



# **RV** *Investigator* Voyage Scientific Highlights and Summary

Voyage #:	IN2019_V07			
Voyage title:	RAN Hydrographic and Maritime Heritage Surveys			
Mobilisation:	Hobart, Wednesday, 10 April 2019			
Depart:	Hobart, 0800 Thursday, 11 April 2019			
Return:	Hobart, 0800 Tuesday, 23 A	April 2019		
Demobilisation:	Hobart, Tuesday, 23 April 2	:019		
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# **Scientific Highlights**

## The Chief Scientist

Emily Jateff is a maritime archaeologist and the Curator of Ocean Science and Technology at the Australian National Maritime Museum. She has over 17 years of experience in investigation of predominately eighteenth to twentieth century historic shipwreck sites, aircraft and other submerged sites located in Australian, North American and International waters.



## <u>Title</u>

RAN Hydrographic and Maritime Heritage Surveys

## **Purpose**

The voyage comprised four projects with the following objectives:

- 1. Undertake mapping of historic shipwreck sites, in partnership with Heritage Victoria and the Australian National Maritime Museum.
- 2. Conduct a modern survey in the primary shipping route through Bass Strait for the Australian Hydrographic Office (AHO).
- 3. Train Marine National Facility Operations and Engineering and Technology (E&T) Team personnel in several routine and new underway and deployed systems.
- 4. Collect data to quantify the variability in the distribution and abundance of seabirds in the marine environment around Australia.

## **Contribution to the nation**

The Australian National Maritime Museum conducted maritime heritage survey activities on board this voyage in collaboration with Heritage Victoria. These surveys sought to locate, identify and image a series of high priority shipwreck sites in Victorian waters.

We imaged the sites of SS *Queensland* and SS *Federal* with on board multibeam systems and deployed the 6000m rated drop camera for collection of video and still imagery. We streamed live drop camera footage of SS *Queensland* in Beagle Marine Park to the public, creating deeper

connections between the public and our underwater heritage. Multibeam and drop camera surveys at locations provided by Heritage Victoria refined the location of SS *Federal,* imaged the site of SS *Vicky* and one new feature (coordinates undisclosed) that will be further investigated by Heritage Victoria and the Maritime Archaeological Association of Victoria (MAAV).

An additional multibeam survey in a 3x5nm area projected to be the location of the vessel SS *Iron Crown* was successful in locating that site on 15 April 2019. SS *Iron Crown* was an Australian merchant vessel built at Government Dockyard at Williamstown, Victoria in 1922. It was a steel screw steamer of the Merchant Navy transporting manganese ore and iron ore from Whyalla to Newcastle when it was sighted and torpedoed by a Japanese Imperial submarine on 4 June 1942. Survivor accounts state that the torpedo struck the vessel on the port side abaft the bridge. It broke its back and sunk within minutes. Thirty-eight of 43 crew went down with the ship.

The location of SS *Iron Crown* is significant as one of four World War II losses in Victorian waters (including HMAS *Goorangai* lost in a collision, SS *Cambridge* and MV *City of Rayville* lost to mines). It was the only vessel that was torpedoed. It is representative of vessels lost to enemy action in Victorian waters during World War II and highlights the significance of the Merchant Navy's role in the transport of vital supplies during World War II, and casualty as result of enemy action.

The *Historic Shipwrecks Act* 1976 provides legislative protection for all shipwrecks in Australian waters over 75 years of age on behalf of the Australian public. Survey for and location of historic shipwreck sites contributes to their ongoing supervision and preservation by state and federal agencies. We imaged four sites (SS *Queensland, SS Vicky, SS Federal and SS Iron Crown*) on this voyage and provided all data to the state agency for use in site management.

## As a result of this voyage

- 1. We have a better understanding of how best to conduct shipwreck surveys on board RV *Investigator*.
- 2. We have found one significant shipwreck site (SS Iron Crown).
- 3. We have mapped three additional shipwreck sites (SS *Queensland*, SS *Vicky* and SS *Federal*) and conducted surveys within four planned survey blocks.
- 4. We have commenced a program of research and analyzation of results of the voyage for including publication in the *Conversation* (April 2019) and the Australian National Maritime Museum's magazine *Signals* (September 2019) and presentation of results at the Australasian Institute of Maritime Archaeology Conference in Brisbane, October 2019. The museum is cohosting a memorial service for the descendants of the SS *Iron Crown* at the Shrine of Remembrance in Melbourne in September 2019.
- 5. Completion of the remaining mapping of AHO Area A outstanding from RV *Investigator* voyage IN2018\_C01, to IHO Order 1a standards. This represents the completion of the first survey of this area using modern equipment and further improves confidence for the safe navigation of international and coastal shipping in Bass Strait.
- 6. A total of 33 species of seabird and 6 species of cetaceans and seals were recorded, expanding the dataset available for the Bass Strait region.

## **Voyage Summary**

## **Objectives and brief narrative of voyage**

This voyage consisted of two primary projects: the multibeam investigation of several maritime heritage sites off the coastline of Victoria, and the completion of an AHO survey within the Bass Strait. In addition, there were a number of other projects taking place during this voyage, including mapping within the Beagle Marine Park, collection of samples as part of the Australian Microbiome (AM) Initiative, seabird and marine mammal observations and training of Marine National Facility (MNF) personnel in several routine and new systems on board.

All of the primary objectives were achieved, with four maritime heritage sites being identified and surveyed and the remaining AHO area being mapped in its entirety. Additional mapping was undertaken within the Beagle Marine Park, several samples were collected as part of the AM Initiative and existing datasets on seabirds and marine mammals within the Bass Strait region were expanded. Several new Marine National Facility personnel were also provided with training in various ship systems and operations.

## **Scientific objectives**

1) To undertake mapping of historic shipwreck sites, in partnership with Heritage Victoria and the Australian National Maritime Museum. GSM and drop camera imaging provide data on current composition, position and stability of important historic shipwreck sites, which is essential for research, management and public reporting.

