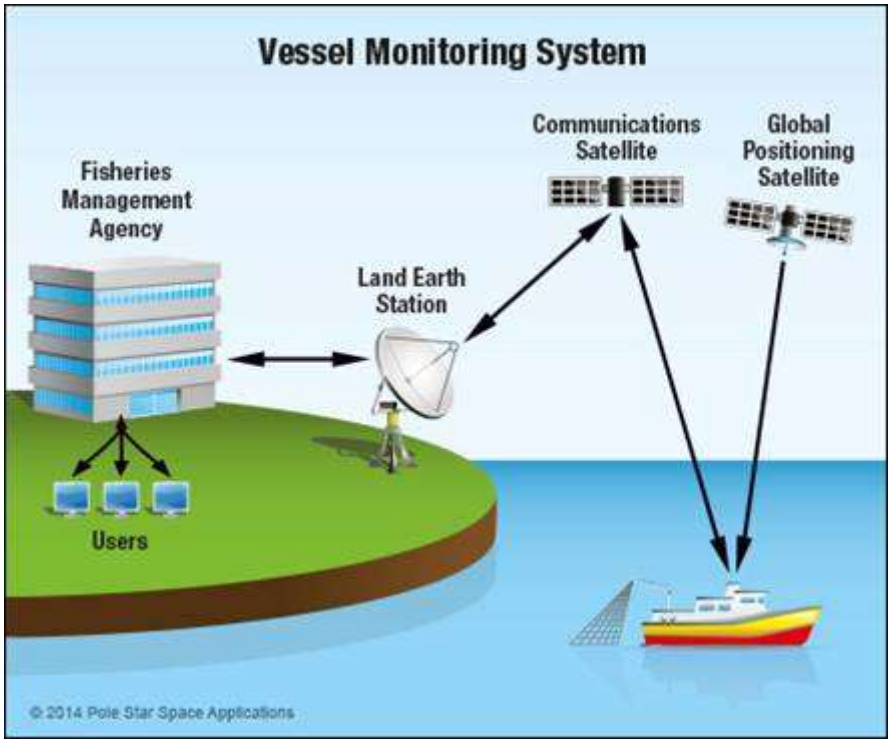

Figure 5*. Vessel Monitoring System Overview. Source: Australian Fisheries Management Authority*

At its most basic a VMS has an automatic location communicator (ALC) which communicates with a satellite system. A typical ALC is shown in Figure 6. The VMS unit is programmed to poll the satellite at a predetermined interval. The ALC, when polling, sends the signal providing the location of the vessel. Depending on the polling rate the ALC data can also reveal the vessels speed and course.

More sophisticated VMS units have provision for two-way communication by email, and a manually activated distress signal. Most of the "ALC only" units have provision for these functions to be added by purchasing additional hardware and software.

Figure 6. VMS ALC unit. © Polestar

With this data, the fisheries agency can monitor aspects of vessel movement such as:

- Entering closed areas
- Using speed and course to determining if the vessel is fishing or steaming
- The vessel's total fishing days within a fishing season

Automatic Identification System

Commercial vessels in some survey classes are required to have Automatic Identification System (AIS) installed. AIS beacons can also be fitted to navigation markers. An overview of the AIS is shown at Figure 7, with the on-board screen shown at Figure 8.

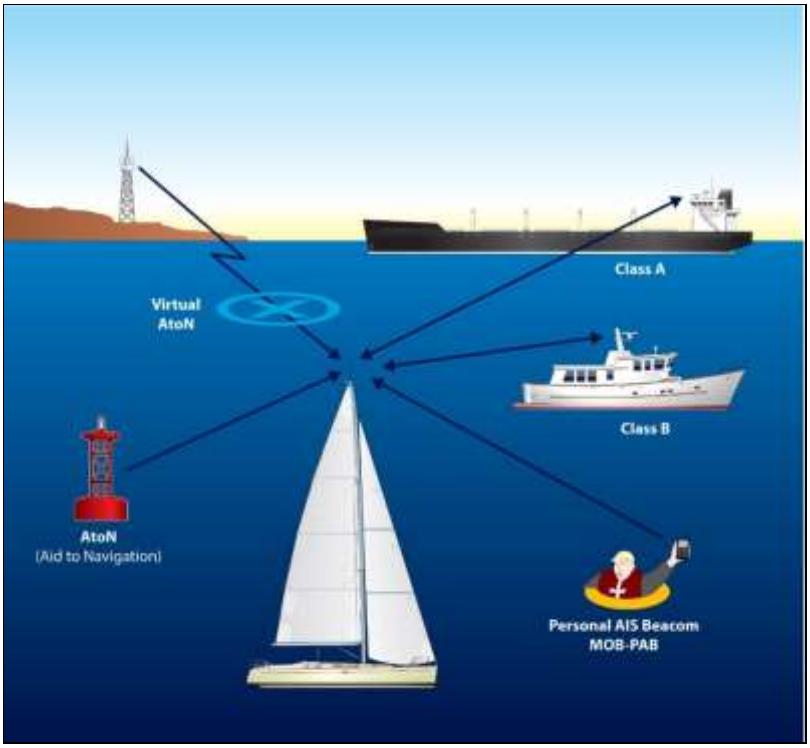

Figure 7. AIS System Overview. © Sail Universe

AIS transponders and receivers use two channels referred to AIS 1 and AIS 2. These are carried on VHF radio frequencies:

- 161.975 MHz (AIS1, or channel 87B) and
- 162.025 MHz (AIS2, or channel 88B)

An AIS will detect other AIS beacons to approximately 20 nautical miles (nm), or over a longer range depending on how high the transponder is positioned above the water. The transponder can also be monitored by satellite.

The AIS broadcasts a Maritime Mobile Service Identity (MMSI), a unique nine digit number that is entered into certain marine radio communications equipment. As a unique identifier, the MMSI assists SAR services to identify the vessel or fixed object to which the AIS is fitted. As is the case with GMDSS, some crew on an AIS fitted vessel are required to have completed a radio operator's certificate of proficiency.

Figure 8. AIS Receiving Unit. © Simrad

In some cases, mariners are allowed to switch off their AIS. This occurs in the fishing industry where skippers want to protect sensitive fishing locations. The ability for mariners to switch off their AIS makes this system impractical as a primary distress mechanism, or to monitor vessel movements for sea safety. As is the case with VMS, the registration of a range of contact and identity details greatly enhances the value of the AIS.

Emergency Position Indicating Radio Beacons

Emergency Position Indicating Radio Beacons (EPIRB) are widely recognised as the best primary distress signal platform. In Australia, EPIRBs are mandatory on all vessels operating more than 2 nm offshore. EPIRBs transmit a distress signal to the COSPAS-SARSAT system on the 406 MHz bandwidth. The signal is then relayed to the information to the country in whose SAR Region the emergency is taking place. Prior to February 2009, EPIRB also transmitted on the 121.5 MHz signal. This frequency is no longer detected by satellite but is used by local SAR agencies for local homing purposes. Prior to 1st February 2009 some analogue beacons solely transmitted on 121.5 MHz. These beacons are no longer detected by satellite.

Until recently, the most commonly found EPIRB units were manually activated by the skipper or crew, or by immersion in water. These units are shown in Figure 9.

The National Standard for Commercial Vessels (NSCV) has been updated with "float free" EPIRB now becoming mandatory on some vessels by January 1 2021 (https://www.amsa.gov.au/safety-navigation/distress-beacons/mandatory-float-free-epirbs). This timeframe reflects the fact that

these classes of vessels will have had to go through maritime survey between the implementation of the regulation and the cut off. Float free EPIRBs still use the same transmission bandwidth but will automatically deploy if they are subjected to a water depth between 1 and 4 metres. This enhances the likelihood a distress signal will be sent in the event of a maritime emergency. A float free EPIRB is shown in Figure 10.

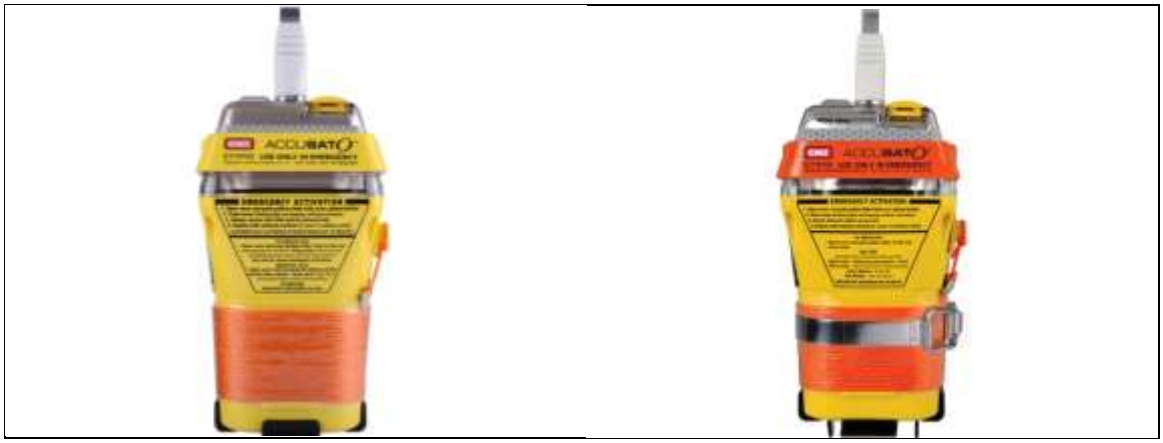

Figure 9*. Water/Manually Activated EPIRB (L), Manually Activated EPIRB (R). © GME*

Figure 10*. Float Free EPIRB. © GME*

The correct operation of a float free ERIRB requires the unit to be installed on the vessel in a position where it can float free of a vessel which has capsized or is sinking and is unlikely to become entangled in the vessel structure.