The primary activity of the GSM investigation of historic shipwreck sites is to conduct surveys of the purported site of SS *Federal*, to provide positive identification of the site and ensure its protection in future. This is supplemented by opportunistic deployments of the drop camera (supported by SIT). The discovery of shipwreck SS *Federal* was reported to Heritage Victoria by sport divers in 2012. Accurate location of SS *Federal* is a priority for Heritage Victoria in order to ensure adequate preservation and protection of this historic site into the future, in accordance with relevant heritage shipwreck protective legislation.

Activities also include opportunistic survey of five 'unidentified targets' in the vicinity of the AHO mapping area and the search area for SS *Federal*. Aims are to positively identify these sites as cultural heritage targets (shipwrecks) via GSM and drop camera investigation.

2) Conduct a modern survey in the primary shipping route through Bass Strait for the Australian Hydrographic Office (AHO). This survey will facilitate safe navigation for international and coastal shipping and improve confidence for subsurface navigation in Bass Strait.

3) Training of Marine National Facility Operations and Support Team personnel in several routine and new underway and deployed systems, including:

- Multibeam patch test calibrations and backscatter calibration lines.
- Commissioning and trialling of new Brenke sled, Seaspy magnetometer (ahead of IN2019\_V04) and RapidCAST SVP.
- Triaxus, CTD casts, multicorer, Smith Mac grab.

4) Seabird and marine mammal observations (Dr Eric Woehler, University of Tasmania):

This project will collect data to quantify the variability in the distribution and abundance of seabirds in the marine environment around Australia. The project will examine the relationships between physical oceanographic features and their use as seabird feeding areas.

The study also seeks to identify species assemblages, or associations, in the species of seabirds observed that are persistent over time. The project will collect new data for seabirds around Australia, for which there are very few (and in many cases, nil) data. The project will use standard survey methods to ensure compatibility with existing data sets for the same species in other areas.

Observations of marine mammals will also be shared with researchers to facilitate greater understanding of the role of oceanographic processes in the spatial and temporal distribution of marine mammals at sea around Australia.

The project will also provide a context to current research efforts tracking seabirds and marine mammals, which are often constrained to a relatively low number of instrumented individuals relative to the population as a whole.

## Voyage objectives

Listed below are the voyage objectives for both the survey and training components of the voyage, in order of priority:

#### 1) Historic Shipwreck Surveys

Conduct surveys of the purported site of SS *Federal* and opportunistic survey of five unidentified targets. In line with standard practice for historic shipwreck sites, location information for survey areas is not included in this report and is available at the discretion of Heritage Victoria, the state agency responsible for site management.

- Multibeam survey of SS Federal
- Multibeam survey of five unidentified targets (UID 2-6)
- Potential multibeam survey of two additional located targets (*Carlisle* and SS *Glenelg*) was not conducted.
- Multibeam survey of SS *Queensland*, which doubles as a multibeam calibration target.
- Approximate hours available for survey areas to be identified by GSM.
- Actual line plans for the search areas will be plotted while on board, taking into consideration prevailing weather conditions.
- Includes opportunistic deployment of the drop camera, in the event that a shipwreck is located and conditions are suitable.
- Drop camera deployment to be prioritised for SS *Federal* site, where possible. At least **two hours** for drop camera deployment is preferred to enable maximum image coverage. Full image coverage of the site would allow production of a photogrammetric site plan.

#### 2) AHO Survey of Bass Strait

- Completion of mapping of Sub Area A within Bass Strait (outstanding from IN2018\_C01): ~24 hours using EM710.
- The survey was conducted according to the GSM Hydrographic Survey Procedure (included as Appendix C with the Voyage Plan) for the original survey. This procedure is current for the

completion of the survey being undertaken on this voyage, apart from the following variations:

- The Kongsberg EM710-MK2 Multibeam Echosounder (MBES) will be used to complete the survey, instead of the Kongsberg EM2040c (Dual Head) Multibeam Echosounder (MBES) used for the original survey during IN2018\_C01.
- The survey area differs in that it includes only the portion of Sub Area A which was left incomplete during the IN2018\_C01 voyage (see Figure 1). As such, timings will vary from the original procedure.
- Sediment sampling using the Smith Mac grab will not occur during this survey.
- The Survey Instruction (SI003) is as Appendix D with the Voyage Plan.



Figure 1: AHO Survey Area A. The hollow section contained within the pink polygon (in the SE corner) is the section to be mapped during IN2019 V07 (SI003).

#### 3) Training and Equipment Trialling

MNF Data Acquisition and Processing (DAP) and Seagoing Instrumentation (SIT) teams:

- CTD casts including hydrochemistry analysis. Test altimeter operation during very shallow (~80m) CTD cast (conduct in area with existing bathymetry data).
- Triaxus tows.
- Operation of ADCPs.
- Drop camera deployment (potentially at located shipwreck sites).

MNF Geophysical Survey and Mapping (GSM) team:

- Multibeam patch test calibrations: one in shallow water and one in deep water; approximately 6 hours required for each.
- Multibeam backscatter calibration lines: conduct during transit into and out of Storm Bay.

- Deployment of RapidCAST SVP and development of associated Standard Operating Procedures (SOPs) for its use: can occur while underway (at a slightly reduced speed).
- Trialling of new Seaspy magnetometer prior to IN2019\_V04: each deployment will occur by hand during daylight hours, take approximately 30-45 mins and can occur while underway (at a slightly reduced speed). Includes the following:
  - Comparison of data quality across a range of towing speeds, from low speeds to maximum speed.
  - Assessment of whether magnetometer can be deployed concurrently with other towed equipment e.g. Triaxus.

MNF Field Operations (FO) team:

- Trialling of the new Brenke sled system.
- Training of new personnel in the deployment of other equipment, including the multicorer and possibly, the Smith Mac grab.

MNF Hydrochemistry team:

• CTD casts including hydrochemistry analysis. At least 3-5 shallow CTDs and 3-5 CTDs conducted at depths of >3000 m, with a maximum of 2 CTDs per 24 hours.

MNF Ship Management Group:

• Training of new personnel in the Voyage Manager role and general vessel operations.

#### 4) Seabird and Marine Mammal Observations

#### Equipment and operations

Seabird at sea data will be collected according to the method described by the BIOMASS Working Party on Bird Ecology. This method has been used by Australian Antarctic Division (AAD) personnel since 1980/81 and reflects the standard protocol for obtaining seabird at sea data.

Observations will be made continuously while the vessel is underway during daylight hours from the specifically designed Observation Deck on board *Investigator*.

Briefly, all seabirds within a 300 m forward quadrant will be recorded, with details of their ages (where identifiable) and behaviours (such as feeding, sitting on water etc.). By using standard methods, the data collected on these voyages will be able to be integrated with other datasets collected adjacent with, or in overlapping areas (e.g. Australian Antarctic Division surveys 1980/81 onwards).

Observations of marine mammals are also included (in the absence of dedicated marine mammal observers) using standard protocols. Observation of marine debris are also recorded.

Data will be entered in real time on laptops connected to the ship's oceanographic and GPS system to automatically record abiotic and biotic data alongside seabird observational records. Standardised methods of data collection ensure continuity and compatibility with extant data for the same species elsewhere and with similar studies of other species.

No equipment is required, apart from access to the Observation Deck on Level 7.

#### Areas of interest

The seabird observation program is passive and has no influence on the ship track.

#### Timing

The observation program is undertaken continuously during daylight hours from *Investigator*.

## **Piggy-back projects**

#### Australian Microbiome (AM) Initiative Sampling and Filtering

The Australian Microbiome (AM) Initiative is a continental-scale, collaborative project aspiring to characterise the diversity and ecosystem service provision of the microorganisms inhabiting natural Australian ecosystems. The mission of the AM Initiative is to develop a comprehensive, publicly-accessible database of microbial diversity across a geographically expansive and diverse range of Australian terrestrial and aquatic ecosystems. In terms of pelagic ecosystems, the Project aims to make these observations at long-term temporal scales (IMOS NRS; repeated voyage transects) and large spatial scales (voyages). The data provide a crucial spatial and temporal scaffold for understanding Australian marine microbiology which in turn underpins long term observations on the status and trends of oceanic health, biogeochemistry and primary productivity.

Details on the AM Initiative can be found here: https://www.australianmicrobiome.com/.

The scientific objectives of the AM Initiative are to expand our existing spatial coverage of voyage samples for genomics analysis from the oceans surrounding Australia. For IN2019\_V07, the primary objective was to trial/demonstrate the ability to incorporate this type of water filtering for genomics samples on a more routine basis utilising the existing capability on board the *Investigator*.

#### **Beagle Marine Park Mapping**

During the voyage, the MNF received an additional request from Neville Barrett of IMAS (on behalf of Parks Australia), for some opportunistic mapping to be undertaken in Beagle Marine Park. As this was not part of the primary scientific objectives and the voyage plan, it was not prioritised until the primary scientific objectives were fulfilled. Two 5 x 5 km<sup>2</sup> areas of seabed were proposed to be surveyed by multibeam sonar within the Beagle Marine Park. This survey component was intended to compliment a recent survey of this marine park by the NESP Marine Biodiversity Hub that uses a spatially-balanced sub-sampling design to understand the nature and extent of seabed habitats within the park. Prior to these surveys, very little was known around the extent of seabed habitats within the park. As it would take several months to fully map the park, a sub-sampling approach was taken instead, to be able to infer the overall extent and distribution of habitats based on a spatiallybalanced sampling design, without the need and expense of fully mapping the park. The 2018 Hub survey completed approximately 14 of these 5 x 5 km sample sites, out of an optimal target of 20. Remaining sites were prioritised for completion during the IN2019\_V07 voyage, if time allowed.

## **Results**

#### 1) Historic Shipwreck Surveys

The site of SS *Queensland* (depth 57 m) was selected by the GSM team as a multibeam calibration target. CSIRO Communications and the Australian National Maritime Museum, in consultation with

Heritage Victoria, scoped this as an opportunity to use the on board drop camera to stream live footage of the site to the public via social media. This research was conducted under permit from Parks Australia (permit no. PA2019-00036) for approved use of the drop camera within Beagle Marine Park.

#### Dimensions: L: 99m x B: 11m x D: 7.62m

SS *Queensland* was an iron screw steamship of 2263 tons gross with three masts and an inverted compound steam engine built in 1875 by Palmers Co. Ltd of Newcastle, UK, owned by E and A.M.S. Company and employed on the Australia to China tea trade. It was on route from Melbourne to Sydney (and from thence to Foo Chow, China), when it was hit midships 15 nm NE of Wilson's Promontory by SS *Barrabool* and sank on 3 August 1876. Passengers and crew were loaded into lifeboats and onto *Barrabool*, which limped to shore. The Marine Board of Inquiry found that the second mate of *Barrabool* was negligent and cancelled his certificate.

SS *Queensland* was located in 2005 by Southern Ocean Exploration (SOE) and its location provided to Heritage Victoria. It was dived in 2010 and a site plan prepared by James Parkinson.

Investigation of MBES and drop camera footage recovered from the site of SS *Queensland* demonstrate no significant difference in site composition from the site plan drawn in 2010. Two masts, engine and anchor sighted on drop camera footage and collapsed hull structure were noted to be in a similar position as seen in 2010. As footage was collected in a single line from E-W, not enough data was collected to determine if loose objects have been removed from the site at this time.

Connecting the public to historic submerged heritage is a significant aspect of maritime archaeological research. Live streaming of drop camera footage from the site of SS *Queensland* in Beagle Marine Park directly connected ongoing field research to online platforms for real-time public engagement with submerged heritage.