EPIRBs are required to be registered with AMSA. Registration can be carried out online at https://www.beacons.amsa.gov.au/beacons.

In future, EPIRB will also transmit on the AIS frequencies which will integrate both systems and make it easier for vessels at sea to locate the activated EPIRB.

Personal Locator Beacons

A similar option is the personal locator beacon (PLB) which operates more or less on the same principle as the EPIRB but is sold as a “wearable” piece of equipment carried by an individual. PLB transmit on the same frequency as EPIRB and thus are monitored within the international SAR systems. A sample PLB is shown at Figure 11.

Figure 11*. Maritime PLB. © GME*

These devices are effective in the case of man overboard (MOB) incidents, which can occur unseen by other crew members. For the greatest benefit, PLB should be tethered to the clothing to ensure that it does not become separated from the position of the crew member. Most manufacturers sell PLB specifically designed for maritime conditions

Satellite Emergency Notification Device

Satellite Emergency Notification Device (SEND) can also transmit an emergency signal. Manufacturers of SENDs have agreement with satellite carriers with the beacon being registered at the time of purchase. In some cases, the SEND owner needs to maintain a subscription to the satellite carrier in order for the distress signal to be monitored. The SEND distress signal is triaged by the satellite carrier and is then passed on to the rescue coordination centre (RCC) in the relevant SAR area.

Many SEND also have a “tracker” function that records the movement of the wearer which can aid a SAR mission. The tracker function uses battery life and can shorten the time for which a distress signal can be transmitted. SEND owners are advised to carry spare batteries with the device. In some cases, the changing of batteries will cancel the distress signal which then needs to be re-activated. Failure to re-activate SEND after a battery change has been known to cause delays and added complexities in SAR missions. It would prove difficult, if not impossible, to change batteries if the SEND wearer is in the water. The reasons above work against SEND being used as a primary distress mechanism at sea.

SEND devices are not officially or independently tested or required to be compliant to any standard.

“Man Overboard” Systems

A number of manufacturers supply MOB alarm systems. These comprise a fixed base station on the vessel and a number of wearable transmitters which are activated when immersed in water, and/or move past a predetermined distance range from the base station. This is usually set at the length of the vessel past which crew cannot physically still be on-board. When activated, the wearable transmitters send a signal to the base station on the vessel which activates an audible alarm. A typical MOB alarm system is shown at Figure 12.

All MOB devices have GNSS capability and transmit latitude and longitude. MOB AIS devices transmit on the AIS frequency which assists the parent vessel in localised searches. Other MOB

devices that transmit on different frequencies such as VHF DSC, Mobile App. The dependability of the MOB systems relies on crew members wearing their MOB transmitter at all times when on deck.

Figure 12. *Man Overboard System. © Raymarine*

Radio

The most common radios found on the Australian fishing fleet are very high frequency (VHF), and ultra-high frequency (UHF).

VHF operates from 30 to 300 MHz (approximately 150 to 165 MHz for marine applications) and UHF 477 MHz. UHF is also commonly referred to as CB Radio. VHF provides 77 channels, 32 of which are allocated to repeater stations (16 Output and 16 input stations). The key maritime frequencies for VHF are channels 16 and 70.

Not all vessels will carry UHF radios, and the only channels monitored are the (DSC) emergency channels on VHF radio.

Telephone

Larger fishing vessels are generally fitted with a mobile telephone, often used in conjunction with a fixed aerial. It is not uncommon for crew members to also carry their personal mobile phones on board. Mobile phone carriers allow for “000” calls to be made as long as the phone has battery power and is within the range of any mobile phone provider.

The range of a mobile phone from a tower is between 20 km (10.8 nm) to 70 km (37.8 nm), which limits the use of such devices for fishing vessels operating outside this range of a phone tower.

Satellite phones, as the name implies, send the phone signal to one of multiple satellites. The signal is then transmitted to the recipient whose response is similarly sent back to the caller via satellite. Satellite phone owners are required to have the user to have a contract with a satellite service operator.

Email

VMS units on Australian commercial fishing vessels that are fitted with two-way communication functions can send and receive email but not voice messages. This level of functionality is mandatory for vessels in survey classes which require the installation of GMDSS.

Bureau of Meteorology[1]

General Overview

The BoM homepage (www.bom.gov.au) offers a range of services. At the broadest scale are synoptic charts showing the weather patterns across the country and into surrounding seas (Figure 13). Similar information can also be viewed as a moving satellite image at http://satview.bom.gov.au/ (Figure 14).

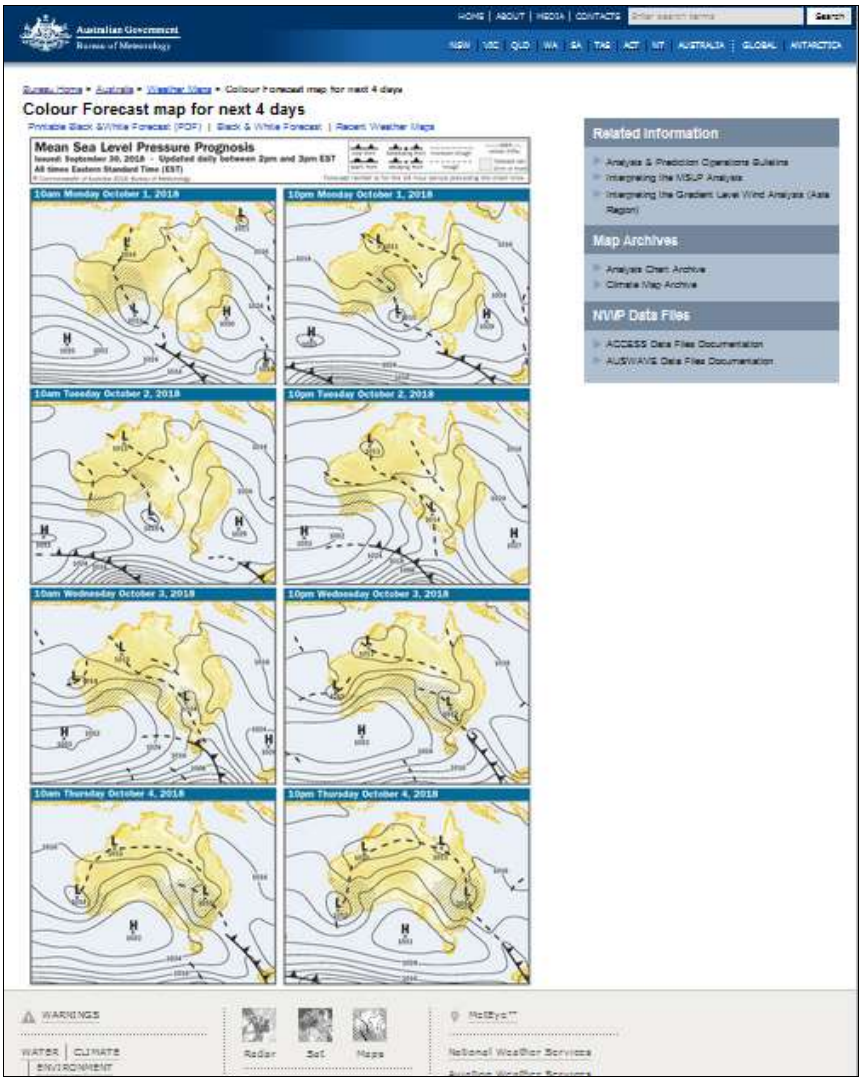

Figure 13. Sample of BoM 4 Day Synoptic Chart

[1] All images in this section reproduced with the permission of the Bureau of Meteorology

Figure 14. Default Screen for BoM Satellite Viewer

BOM also provides localised services such as capital city forecasts, with links to State and Territory weather forecasts and warnings at a regional level, satellite images, rain radars (Figure 15), other climate and weather services, and the MetEye service. The BoM site also has a dedicated "Marine and Ocean" page at www.bom.gov.au/marine.