Figure 2: MBES image of SS *Queensland*, as surveyed on 13 April 2019, by Craig Davey and Phil van den Bossche, GSM team on board RV *Investigator*. Courtesy CSIRO/Marine National Facility.

Survey for the SS *Federal* was a priority of the maritime heritage survey project. An avocational diving group initially located SS *Federal* in 2012, with some video footage of the dive available on the internet. Unfortunately, a precise location for the site had not yet been provided to Heritage Victoria. This survey provided a precise site location, multibeam sonar and drop camera imagery to Heritage Victoria to assist in ongoing management of the site.



Figure 3: MBES image of SS *Federal* as surveyed on 15 April 2019, by Craig Davey and Phil van den Bossche, GSM team on board RV *Investigator*. Courtesy CSIRO/Marine National Facility.

Collier SS *Federal* was on a run from Port Kembla to Albany when it was lost in a storm on the 21 March 1901, carrying 3,486 T coal. The lighthouse keeper on Gabo Island said that SS *Federal* passed so close to shore that he could have 'tossed a biscuit into her". In defiance of regulations it continued to hug the coast with indications that it went far off the recommended SW course, and came to grief on submerged rocks during a storm with full loss of life.

A Marine Court of Inquiry was held into the loss of the SS *Federal* but it was unable to come to any conclusion. Some of the bodies recovered were in lifeboats and wearing life belts, so it was apparent that the crew had time to prepare to abandon ship and many made it ashore before expiring. Even though the wreck was known to have happened by 23 March, a ship was not sent out to look for bodies until 2 April. After the SS *Federal* disaster, Everard Lighthouse was upgraded to a recognised signalling station capable of communicating with ships and other stations, including Gabo Island.

The SS *Federal* is sitting at an angle perched on top of a 6 m deep scour (vessel is located in tidal flow within Bass Strait). The site is quite broken up, with the stern smashed, although bow not sighted, hull plate on starboard side beginning to fall into scour. Drop camera and GoPro footage collected from the site will be used to identify if there has been any noticeable change in the overall composition of the site since it was first imaged in 2012.

The search for the SS *Iron Crown* was an opportunity to test blue water research vessel *Investigator*'s capabilities to locate and identify shipwrecks in deeper waters. At this water depth, we were operating at the mid-upper extent of the MBES system (<1000 m) so it provided a perfect test case for locating and imaging sites in deeper waters. It also provided an excellent opportunity to put the drop camera in the water and test its feasibility in deeper waters for imaging submerged sites.

The SS *Iron Crown* is significant as a Merchant Navy vessel operating in Australian waters during World War II. Heritage Victoria and the Maritime Archaeological Association of Victoria (MAAV) list the SS *Iron Crown* as one of the 'top 20 undiscovered shipwrecks in Victoria'.



Figure 4: MBES image of SS *Iron Crown* as surveyed on 16 April 2019, by Craig Davey and Phil van den Bossche, GSM team on board RV *Investigator*. Courtesy CSIRO/Marine National Facility.

SS *Iron Crown* was an Australian merchant vessel built at Government Dockyard at Williamstown, Victoria in 1922. It was a steel screw steamer of the Merchant Navy transporting manganese ore and iron ore from Whyalla to Newcastle when it was sighted and torpedoed by a Japanese Imperial submarine on 4 June 1942. Survivor accounts state that the torpedo struck the vessel on the port side abaft the bridge. It broke its back and sunk within minutes. With no time to deploy lifeboats, thirty-eight of 43 crew went down with the ship.

The SS *Iron Crown* sank quickly—with one account stating within five minutes—and as such, some sections of the vessel, such as the bow, retain a striking amount of structural integrity, with some more significant damage noted to the superstructure at midships. Time constraints limited our collection of drop camera footage at the site and we were unable to recover any imagery from the stern section of the vessel. Identification of the SS *Iron Crown* is significant as an important World War II era shipwreck site in Victorian waters. Data recovered from the SS *Iron Crown* survey will assist in reconstructing the wrecking event and provide a measure of closure to the descendants whose relatives lost their lives in the attack.

In addition to the location of SS *Federal* and SS *Iron Crown*, we conducted surveys to locate, identify and image a series of high priority shipwreck sites in Victorian waters provided as targets identified through aerial magnetometry. Extensive survey within these areas (UID 2-6) did not locate any new shipwreck sites, although extensive mapping and limited drop camera imagery of the shipwreck site SS *Vicky* were acquired for management purposes.



Figure 5: MBES image of SS *Vicky* as surveyed on 17 April 2019, by Craig Davey and Phil van den Bossche, GSM team on board RV *Investigator*. Courtesy CSIRO/Marine National Facility.

#### 2) AHO Survey of Bass Strait

The outstanding survey area (a portion of Area A) was completed during this voyage, using the EM710 (see Figure 6). During the survey, all other sounders were switched off and the EM710 was triggered internally to increase the ping rate for a greater sounding density. Throughout the duration of the survey, sound velocity profiles were performed, using the Valeport Monitor SVP at regular intervals (~6-8 hours). This represents the first survey of this area using modern equipment and further improves confidence for the safe navigation of international and coastal shipping in Bass Strait.



Figure 6: AHO and Beagle Marine Park mapping areas completed during IN2019\_V07.

#### 3) Training and Equipment Trialling

#### Data Acquisition and Processing (DAP):

All primary objectives were achieved. Mapping and drop camera deployments on shipwreck sites were successful and demonstrated the capabilities of RV *Investigator* for ongoing shipwreck exploration. The calibration and testing on the SS *Queensland* site increased success with the other deeper water and unknown sites of the SS *Federal*, SS *Iron Crown* and SS *Vicky*.

Several CTD and Triaxus deployments provided opportunities to train new staff in systems and data processing.

No major issues occurred during the voyage, however new staff were provided with training opportunities through the resolution of some minor issues:

- The issue the VSAT system was having around locking onto the satellite was resolved through Acutec logging on and repairing a misconfigured setting.
- Trouble-shooting of WiFi with remote assistance from IM&T, leading to some improvements. A network infrastructure reboot has been scheduled for the next port period to resolve remaining issues.
- Issues with the research winch console were resolved by reinstalling from a previous image.
- Identifying needs for further documentation around the intranet Wordpress website.

Many new features and systems were added to improve operations:

- A dimmer was added to the drop camera lights for better deep water and night operations and a dimmer control was added to the software UI.
- A new VGA switch was added to the winch consoles in the cathouse allowing mirrored display of either the trawl or research winch console to be sent to Ops.
- A script for displaying other vessels on OpenCPN was deployed to the influx server.
- A new coring elog tab was added with a script to automatically calculate target scope.
- Monitor, NUC and internet access was added to Level 7.

The training of new staff in most essential ship systems was successful and documentation has proven to be very useful.

#### **Seagoing Instrumentation (SIT):**

The wreck of SS *Queensland* was used a calibration target for the EM710-MK2 Multibeam Echosounder, afterwards the drop camera was deployed to successfully film the wreck (while live streaming to shore).

The multibeam survey of Sub Area A within Bass Strait (outstanding from IN2018\_C01) was completed using EM710.

Multibeam surveys were undertaken on several potential unidentified ship wrecks. The drop camera was used on five occasions to film and assist in identifying shipwreck sites. The drop camera performed well and , with modifications to the lighting systems, we managed to film some useful footage.

Multicorer operations were successful and the USBL channel changer worked without any issues. Brenke sled and Smith Mac grab operations were also successful.

The commissioning of the RapidCAST SVP system was completed with GSM achieving reliable operation of the profiler. Several improvements were identified that will be incorporated when possible.

Several CTD casts were performed during the voyage with some issues requiring resolution.

Triaxus was towed 3 times and overall performed well without any communication problems, although there were some issues with sensors which are being investigated by SIT.

The new support staff members received a broad exposure to science operations aboard *Investigator*. They all performed very well on their first outing and the voyage has sufficiently prepared them for further training and participation in upcoming voyages.

#### Geophysical Survey and Mapping (GSM):

This voyage covered approximately 3,500 line kilometres (1,890 nautical miles). Total amounts of geophysical data by instrument over the course of the voyage are shown in the table below.

Instrument	Data type	Raw data	Number of lines
EK60	Split beam	9.8 GB	178
	echosounder		
ME70	Fisheries	0 GB	0
	multibeam		
	echosounder		
EM122	Multibeam	3.37 GB	102
	echosounder (.all)		
EM122	Water column	6.80 GB	89
	(.wcd)		
EM710	Multibeam	67 GB	337
	echosounder		
EM710	Water column	556 GB	337
	(.wcd)		
SBP120	Sub Bottom	4.67 GB	292
	Profiler		
Gravity Meter	Gravity	197 MB	13

A deep water patch test and backscatter calibration lines were performed for the EM122. Backscatter calibration lines were also run for the EM710.

The Teledyne RapidCAST system, comprising the Rapid Winch and Sound Velocity (SV) probe, was tested in Bass Strait and off the SE coast of Tasmania with several trial deployments. Deployment tests were at first performed with the 'dummy' weight and float collar and after a successful trial, the SV probe was deployed. Several casts to 55 m were undertaken at vessel speeds of 2 and 4 knots. Although the winch system controlled via the Ops Room worked well, we had no initial success in acquiring data. A second trial was attempted and the setting in the SV probe was changed to trigger at 3 m water depth with a stop step of 3 m. This fixed our previous issues which included premature SV triggering at 1 m before deployment, and full SV casts were subsequently acquired.

A recently purchased SeaSPY marine magnetometer was taken on board for testing and commissioning during this voyage. During mobilisation, the system was dry-tested on deck and found to be working well. As the system was purchased without a winch, the deployment of the

magnetometer was done by hand and aided by a capstan operated by the marine crew and members of the Field Operations team. The marine crew indicated that this system was acceptable for testing, but that a winch solution should be sought for voyages with longer tow periods. Approximately 1500 m of lead-in was required for the vessel to come onto a planned line while paying out the required 250 m of tow-cable by hand, which is considerably more distance than would be expected using a winch. A pass over the wreck of the SS *Federal* provided a suitable magnetic anomaly ('spike') to indicate that the system was functioning correctly. Tow speed tests of 4 and 8 knots also indicated that the magnetometer maintained an altitude as specified by the manufacturer (i.e. ~22 m @ 4 knots and ~13 m @ 8 knots). To fully commission the SeaSPY2 on RV *Investigator* in the most efficient and safest operational manner, we would require a winch, slip ring and deck cable as well as a dedicated laptop computer.

Sound velocity profiles were performed, using the Valeport Monitor SVP at regular intervals (~6-8 hourly) for the AHO survey, and casts were also taken for each of the Beagle Marine Park site surveys. SVPs were all rope deployed (by hand) and a total of 10 casts were recorded. At the request of the Master, all SVP rope deployments must occur at the stern of the vessel.

#### Hydrochemistry:

Experiments conducted are as set out below:

- 1. Ideal wait times between the Conductivity Temperature Depth (CTD) sensors arriving at intended sampling depth and the firing of Niskin bottles looking to see if a shorter wait time reduces quality of data by introducing pluming effects.
- 2. An assessment of the Hydrochemistry team's precision of sampling and analysis for nutrients, dissolved oxygen (DO) and salinity.
- 3. Resolving the Deep Chlorophyll Maximum (DCM) at what sampling intervals provide the best resolution of the DCM? Is there a minimum interval that should be adhered to when trying to resolve the DCM?

Experimental samples were taken from three deep and four shallow CTD casts, conducted at seven different sites.

Additional salinity samples were collected and analysed during the voyage from the underway seawater supply to calibrate the Thermosalinograph (TSG).