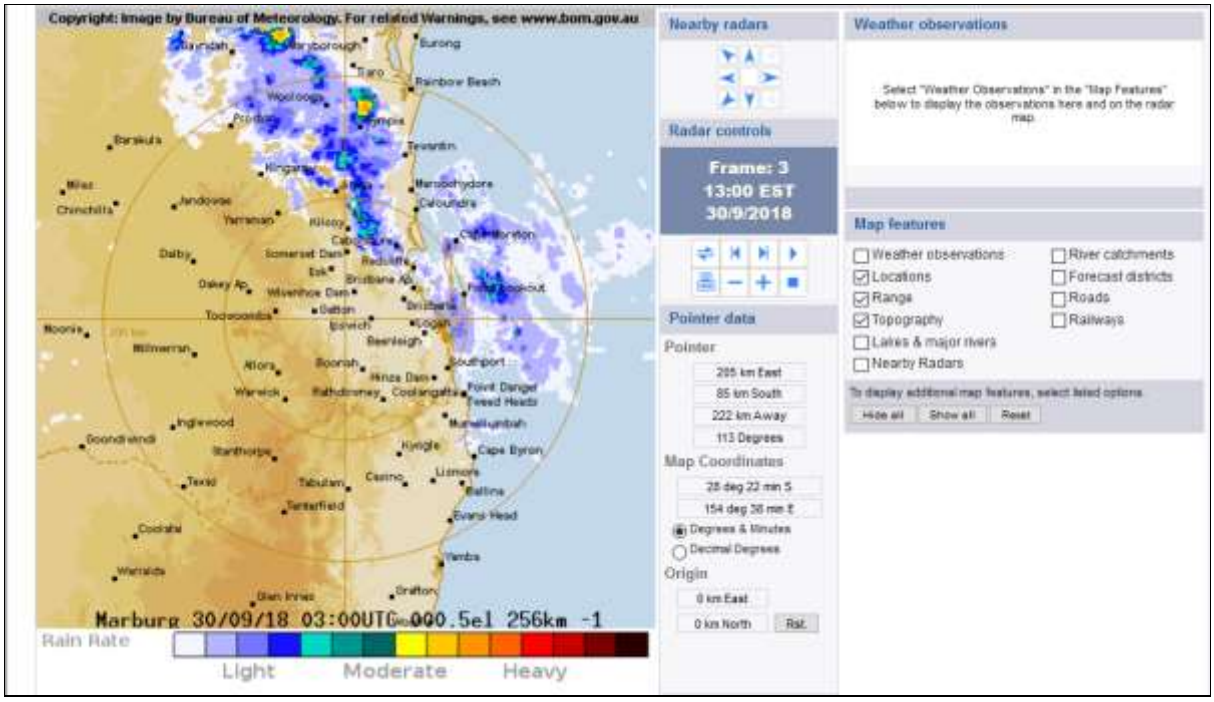

Figure 15. Sample of the BoM Rain Radar

Marine weather warnings are relevant to "coastal waters" which extend to 60 nm from the coast and are divided into areas around the country, as seen below in the Western Australian example below at Figure 16. Marine wind warnings provide advice about warning conditions covering the current day and the following day. The wind warning is included within the marine forecast to provide mariners with relevant information about wind speed, wind direction and wave conditions.

The BoM recommends mariners primarily use the coastal waters forecasts and warnings, as they have been adjusted by BoM meteorologists, and remove the need to interpret synoptic charts.

BoM also uses the following phrase on forecast and warning products to raise risk awareness: "Please be aware: Wind and wave forecasts are averages. Wind gusts can be 40 percent stronger than the forecast, and stronger still in squalls and thunderstorms. Maximum waves can be twice the forecast height."

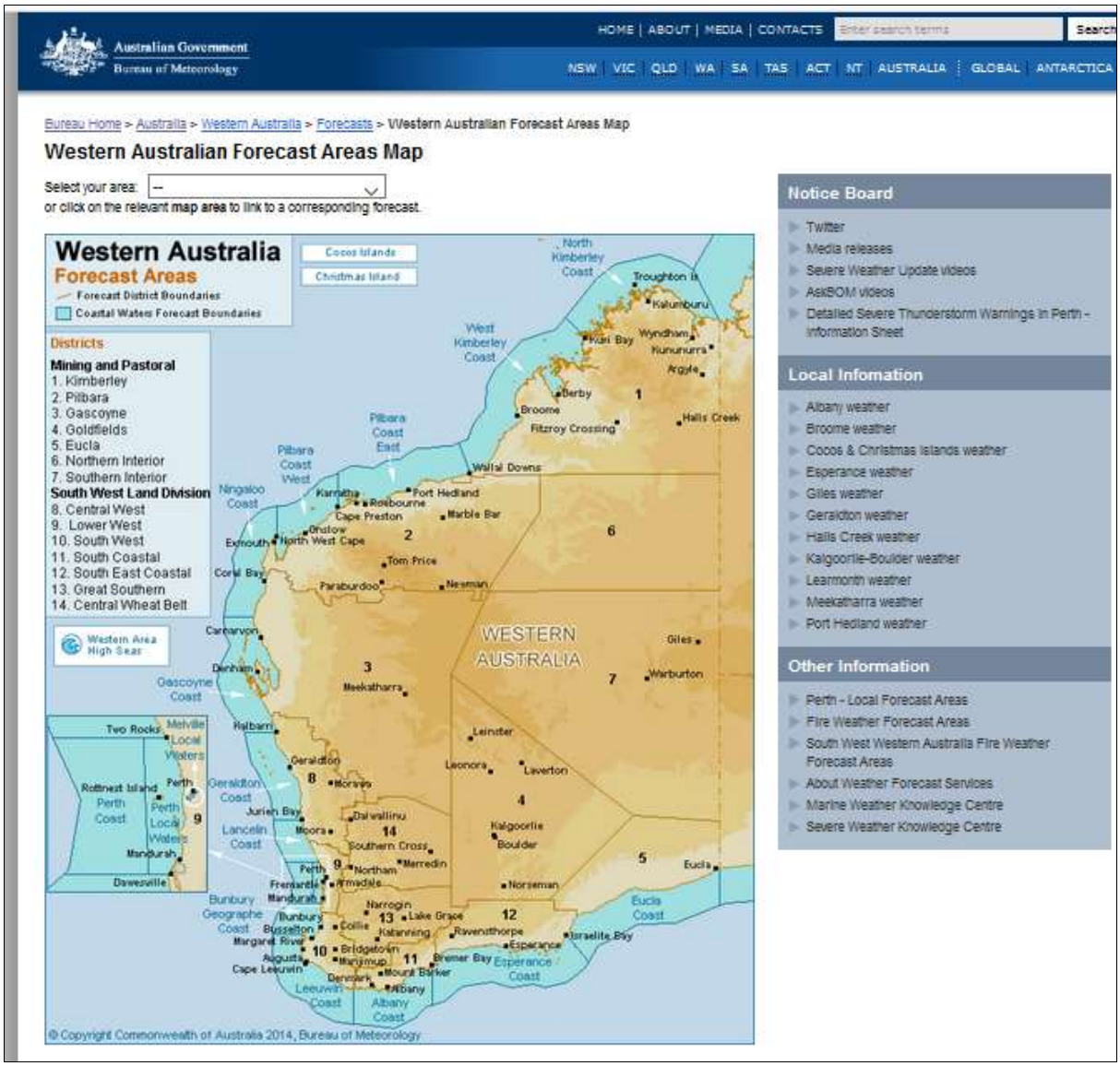

Figure 16. BoM WA Coastal Waters Map

Forecasts and warnings use a standardised set of language and terms, when referring to wind speed, wave height and weather conditions. Examples are shown in the following diagrams (Figs. 17 to 20), and are available on the BoM Marine Weather Knowledge Centre at www.bom.gov.au/marine/knowledge-centre.

Early in the morning:	Expected to occur before 7am.
In the morning:	Expected to occur between 1am and 11am.
In the late morning:	Expected to occur between 9am and midday.
During early afternoon:	Expected to occur between 12pm and 4pm.
During the afternoon:	Expected to occur between 1pm and 9pm.
In the evening:	Expected to occur between 6pm and midnight.
Later in the evening:	Expected to occur after 9pm.