#### **Field Operations:**

This was a unique opportunity for the Field Operations team to undertake training and field testing of equipment without any science pressures. We are very grateful for this opportunity.

All Field Operations staff had their own cabins and worked 08:00 – 20:00 shifts with a sliding start time.

The weather allowed us to complete a lot of training on the equipment prior to in-water testing. The in-water testing proceeded smoothly, with all tests carried out in a professional and efficient manner. Training and testing of the Smith Mac grab and Brenke sled went smoothly and both systems are now ready for active deployment.

Testing of the modifications to the multicorer took up most of the time allocated to Field Operations and was successful in many ways. Training of staff in using the multicorer was also successfully carried out.

Due to variations in the seafloor and performance of each tube on the corer (some leaked) the samples were not consistent within each deployment or between deployments. This means the data has a larger standard deviation than we would like. Overall the results indicate that the damper has very little effect on the sample size and that releasing the unit after landing increased the depth of penetration of the corer. Video footage taken at the time shows that the unit seems to develop not only a bow wave but carries a large volume of water with it, creating a large sediment cloud after impact on the seafloor. The effects of this on the science needs to be discussed with any future Chief Scientists.

#### 4) Seabird and Marine Mammal Observations (Woehler)

Continuous surveys of seabirds and marine mammals were undertaken during daylight hours throughout the voyage. Observations were centred on the southeast of Tasmania and south of Victoria, with the transits between these two areas undertaken at night. Details of observations of marine debris were also recorded.



Figure 7: Voyage track with sites of survey observations shown.

A total of 33 species of seabird and 6 species of cetaceans and seals was recorded. More than 1500 seabirds were recorded, primarily Short-tailed Shearwater, Shy Albatross and Australasian Gannet. Several large pods of Short-beaked Common Dolphin were encountered in Bass Strait. A small pod of Humpback Whales was recorded off the Gippsland coast.

Two Northern Hemisphere jaegers (related to Southern Hemisphere skuas) were observed in Bass Strait, and a Subantarctic Skua (likely from Macquarie Island, the nearest breeding location for the species) was observed off the Freycinet Peninsula coast. Several species of New Zealand seabirds were observed, including Southern Royal Albatross.

The voyage provided an excellent opportunity to collect data from Bass Strait, for which there are relatively few survey data available. The survey data are presently being reviewed for quality assurance/quality control before being lodged with various national and international data repositories such as OBIS and GBIF.

### **Piggyback Projects**

#### AM Initiative Sampling and Filtering

Our scientific objectives were successful in that six CTD casts, that included collection of water samples for genomics, were conducted off the East Coast of Tasmania and in the Bass Strait region, an oceanic area that we have limited spatial coverage for. In addition, three of these sampling points were located on the eastern Australian continental margin allowing the collection of deep-sea samples for genomics. This is an area that remains understudied due to inherent difficulties around collecting samples from the deep-sea. Further processing and analysis of these samples is expected to expand our knowledge of microbial communities in Australia's south-eastern waters and the deep ocean of the continental margin. Genomics data generated from samples collected on this voyage will be contributed to the AM Initiative. The eDNA samples collected on this voyage also represents a valuable resource suitable for genomic interrogation of a diverse range of taxa at multi-trophic levels, not just microbes, providing further insights into biodiversity and marine ecosystem processes. Our objective to trial/demonstrate the ability to incorporate collection and filtering of water for genomics samples was also successful with positive and constructive feedback for improving the process from the crew involved in this project.

#### **Beagle Marine Park Mapping**

An additional two sampling sites within the Beagle Marine Park were mapped by RV *Investigator* during IN2019\_V07 (see Figure 8). Time became available to complete one 5 x 5 km sampling site (BMR Site 13) and partially complete (~52%) a second 5 x 5 km sampling site (BMR Site 15). Block 13 took 11 hours to map at an interline spacing of 150 m in an average water depth of ~63 m. The mapping of these two sampling sites adds greater statistical confidence to estimates of habitat cover in the area as well as improving knowledge of the physical processes that structure the seabed features of this region. The seabed in the new areas surveyed appears to be predominantly soft sediment/gravel beds, and shows evidence of significant sediment mobility due to the strong currents that move through the eastern entrance to Bass Strait. Future re-mapping of these features will be particularly informative of the time-scale of events that structure the seabed ripple and dune features seen in the bathymetry.



Figure 8: Beagle Marine Park mapping sites (sites 13 and 15 indicated by yellow arrows).

## **Voyage Narrative**

#### 13 April 2019: GSM and drop camera operations of SS Queensland

Following site location and calibration, the project team deployed the drop camera over the site in an east to west orientation along the length of the site. Communication between the winch operator, operations room and bridge allowed for movement of the drop camera above the site (at approximately 10 m height above the wreck) over the length of the site in 5 m intervals from the collapsed section of the hull at a speed of 0.12 knots.

Drop camera deployed at 12:30, but cut out at 25m depth, location held until issues resolved. Drop camera footage was broadcast throughout the ship and live streamed to the public. Drop camera recovered at 14:00 with 35.57 min of footage collected.

The methodology for the location of sites via MBES with following deployment of drop camera at a precise location along the identified hull structure was found to be a valid and efficient means of site investigation. We recommend that a similar methodology be used on subsequent sites to be investigated on IN2019\_V07. Note that the entire operation took approximately 5-6 hours given exact known location of vessel (coordinates provided).

Discussion with the SIT team following investigation will provide for additional attachment of at least 2x GoPro Hero cameras to the drop camera system to provide for collection of still photographs, in addition to video.

#### 14 April 2019: AHO mapping

AHO mapping continued throughout the day and into the evening. For the duration of the survey, the Sound Velocity Probe (SVP) was deployed approximately every 6 hours, to calibrate the multibeam echosounders.

#### 15 April 2019: Initial survey for UID Sites 2-4

The AHO survey was completed in the early hours of 15 April 2019. Following completion of the survey, the vessel began its transit to the site of the SS *Federal*.

As we were passing directly over the survey blocks for UID sites 2-4 we decided to conduct opportunistic investigations at these locations while transiting to the survey area for SS *Federal*. We began GSM investigations at 0500.

For our first survey area (UID 2) we adjusted our track to pass site at 200 m SW as advised by Heritage Victoria that all UID sites found to be located 280 m SW of aerial magnetometer point. Only a single transect was conducted 200 m S of the point and failed to positively locate the site.

Our transit then passed over the projected location of UID 4 but no immediately identifiable target was located. However, the bridge noted a fishing vessel moored approximately 0.85 nm due west. We marked the position. A very flat bottom was noted for this area, and it is possible that the fishing vessel is moored over the site.

We then transited to the provided location for UID 3 and conducted a 600 m survey block around the provided waypoint. No targets requiring further investigation were identified.

We then decided to head for SS *Federal*, but ideally we will be able to return to this area on our transit back to Tasmania and complete appropriately sized survey areas around these waypoints.

#### 15-16 April 2019: GSM and drop camera investigations of SS Federal

GSM located the site of SS *Federal* at 1700 and conducted a close interval multibeam survey from 1730 to 1930, running a total of nine transects within a 350 m radius of the site.

At approximately 2000 the drop camera was deployed at amidships at a location just forward of the funnel. The drop camera is fitted with one wide angle camera facing down, one video camera facing forward (tilted at a 45 degree angle) and one GoPro, facing down, set on a timer to take one 12 megapixel image every 2 seconds.

The drop camera does not have the ability to move horizontally. The methodology used on SS *Queensland* (a single pass conducted along the length of the vessel) was not possible at this location due to particulate matter that obscured visibility of the site at a safe distance. The secondary methodology was that the winch operator would deploy the camera to a 3-5 metre distance above the wreck, hold for 2-3 minutes to capture footage, partially recover the drop camera, and then request that the ship move forward in 5-10 metre increments.

This was done in a series of stations around the site starting from midships moving aft. The stern section was reached and very little hull structure spotted at aft end. Long thin sections of steel

pipe/cable/riveted hull section sticking out into the water column prevented further investigation in this section. Concluded survey operations at 1000 for review and projected return to site later in the day to image the bow section. Unfortunately, requirements to conduct other scientific activities prevented a return to the site.

Floodlights on drop camera meant that the hundreds of fish on the wreck were right in the light the whole time. It was great to see so much life on the site, however, it will impact the imagery. Drop camera footage was collected for bow, stern and midships sections and into the scour. GoPro footage was collected for the first seven drop camera deployments, then the card filled and the remainder of the site was not captured on the GoPro.

#### 16-17 April 2019: GSM and drop camera investigations of SS Iron Crown

We arrived on location at the S *Iron Crown* survey area at 2200. We initiated a survey area of 3 nm x 5 nm with the survey area coverage estimated at approximately six hours at 7.5 knots, with each transect taking approximately 30 minutes to complete. Coordinates were received from Heritage Victoria and based on historical information that the SS *Iron Crown* (Victorian Heritage Register VHR Number S340) was torpedoed and sunk 44 nm SSW of Gabo Island.

The survey block was quite large and water depth averages 600-1500 m, which is operating at the farther extent of the MBES system. If located, site identification may not be possible until post-processing of data. This survey is an excellent test case for heritage site location in maximum water depth, and a test of the limits of the multibeam system (which has an upper limit estimated at 1000 m). There is also the potential to test the drop camera at a more extreme depth (rated to 6000 m, deployed to date to no more than a few hundred metres).

A possible feature was noted at 1600 m depth about 5 min in to the start of TR IC11. The feature measured about 100 m in length with an approximate beam of 16-22 m and profile of 8 m. TR IC12: Return (45 min)—intent to ping again the feature noted on TR IC11. Feature sighted again but at the same level as ambient noise, so was very difficult to refine. Ran ship north at a 30 degree angle from start of Transect IC12 perpendicular and across the feature located on TR IC11. The feature was still visible, however noise was still present, so the ship then ran south at a 30 degree angle perpendicular to site. Still present: location at 667-675 metres of water. We determined that further refining of the site is impossible at depth and made the decision to deploy the drop camera at 0200 at the midships point of the site which resulted in immediate positive identification of a shipwreck site.

The Seagoing Instrumentation Team (SIT) attached the oil-filled bladder to the drop camera cage, tweaked lights and weights and, with the support of the ASP deck and bridge crews, deployed the drop camera. The camera collected footage of the stern, midship and bow sections of the wreck. These were compared to archival photos, and given location, dimension and noted features, we believe it is the SS *Iron Crown*. The discovery was live broadcast across the ship and there was great excitement throughout, including from the Chief Scientist, who was so enthralled she stopped taking good notes. Drop camera investigations concluded at 0400 on 17 April 2019.

#### 17 April 2019: Survey for sites UID 4-6

After conducting geophysical activities during daylight hours, we transited to survey area around provided coordinates for UID 6 (a-b) and commenced a survey block of 2 nm N/S by 1 nm E/W at

1645, which was completed at 1915 (2.5 hr duration). Multibeam survey over the provided magnetic dipole anomalies failed to relocate the features. However, backscatter data recorded a feature of 66 m length overall and approximately 23 m wide that did not show up in the bathymetry data which will be forwarded to Heritage Victoria for further investigation.

Arrived at UID 5/SS *Vicky* at 2100 and initiated the first transect across the provided coordinates, hitting a target at 59 m water depth, of 51 m length. This site was imaged with multibeam sonar and drop camera to provide additional information to Heritage Victoria for site management purposes. The drop camera was deployed at 2200 and recovered at 0000 due to high current.