Figure 17. BoM definitions for the time of day

Strong wind warning	Winds averaging from **26 knots and up to 33 knots.**
Gale warning	Winds averaging from **34 knots and up to 47 knots.**
Storm force wind warning	Winds averaging from **48 knots and up to 63 knots.**
Hurricane force wind warning	Winds averaging **64 knots or more.**

Figure 18. BoM definitions for wind warnings

Sea

Description	Height (metres)	Effect
Calm (glassy)	0	No waves breaking on beach
Calm (rippled)	0 - 0.1	No waves breaking on beach
Smooth	0.1 - 0.5	Slight waves breaking on beach
Slight	0.5 - 1.25	Waves rock buoys and small craft
Moderate	1.25 - 2.5	Sea becoming furrowed
Rough	2.5 - 4	Sea deeply furrowed
Very rough	4-6	Sea much disturbed with rollers having steep fronts
High	6-9	Sea much disturbed with rollers having steep fronts (damage to foreshore)
Very high	9-14	Towering seas
Phenomenal	over 14	Precipitous seas (experienced only in cyclones)

Figure 19. BoM definitions for sea conditions

Swell

Description	Wave Length	Period	Wave Height
Low swell of short or average length	0 - 200 m	Less than 11 sec	0-2 m
Long, low swell	over 200 m	Greater than 11 sec	0-2 m
Short swell of moderate height	0-100 m	Less than 8 sec	2-4 m
Average swell of moderate height	100-200 m	Greater than 8 sec, less than 11 sec	2-4 m
Long swell of moderate height	over 200 m	Greater than 11 sec	2-4 m
Short heavy swell	0-100 m	Less than 8 sec	over 4 m
Average length heavy swell	100-200 m	Greater than 8 sec, less than 11 sec	over 4 m
Long heavy swell	over 200 m	Greater than 11 sec	over 4 m

Figure 20. BoM definitions for swell conditions

Communication options

HF radio (voice)

Marine weather warnings and forecasts are broadcast from Charleville (eastern waters) and Wiluna (western waters) on High Frequency (HF) radio. Broadcast frequencies for Charleville are:

- Day-time (0700 – 1800 EST): 4426, 8176, 12365, 16546 kHz
- Night-time (1800 – 0700 EST): 2201, 6507, 8176, 12365 kHz

The Charleville warnings are repeated every hour, and forecasts are broadcast on a fixed schedule repeated every four hours:

- Queensland
- High Seas (Northern, North Eastern, South Eastern, and Southern areas)
- New South Wales and Victoria
- Tasmania

Broadcast frequencies for Wiluna are:

- Day-time (0700 – 1800 WST): 4149, 8113, 12362, 16528 kHz
- Night-time (1800 – 0700 WST): 2056, 6230, 8113, 12362 kHz

The Wiluna warnings are repeated every hour, and forecasts are broadcast on a fixed schedule repeated every four hours:

- Western Australia (Northern Zones: NT-WA Border to North West Cape) & Northern Territory

- Western Australia (Western Zones: North West Cape to Cape Naturaliste), Western Australia (Southern Zones: Cape Naturaliste to WA-SA Border)
- South Australia
- Queensland (Gulf waters), High Seas (Northern, Western, and Southern areas)

The full schedule of broadcasts can be found at http://www.bom.gov.au/marine/radio-sat/voice-services.shtml.

VHF radio (voice)

A network of VHF marine radio broadcasting stations provide broadcasts of the BoM's marine forecasts and warnings at scheduled intervals. Details of schedules are coordinated by the individual marine radio base in each State/Territory.

AM/FM radio (voice)

Weather forecasts and weather warnings may be broadcast on free to air media at the discretion of the individual broadcaster.

MetEye

Another BoM product of relevance to mariners is the MetEye service (http://www.bom.gov.au/australia/meteye/). MetEye provides graphical forecast information on:

- Wind (in knots)
- Waves
- Temperature
- Storms, fog
- Rainfall
- UV

MetEye has national coverage including the coastal waters areas, and has the capacity for users to zoom into discrete areas on land or sea. Each forecast cell on the map is 6 km square, and forecasts are updated twice daily. The MetEye coverage map is shown below in Figure 21, as are screen shots of various MetEye overlays (Figs. 21 to 24).

MetEye has additional capacities which include, inter alia, the ability to zoom in to small regions in the view, to click on any point and get wind and wave information, or to search using map coordinates.

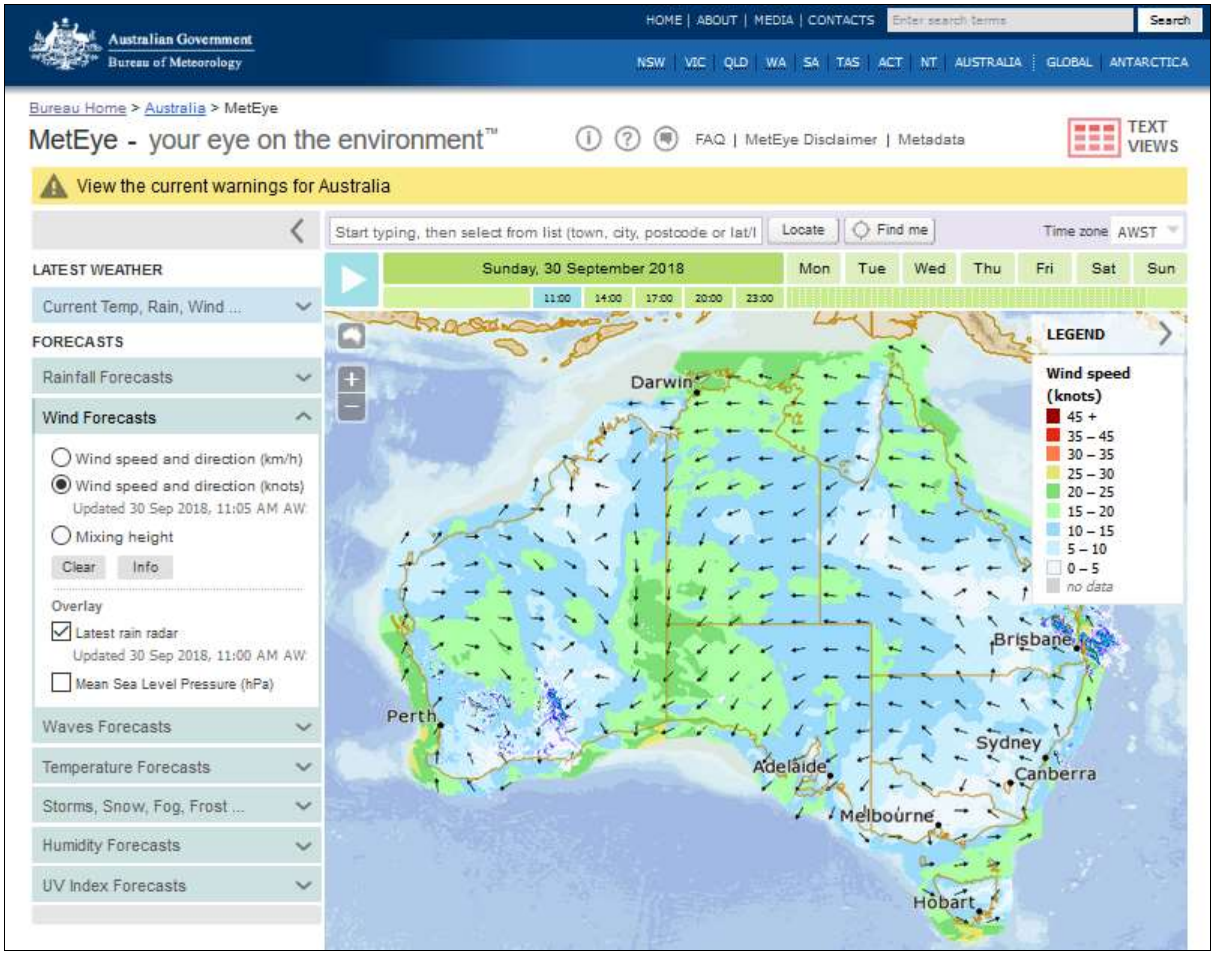

Figure 21. MetEye Coverage Map

Figure 22. MetEye Forecast by Location (user defined)

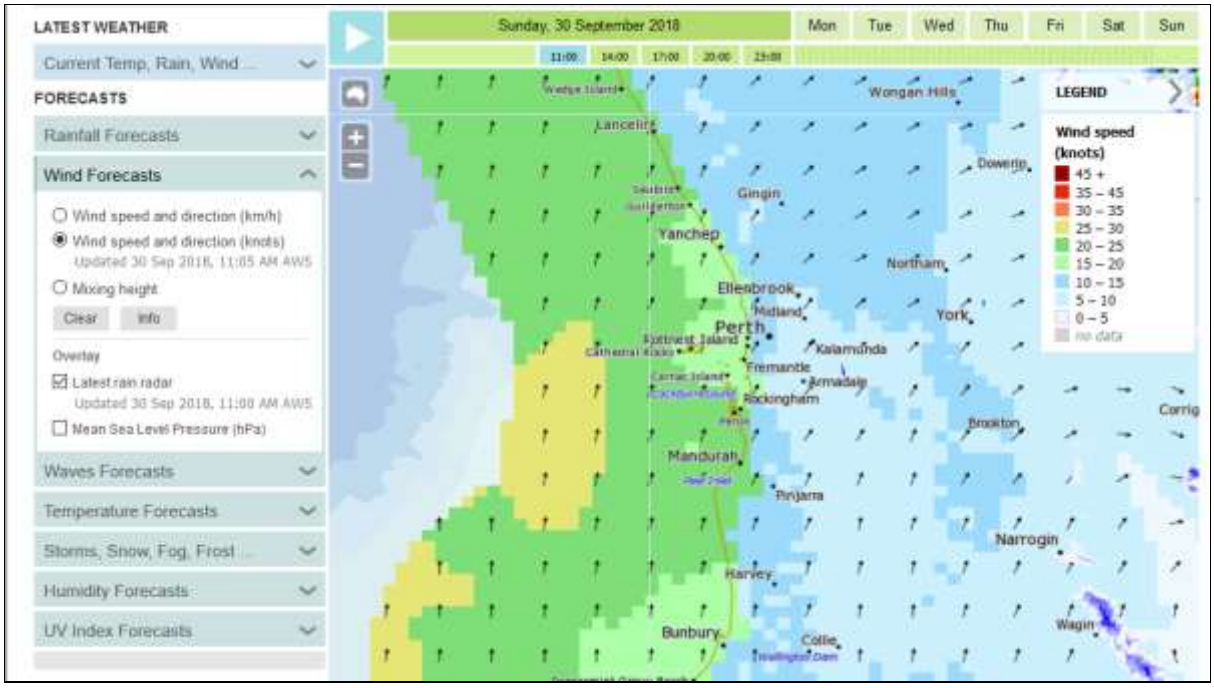

Figure 23. MetEye Wind Speed and Direction Forecast by Location (user defined)

Figure 24. MetEye Total Wave Height Forecast by Location (user defined)

Weather Apps

There are a number of free, or subscription based weather apps[2], which can be used on a computer, mobile phone or tablet. Weather apps typically draw data from a number of sources (including the BoM) and combine them often presenting the graphic output in a more commercial, or user friendly manner. Figure 25 shows data sets for the same time and location sourced from the BoM and a weather app.

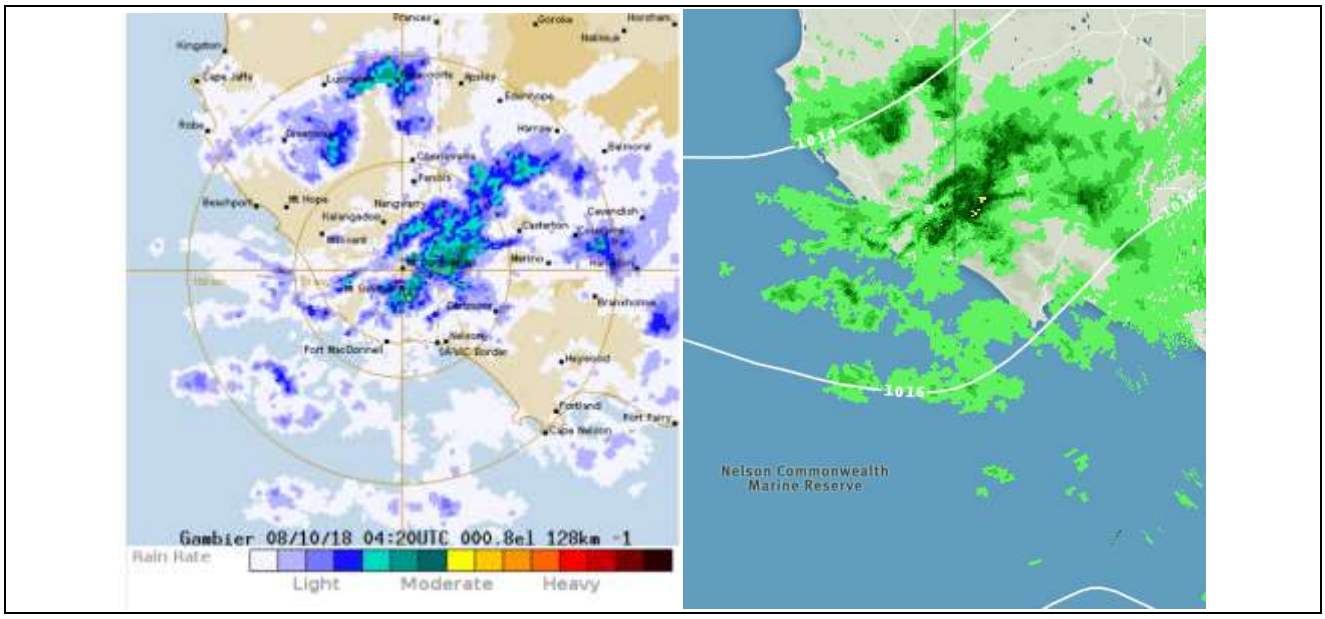

Figure 25. Rain Radar Comparison: BoM (L) and a Generic Weather App (R)

Weather apps are frequently reviewed in technology magazines and online forums. It is not unusual for weather apps with Australian coverage with better independent reviews to have sourced some of their data from the BoM. This is typically referenced in the app itself. It is important that mariners using weather apps to inform their voyage consider the source of the data. The BoM has its own weather app which can be seen at http://www.bom.gov.au/app/.

Weather apps may also source data from services such as the National Oceans and Atmospheric Administration (NOAA) in the US, and other national weather agencies. This allows them to have significantly more international coverage accessible from the one electronic portal.

While such apps have the ability to provide more global coverage at a single access point, they do not appear to provide additional analysis of the data they receive and show. That is, a weather app may make the information more accessible but it typically offers no higher resolution in forecast, and no higher accuracy.

[2] A number of weather apps were reviewed as part of this project. A decision was made not to name these because it is not possible to review all available products, and it is not the intention of this report to recommend one over the other, or over the services provided by the BoM.

Discussion

Figure 26 summarises the technical and maritime aspects of the various electronic platforms analysed above. The table does not include the BoM as this is a broad service and not a specific maritime communicating/communications platform.

System	Designed specifically for Emergency Signalling	Can be Used For Emergency Signalling	Monitored by Third Party	Linked to Formal SAR Authorities	Mandatory for Australian Fishing Fleet
EPIRB	Yes	Yes	Yes	Yes	Yes, for vessels operating >=12nm from land. From 2021 all fishing vessels >=12m operating beyond 2nm from land, and all fishing vessels <12m operating
PLB	Yes	Yes	Yes	Yes	Voluntary
GMDSS	Yes	Yes	Yes	Yes	Yes for vessels in survey operating beyond LCS areas of coverage. The equipment onboard varies
VMS	No	Depends on VMS configuration	Yes	Depends on inter agency agreement	Depends on fisheries regulation
AIS	No	No	AIS Data is available to AMSA, however: 1. It is not monitored, 2. It is not 'real time', 3. its integrity cannot be	AIS Data is available to AMSA, however: 1. It is not monitored, 2. It is not 'real time', 3. its integrity cannot be	No
Radio	No	Yes	Yes	Yes	VHF - Yes for vessels in survey; HF also required for vessels operating
Satellite Phone	No	Yes	Third party must be dialled	No	Yes, for vessels operating beyond LCS areas of coverage
Mobile phone	No	Yes	Third party must be dialled	No	Voluntary
Man Overboard (MOB) device	Requires visual monitoring onboard vessel	Requires visual monitoring onboard vessel	Requires visual monitoring onboard vessel	No	Voluntary
Satellite Emergency Notification Device (SEND)	Yes	Yes	Yes	Yes	Voluntary

Figure 26, Summary Matrix of Electronic platforms

The technical review leads to the conclusion that EPIRB is, and should remain the primary electronic platform upon which the Australian fishing industry should transmit distress signals. The EPIRB transmission frequency is monitored by a formal network of satellites and national SAR agencies under SOLAS. Distress signals are received are sent immediately to SAR agencies. Those agencies have their own SAR assets, and access to agencies and private sector organisations with assets which can be used in a SAR mission. The national agencies also have the expertise and formal structures to coordinate a SAR mission effectively.

The integrity of the EPIRB platform will be further strengthened as float free EPIRB are fitted to some vessels (https://www.amsa.gov.au/safety-navigation/distress-beacons/mandatory-float-free-epirbs), through the increased adoption of PLBs, and by the next generation of EPIRB that will also transmit on the AIS frequency.

The mandatory fitting of float free EPIRBs will not take effect until 1 January 2021. The gap between the implementation of the regulation and its execution reflects the fact that all relevant vessels will need to go through survey in the period and must be fitted with the float free unit to pass survey. There is no impediment to vessel owners having a float free EPIRB fitted to their vessels ahead of their next survey, thereby increasing the safety of themselves and their crews.

There are also a range of options for increasing the safety of individual fishers at sea with wearable, PLB, SEND and MOB systems. The effectiveness of PLB and SEND is greatly increased if the wearable beacon is tethered to the crew member thus preventing it floating away to a different location.

All MOB devices have GNSS capability and transmit latitude and longitude. Some MOB devices transmit on the AIS frequency which assists the parent vessel in localised searches. Other MOB devices that transmit on different frequencies such as VHF DSC, Mobile App. The dependability of the MOB systems relies on crew members wearing their MOB transmitter at all times when on deck.

The technical review noted users of SENDs may need to carry batteries which may need to be replaced at some time after activation and this is problematic if the crew member is in the water. It is also noted that a SEND may need to be re-activated after batteries have been changed.

Recommendation 1. It is recommended the Australian fishing industry and/or the entire maritime community develop a campaign raising awareness of the benefits of float free EPIRB and encourage vessel owners to install such units in a timely manner.

This campaign could also include highlighting the safety benefits to individual crew members available through PLB, SEND and MOB systems, and the limitations of each in using either as a distress signalling platform.

Some of those consulted had concerns a float free EPIRB may become entangled in the structure of a vessel should it overturn. This report cannot comment on the validity of such concerns but it is noted AMSA and EPIRB manufacturers are aware of these concerns. It is also noted that both parties are investigating the development of detailed installation instructions which would mitigate the chance of EPIRB entanglement in such cases.

Recommendation 2. It is recommended AMSA and manufacturers on float free EPIRBs continue developing detailed installation instructions to mitigate the probability of a float free EPIRB becoming entangled in the vessel's structure in the case of maritime emergencies such as a vessel overturning.

The effectiveness of the SAR agency's response to an EPIRB or PLB distress signal is strengthened by the ability to be able to attempt contact with the vessel, and to make contact with its shore based representatives. In many cases this will be the families of the crew. Contact details for the vessel and shore based representatives are recorded when the EPIRB or PLB is first

registered. These details can change over time as vessels are bought and sold, and as shore based representatives change location or phone details. As a result, it is imperative that EPIRB owners review and update the contact details for their beacon regularly. This can be done on the AMSA website at http://beacons.amsa.gov.au/registration/.

There is merit in the Australian fishing industry, and the wider maritime community, to develop and participate in an awareness campaign to this end. It is noted that agencies such as the Western Australian Department of Fire and Emergency Services (DFES) have a campaign to change smoke detector batteries on 1st April each year. This campaign not only raises awareness, it gives a focal date on which action should be taken. World Maritime Day is observed on the 26th September each year, which may make a suitable target date.

Recommendation 3. It is recommended the Australian fishing industry and or the wider maritime community develop a campaign nominating a specific date at which EPIRB or PLB owners should review and update the contact details registered against their beacon serial number.

Vessel and shore based contact details are also registered by fisheries management agencies when a VMS is registered to a fishing vessel. It is important that these too are kept up to date, especially if the loss of a VMS signal from a fishing vessel is to be forwarded to the relevant SAR agency for investigation and action.

Recommendation 4. It is recommended that the Australian fishing industry, AMSA, state and territory fisheries agencies, and AFMA work towards an annual risk based audit which correlates the contact details held by AMSA and the various fisheries management agencies for fishing vessels. It is not a recommendation of this report that the audit cover all vessels fitted with VMS and EPIRB every year. This recommendation will require the involvement of both AMSA and State and Commonwealth fisheries agencies and it is noted that legal privacy requirements may limit the exchange of such information between the two agencies.

Manually activated EPIRBs, water activated EPIRBs and wearable PLBs can all enhance safety at sea for the Australian fishing industry regardless of the installation of float free devices on vessels. It is feasible that not all crew may know the location of the vessel's EPIRBs or how to activate them.

Recommendation 5. It is recommended that the Australian fishing industry ensure that all crew on a vessel are formally made aware of the location and activation method of all EPIRB or PLB on board as part of their occupational health and safety (OHS) induction when they join the vessel. The same process should be undertaken for all passengers (scientists, observers etc.) who go to sea on a vessel.

Australian fisheries management agencies deploy VMS as a fisheries management tool, not a distress signalling platform. Mandatory VMS units must be "Type Approved" and most do not require VMS units with two-way communication, or distress signalling capacity.

VMS data is held in confidence between the licence holder and the fisheries agency. In most Australian cases the VMS data can only legally be shared by the fisheries agency with law enforcement agencies.

Most fisheries agencies which use VMS as a management tool stipulate it is a breach of fishing licence conditions to switch the VMS off without notification, whether at sea or in port. Notification is usually in writing in the form of a temporary switch off (TSO) declaration. TSOs are used in instances such as the vessel anchoring up after a fishing season or being taken out of the water for maintenance and repairs.

VMS on fishing boats are, however, sometimes turned off contra to fisheries management rules, presumably to mask activities they do not wish the management authorities to see. In some cases this activity can be presented by the fisher as an intermittent fault with the VMS coming back on line after a time. Some agencies react to suspicious fisher behaviour by mandating the installation of an authority owned, battery operated VMS unit and ordering the vessel owner to have their

private unit checked and/or repaired. Despite the capacity to mandate the installation of an agency owned VMS unit, the process of identification, installation of a temporary VMS and the repair of the private VMS could take some weeks. There are legitimate technical failures in VMS units which will result in the loss of signal.

Fisheries management authorities also note there can be multi-hour delays in receiving VMS information from the earth station relaying satellite signals. As a result of these factors, between 50 and 100 Australian fishing vessels can be “offline” on the mandatory VMS platform at any given point in time.

There may also be circumstances where a vessel is in distress but can still be transmitting a VMS signal. Two common scenarios are a ship fire, or a vessel running aground and beginning to break up. Some VMS have a short term battery backup for the ALC which means the VMS will keep transmitting even if the vessel loses power. The waterproofing on modern ALC also means they can still transmit for a period after being immersed in shallow seawater.

It is factors relating to the reliability of the VMS signal, and technical issues such as delays in receiving the signal which result in the professional view that VMS is not suitable as a primary distress signalling platform – consistent with the position of management and safety authorities.

Families interviewed as part of this project indicated they would rather have a false alarm, and be given notice to try and contact the vessel than to not be notified of the loss of a VMS signal. In the case of the *FV Returner*, families state they had sufficient knowledge of the fishing patterns of the boat to know roughly which area it would have been in, and were in contact with other fishing vessels in the area who could have verified or approximated the last known position of the boat, and would have voluntarily gone to the area in an attempt to make visual contact or initiate a search.

VMS may be able to play a secondary role in alerting authorities to a potential distress situation. There may be capacity for a formal interagency protocol between fisheries management agencies and SAR agencies under which the loss of VMS signal is passed on. The appropriate recipient of this information in the first instance is the state or territory police service. During consultation AMSA made the observation these agencies are the agency best positioned to triage the intelligence and determine a course of action. Triage may include, among others:

- Attempting to contact the vessel;
- Attempting to contact the shore based representatives of the vessel;
- Checking whether the vessel’s AIS is transmitting;
- Determining if other vessels are operating in the area (using AIS) and diverting them to the last known VMS position; and
- Alerting nearby sea rescue organisations.

The results of the triage process would then dictate whether the situation has been resolved or if a full SAR mission is required.

These issues associated with the use of VMS as a secondary platform in SAR, including suggested actions for fisheries management agencies when loss of a VMS signal is detected, and passing on information of the loss of VMS signal to agencies with triage and SAR capacity, were among those examined by the Western Australian and Queensland Coroners investigating the loss of the *FV Returner*, and *FV Dianne* and *FV Cassandra* restively.

The local police services were identified as the appropriate triage agency. The rationale was the police service are well placed to assess the appropriate response and have the skills to conduct a formal investigation. AMSA echoed these 2 points in stating the police services should be the lead agency in SAR evaluation and mission control.

Families and others consulted as part of this project expressed a desire for this process to be codified in a manner which set mandatory time frames for each stage of the notification and triage

processes. The agencies involved may then be bound to such timeframes under a standard operating procedure (SOP) or some other formal instrument. An example of how a time based protocol may function would be for a fisheries management agency to pass on the occurrence of four consecutive missed VMS polls to the relevant SAR authority, usually the state or territory police service.

Recommendation 6. It is recommended that Australian fisheries management agencies pass on information on the loss of a VMS signal, and the last known position to the relevant SAR authority under a formal protocol including timeframes for each action.

Not all fisheries management agencies monitor their VMS signals after hours, including weekends for staffing/resourcing reasons. This too was investigated in the abovementioned Coronial Inquest. This report has neither the scope, nor the information technology expertise to determine how a VMS system may be monitored remotely and therefore on a 24 hour, 7 day a week basis.

An option which may be available is an automated alarm system alerting the fisheries management agency to the loss of a VMS signal and transmitting that data to the relevant SAR authority. It is noted there may be IT, resourcing and regulatory issues which need to be addressed before such a system can be implemented.

Recommendation 7. It is recommended that Australian fisheries management agencies investigate mechanisms to automate an alert system which can notify the relevant officer of the loss of a VMS signal out of hours, and link the immediate actions to Recommendation 6.

Individuals and organisations can purchase and monitor their own VMS systems should they choose to, regardless of the regulatory requirements of the jurisdiction they operate in. This would allow shore based representatives of the vessel to monitor the signal from the vessel. ALC only VMS units cost approximately $1,300 with VMS with two way communication and distress signalling starting at approximately $7,500. It is likely this may be cost prohibitive as each private VMS operator would also need to carry the cost of their own satellite tracking.

A variation of this model is for the Australian fishing industry to establish an industry funded VMS platform and spread the single set of polling costs across all subscribers. As mentioned above, not all fishery management agencies monitor their VMS at all times, and not all take the loss of a VMS signal as a sign there is a vessel emergency. A private platform would need to have a management structure which accounted for these circumstances and perhaps one which may be held accountable if a vessel lost VMS signal, was in distress, but was not acted upon appropriately by staff. It is to be expected a private platform will generate false alarms caused by the loss of VMS signal from vessels not in distress for reasons reported above.

A third option for the private monitoring of a VMS signal is for the vessel owner to be able to access the fishery management agency's VMS platform for information on their vessel. This would require the vessel owner to purchase the necessary software to receive the VMS feed but there is the prospect they would not need to pay for satellite polling as the agency has absorbed the cost as part of their operations. Consultation with some VMS providers indicates that such an arrangement may be possible in the next year or two. The software cost to shore based representatives of the fishing vessel are not known at this stage.

Recommendation 8. It is recommended the Australian fishing industry investigate the formation of an industry funded VMS platform to operate on a subscriber basis to spread satellite polling costs. This recommendation is tempered by the fact vessels would need to purchase their own VMS units, and such a platform would need to be staffed and resourced and may be open to professional liability claims should it be promoted as a formal sea safety entity.

The Australian fishing industry should also continue to monitor the prospect of owners being able to access the fishery management agency's VMS signal for their vessel without paying for satellite monitoring costs, and to take advantage of such an outcome if or when it becomes available.

The use of AIS as a primary distress signalling platform is even more problematic than the use of VMS, as AIS can be switched off legally which further reduces the likelihood a loss of AIS is the result of a maritime emergency. AIS are also subject to the same electrical faults and potential earth station delays as VMS.

There is potential for AIS to play a role in sea safety for Australian fishing vessels in a wholly private capacity. Vessel skippers and shore based representatives could develop a protocol between themselves which could potentially differentiate between the loss of signal in an emergency situation, and the loss of signal due to manual shut down or technical issues such as earth station delays or electrical faults. Skippers could notify shore based representatives if they intend to switch the AIS off, at what time, and the approximate time they expect to switch it back on. Skippers could also notify shore based representatives if they are experiencing electrical problems on board, or if the AIS unit itself is malfunctioning. It is noted neither party would be able to determine an earth station delay.

Recommendation 9. It is recommended the Australian fishing industry develop an information package on protocols between vessels and shore based representatives which integrate AIS into sea safety initiatives with an emphasis on protocols to attempt to differentiate between a loss of signal as a result of a maritime emergency or due to manual switch off of the AIS, or a technical fault.

Australian fishing vessels are also equipped with radio communication equipment which may be formally linked into a GMDSS system in some cases. Some vessels are also equipped with email capacity or a mobile phone. While a vessel will have at least one trained radio operator, it is possible that this person may not be available in a maritime emergency. It is also not uncommon for deck crew to be unfamiliar with the full suite of electronics in a wheelhouse.

Recommendation 10. It is recommended the Australian fishing industry encourage its members to develop induction packages for their crew which include the location of radios, email facilities, satellite phones, and fixed mobile phones. The induction could also include knowledge of the monitored VHF digital selective calling (DSC) emergency channels on VHF radio, and that triple zero can be called from any Australian mobile phone if it is in range of any phone carrier. Induction should also involve crew members being informed of who the trained radio operators on-board are.

The BoM provides a number of services of use to mariners, and which can add to safety at sea through forecasts and warnings. These services are delivered through platforms including free to air television and radio, internet and mobile phone, scheduled radio broadcasts, and email via Inmarsat for vessels which have VMS with two way communication capacity. The services referred to are provided free of charge. Consultation conducted as part of this project indicates that knowledge of the full spectrum of services provided by the BoM may not be widely understood in the Australian fishing industry.

Consultation also revealed that knowledge of the precise definitions of the terminology used by the BoM is poorly understood by the Australian fishing industry. Examples of such precise definitions which apply to vessels at sea are shown below

It is clear from these examples that the sea safety implications for Australian fishing vessels at sea will vary depending on vessel size, distance from shore, and availability of shelter opportunities such as islands and harbours, and fishing method.

The full information package for the technical terms used by the BoM for marine forecasts and warnings can be found at http://www.bom.gov.au/marine/knowledge-centre/reference/waves.shtml and http://www.bom.gov.au/marine/knowledge-centre/reference/wind.shtml.

Recommendation 11. It is recommended the Australian fishing industry, in conjunction with the BoM, consider developing an information package on the various services offered by the BoM and the technical terms used by the BoM for marine forecasts and warnings. It is recommended this module be available to all crews and shore based representatives to enable them to be able to contribute to decision making if there are concerns with weather and sea conditions while at sea.

Australian fishing vessels should have a safety management system (SMS) which assesses risks to, and on the vessel. The SMS lays out the actions required, and responsibilities for responding to safety issues. Details and SMS templates can be found at https://www.amsa.gov.au/vessels-operators/domestic-commercial-vessels/how-develop-safety-management-system.

In addition, a range of data driven standard risk evaluation strategies exist in different industries. One such example is shown in Figure 27.

		Impact				
		Trivial	Minor	Moderate	Major	Extreme
Probability	Rare	Low	Low	Low	Medium	Medium
	Unlikely	Low	Low	Medium	Medium	Medium
	Moderate	Low	Medium	Medium	Medium	High
	Likely	Medium	Medium	Medium	High	High
	Very likely	Medium	Medium	High	High	High

Figure 27. Generic Risk Matrix. Source: Just Get PMP

For safety of a vessel at sea, the text in the coloured boxes can be replaced with wind, sea and swell conditions. The coloured outcomes could then be translated to actions such as:

- Green: Continue fishing
- Amber: Consult with crew and shore based representatives to determine a course of action
- Red: Immediately cease fishing and seek shelter

As mentioned above, such a risk matrix needs to be tailored to individual vessels, or comparable vessels operating in the same fishery using the same gear type.

The BoM has information to support including weather safety into a SMS (www.bom.gov.au/marine/knowledge-centre/reference/guidelines.shtml). This also includes considering the combination of risk factors, and encouraging mariners to take a multi-hazard approach.

The risk matrix above is not intended to replace a formal SMS as it applies only to weather conditions.

Recommendation 12. It is recommended the Australian fishing industry urge vessel operators and owners to develop a data driven risk based decision making matrix based on the definitions of BoM terminology and specific to the vessel size, area of operation, fishing gear etc. It is recommended that all crew on-board are made aware of the matrix and understand it.

The issue of vessels receiving notification of localised, rapidly deteriorating weather systems was raised by nearly all of the families consulted. Currently the BoM has a range of ways to distribute warnings to mariners, including over VHF and HF radio. The BoM also emphasises the importance of doing the 'five vital weather safety checks' before heading out, to reduce the chances of being caught out by rapidly deteriorating weather (see http://www.bom.gov.au/marine/knowledge-centre/hazards.shtml).

An option is “push messaging” where such alerts could be broadcast through the mobile phone towers in the affected area. This system is commonly used by emergency services in cases of

natural disasters such as bushfires and floods. It is also used by police services where a localised and common threat exists. An example could be the know location of an armed fugitive.

It is noted that push messaging via mobile phone towers would only be of benefit to vessels at sea within mobile phone range, and that the warning would also be delivered to all mobile phone users on land within the broadcast range. These factors may make push messaging impractical for sea safety within the Australian fishing industry.

Consultation carried out during this project revealed both the BoM and AMSA continuously seek new methods of conveying safety information to the Australian fishing industry, including as technologies advance and support the provision of real-time weather information, and information at a more local scale. AMSA also has an existing consultation framework to work directly with the industry.

Recommendation 13. It is recommended the Australian fishing industry continue to work with AMSA and the BoM in designing a system of determining and transmitting information on rapidly deteriorating, localised weather events.

The "culture of safety", or lack thereof was raised by nearly all of the families and friends consulted as part of this project. Several noted that industries such as mining and construction which have previously been considered high risk have developed substantial safety measures over the past 20 to 30 years while the fishing industry has not. Factors which are seen as contributing to less than optimum safety at sea for the industry include crews ignoring levels of risk, insufficient training for crews, exclusion of crews from the decision making processes of skippers, and profit driven motivation which results in fishing continuing in marginal or unsafe sea conditions. This list is not intended to be comprehensive.

On a more specific level, some commentators noticed individual fisheries, and/or individual fishing methods pose unique safety issues. Examples may include a demersal trawler "pinning up" on the ocean floor in marginal weather, large live sharks or sea snakes regularly being brought on-board as bycatch, the need to fish close to reefs and rocks, or the use of very small vessels.

This project does not have scope to comment on the generic issue of the culture of safety within the Australian fishing industry but the topic is covered by FRDC project 2017-046 *"What's stopping you from protecting yourself and your mates? Identifying barriers to the adoption of safe work practises in the small-scale wild catch commercial fishing industry"* http://frdc.com.au/project/2017-046. This report does, however, note maintaining safety at sea requires a multi-faceted and complex system.

The issue of unique threats to safety which are fishery specific, or area specific can be addressed by this project. FRDC's SeSAFE initiative (FRDC project 2017-194 "*SeSAFE - delivering industry safety through electronic learning*" http://frdc.com.au/project/2017-194.

The SeSAFE platform is well suited to individualised training modules which can address localised safety issues such as those noted above.

Recommendation 14. It is recommended the Australian fishing industry promote a positive safety culture within the industry. The use of SeSAFE modules can address fishery or area specific safety issues and these modules be made available as part of the normal induction and training packages for crew.

Conclusion

The formal objectives of this project were to:

1. To identify an electronic platform which can accurately and automatically receive a signal from Australian fishing vessels wherever they operate to determine in a timely manner if the vessel is still able to receive and transmit a signal
2. To determine a protocol for timely action if a signal has been deemed to be lost
3. To identify an electronic platform which can alert skippers of heightened risks from fast developing, or fast changing weather and sea conditions
4. To make recommendations for the integration of these platforms into regulation through Australian maritime and fisheries jurisdictions

Sitting above the objectives is the observation from AMSA and AFMA that EPIRBs should remain the primary platform for the broadcast of maritime distress signals. The EPIRB transmission frequency is monitored by satellite and forms part of a formal global network of official SAR organisations who are best placed to triage distress signals and act on them accordingly. In the context of the Australian fishing industry, the functionality and reliability of the EPIRB platform has been strengthened by the introduction of float free EPIRBs on some survey classes of vessels, and the knowledge that the next generation of EPIRB will also transmit on the AIS frequency.

Objective 1. To identify an electronic platform which can accurately and automatically receive a signal from Australian fishing vessels wherever they operate to determine in a timely manner if the vessel is still able to receive and transmit a signal

The issue of the loss of an electronic signal from an Australian fishing vessel has previously been examined by the Western Australian and Queensland Coroner's Courts and is revisited by this report. This report has found the use of the VMS signal as a "second tier" or "corroborative evidence" system for alerting authorities to vessels which may be in distress has regulatory and technical advantages over the AIS as the former has regulations in place to prohibit vessel operators from manually switching the system off.

The report notes, however, that there are some aspects of VMS which add uncertainty into any triage procedure for determining if a vessel is in distress. These include:

- Not all VMS units are fitted with distress signalling capability, nor do all VMS have two-way communication capacity;
- Not all fisheries management agencies monitor VMS outside normal business hours as VMS is viewed as a fisheries compliance tool, not an emergency signalling platform;
- There can be delays from the service provider's reporting of an active signal due to issues at their earth station. In some cases, these delays can be several hours;
- Some fishers illegally switch their VMS off at sea;
- A vessel can still be transmitting a VMS signal if it is in distress in instances such as ship board fires or explosions, or if it has run aground and is breaking up; and
- VMS are prone to the same technical malfunction/electrical issues that affect all on-board electrical systems.

Notwithstanding these observations, this report finds VMS would be a beneficial method of utilising an existing maritime electronic platform to enhance safety at sea for the Australian fishing industry.

Both this report and that from the Western Australian Coroner's Court found that the transmission of the loss of a VMS signal and the last known location of the vessel to the SAR authorities in timely manner should occur. The Western Australian Coroner's Court recommended the

information be passed onto the Western Australian Police Service on the basis they are best equipped to triage the information and launch a SAR mission. This report found the transmission of such information should also be directed to AMSA's RCC for the same reasons, but also noting AMSA have national jurisdiction and are the formal SAR agency for Australia.

The report also examined PLB, SEND and MOB systems as electronic platforms which may have the capacity to increase sea safety for the Australian fishing fleet. The report found that while each of these devices increase the sea safety of individuals on-board, they do not add to the safety of the vessel as a whole. It is noted PLB transmit on the same frequency as EPIRB and are thus monitored under the formal international safety at sea systems. Both MOB and SEND transmit to satellite but both require the owner to maintain a subscription with a satellite carrier.

Objective 2. To determine a protocol for timely action if a signal has been deemed to be lost

There can be no doubt that having a formal protocol for the triage the information relating to the loss of an electronic signal from an Australian fishing vessel, and one which included timeframes for the various responses to new intelligence would greatly enhance the effectiveness of using VMS as a "second tier" or "corroborative evidence" mechanism to increase safety at sea for Australian fishing vessels.

Some Australian fisheries management agencies do have protocols in place to pass on VMS information within a specific timeframe. AMSA is Australia's formal SAR organisation and is best placed to develop timeframe based triage protocols. The articulation of such protocols is beyond the scope of this report. AMSA also has existing mechanisms for consultation with the Australian fishing industry, and a willingness to work with fisheries management agencies to develop such a time based triage system.

Objective 3. To identify an electronic platform which can alert skippers of heightened risks from fast developing, or fast changing weather and sea conditions

The current process used by the BoM is to provide forecasts and warnings for broad scale coastal waters areas, based on average wind and wave conditions for that area. It is unlikely a system for alerting vessels to localised and rapidly deteriorating weather conditions would function adequately under these criteria. It is noted that services such as the BoM's MetEye system provide much more localised information, but this service may not be appropriate for all vessels at sea given it is a web based platform.

The BoM has indicated a willingness to continue working with the Australian fishing industry on such new communication systems for the fishing industry.

Objective 4. To make recommendations for the integration of these platforms into regulation through Australian maritime and fisheries jurisdictions

The fisheries management agencies consulted have indicated a willingness to work with AMSA and the Australian fishing industry on the issues raised in this report, as have BoM. The fisheries management agency in Western Australia demonstrated its willingness to act on such initiatives well before the recommendation was made by the Western Australian Coroner's Court.

The principle initiative to be codified in policy, practice or procedure is for fisheries management agencies to pass on information of the loss of VMS signal and the last known location of the vessel to the relevant SAR agency, usually the state or territory police service. Formal SAR agencies are best placed to develop a formal triage process to handle this information, and are best placed to

determine criteria such as the timeframe for actions to take place, and using additional intelligence gained in the triage process to either resolve or escalate the situation.

While drafting such a protocol is beyond the scope of this report, the development of a triage process with associated timeframes for actions is one of its recommendations.

There are a number of agencies which routinely record the contact details for vessels and shore based representatives. These include records taken during the registering of:

- Fishing concessions;
- VMS units;
- Fishing vessels; and
- EPIRB(s).

It is noted such details can become out of date and the report makes recommendations on how this may be managed. A risk based audit across the various sources of contact details would be of assistance to SAR agencies.

Other

The report has made 14 recommendations but some of these may not transition easily into government policy, practice or procedure. Recommendations made directly to industry are less encumbered by formal policy constraints. Some of the recommendations are directed at the Australian fishing industry as a whole as they have universal application. Some involve the industry working “upwards” with relevant government agencies and others working “downward” with individual fishers, industry associations or peak bodies.

The report also makes recommendations on how information which can increase safety at sea in the Australian fishing industry, can be transmitted electronically to the Australian fishing industry and which exists in the public domain can be synthesised into existing training programs such as SeSAFE or into crew safety and induction training by the industry.

Besides considering the use of electronic platforms to increase safety at sea for the Australian fishing industry, the report emphasises that maintaining safety at sea is complex and all encompassing.

Safety is, quite literally, everyone’s business.

Implications

The implications from the report's findings include (among others):

- There are a number of recommendations which will require liaison between the Australian fishing industry and government agencies. Some of these agencies already have formal consultation bodies designed specifically to work with the industry;
- There are a number of recommendations which are aimed solely at industry. These recommendations can be taken up as initiatives "for industry, by industry"
- There seem to be no significant impediments to achieving substantial progress on the findings of the report.

Extension and Adoption

Before its release, this report was circulated for comment to the:

- Commonwealth government agencies consulted;
- Families of those who worked to get this project approved;
- Peak fishing industry associations in each state and territory;
- Principal Investigator of the FRDC SeSAFE initiative (FRDC project 2017-194 "*SeSAFE - delivering industry safety through electronic learning*" http://frdc.com.au/project/2017-194
- A small number of fleet managers in industry

Peak fishing industry associations in each State and Territory were asked to canvass the appropriate staff member in their organisation and, where possible, their members for their views and comments. These have been considered and included where appropriate.

The implementation of the Recommendations can proceed with little to no additional extra funding. This largely involves the Australian fishing industry working within existing government consultation structures, and developing initiatives at the State and Territory level, or the national level via existing peak fishing industry bodies.

There would be merit in each of the government agencies, and the industry bodies to circulate print/internet media stories based on the sections of the report relevant to their activities.

Project coverage

This project has direct relevance to the:

- Australian fishing industry;
- Commonwealth, State and Territory government agencies which respond to maritime distress signals and mount search and rescue operations;
- Providers of safety and emergency technology;
- Recreational anglers and all who go to sea in Australian waters.