We returned to the location of UID 4, arriving at 0030 to survey the area north of provided coordinates transecting the location where the moored fishing vessel was spotted on 15 April 2019 at 0.85 nm due west at position. A survey area of approximately 2.8 kilometres by 3.4 kilometres did not locate any heritage features of interest within this area. This concluded the maritime heritage surveys. Mapping data will be provided to Heritage Victoria and the AHO.

#### **Summary**

The primary goals of the maritime heritage surveys were to conduct surveys of the purported site of SS *Federal* and opportunistic surveys of five unidentified targets (UID 2-6). An additional consideration of the work was to include opportunistic deployment of the drop camera.

Conducted work included multibeam and drop camera surveys at locations provided by Heritage Victoria. This included the precise location of the SS *Federal*, imaging of the SS *Queensland* and SS *Vicky* and survey of one new feature (coordinates undisclosed) that may be further investigated by Heritage Victoria and the Maritime Archaeological Association of Victoria (MAAV). We led additional multibeam surveys within an area projected to be the position of the sinking of the SS *Iron Crown* and located the vessel in 670 m depth.

The drop camera was deployed for the collection of video and still imagery at SS *Queensland*, SS *Iron Crown*, SS *Federal* and SS *Vicky*. It was proposed that at least two hours was required for drop camera deployment to enable maximum image coverage, allowing for production of a photogrammetric site plan. We have achieved initial positive results with photogrammetric manipulation of imagery associated with particular sections of the SS *Iron Crown* and SS *Federal*. Although it is recommended that future investigations should consider no less than six hours of drop camera deployment, or use of a remotely operated vehicle imaging platform for full site coverage.

In addition to completing the primary aims of the voyage, we live-streamed drop camera footage of SS *Queensland* within the Beagle Marine Park to the public, creating deeper connections between the public and our underwater heritage. An online story and archived footage from these investigations is available via the CSIRO Blog.

All data recovered from the maritime heritage surveys are provided to Heritage Victoria for use in interpretation, preservation and management of historic shipwreck sites located in Victorian waters.

The AHO mapping area was completed in its entirety according to IHO Order 1a standards. This data will be used by the Australian Hydrographic Office to update nautical charts in the area.



				DATA TYPE	DESCRIPTION
ltem No.	PI see page above	NO see above	UNITS see above	Enter code(s) from list at Appendix A	Identify, as appropriate, the nature of the data and of the instrumentation/sampling gear and list the parameters measured. Include any supplementary information that may be appropriate, e. g. vertical or horizontal profiles, depth horizons, continuous recording or discrete samples, etc. For samples taken for later analysis on shore, an indication should be given of the type of analysis planned, i.e. the purpose for which the samples were taken.
	Neville Barrett	35	Km2	G74	Two 5 x 5 km areas of seabed were surveyed with multibeam echosounder (EM710) within the Beagle Marine Park, recording bathymetry and backscatter. This data compliments a June 2018 survey within the Beagle AMP by the NESP Marine Biodiversity Hub, using a spatially balanced design to sub-sample the seabed geomorphology of the marine park. It allowed two extra spatial « replicates » to be added to that already completed, allowing improved estimation of the types and overall representation of seabed habitats within the park. Acquired bathy and backscatter data will be added to the AusSeaBed database and web portal upon completion of post-processing.
	Jodie Van de Kamp	6	Stations	H10	Collection of water samples for genomics (as part of the AM Initiative) from 6 CTD stations. Water samples were filtered through Sterivex filters. A total of 22 samples were collected from several depths (generally, surface, mix layer, and maximum cast depth) from the 6 CTD stations.

## **Curation Report**

Item #	DESCRIPTION
1.	The acquired dataset (multibeam bathymetry and backscatter) covering sampling sites
	within the Beagle AMP will be held by both CSIRO (via the MNF team) and Geosciences
	Australia (via AusSeaBed project and associated database). The data should be openly
	available from both these sources once post-processed.
2.	The 22 AM Initiative samples (Sterivex filters containing samples from 6x CTD stations) are
	currently being stored at -80°C at the CSIRO Marine Laboratories in Hobart. They will be
	processed within 2-3 months and the data will be made publically available via the AM
	Initiative data portal ( <u>https://data.bioplatforms.com/organization/about/australian-</u>
	microbiome) by the end of 2019.



## **Track Chart**

Figure 9: IN2019\_V07 Voyage Track.

## **Acknowledgements**

The Chief Scientist wishes to acknowledge project partner Heritage Victoria, the Maritime Archaeological Association of Victoria, and all the professional and avocational maritime archaeologists and divers who kindly responded to questions from the field. Your support, knowledge and enthusiasm for locating and identifying important cultural heritage sites is very much appreciated.

I wish to acknowledge and express appreciation to the CSIRO Marine National Facility for recognising the importance of locating and identifying maritime heritage sites in Australian waters. Thank you to the Voyage Managers, the ASP crew of RV *Investigator*, our science party, and the GSM, SIT and DAP teams who connected us to the bottom of the ocean, and back to the mainland. The combined expertise, professionalism and willingness to adapt to support the delivery of science programming made this project one of the highlights of my career. There is nothing like seeing the bow of a shipwreck for the first time in over 75 years... thank you all for sharing that with me. Thank you also to CSIRO MNF Communications, who were a pleasure to rely on for the live link to SS *Queensland* and management of post-voyage media.

### **Signature**

Your name	Emily Jateff
Title	Chief Scientist
Signature	le
Date:	21 June 2019
Your name	Neville Barrett
Title	Principal Investigator (Beagle Marine Park mapping)
Signature	11 Count
Date:	30 May 2019

## Appendix A - CSR/ROSCOP Parameter Codes

	METEOROLOGY
M01	Upper air observations
M02	Incident radiation
M05	Occasional standard measurements
M06	Routine standard measurements
M71	Atmospheric chemistry
M90	Other meteorological
	measurements

	PHYSICAL OCEANOGRAPHY
H71	Surface measurements underway (T,S)
H13	Bathythermograph
H09	Water bottle stations
H10	CTD stations
H11	Subsurface measurements
	underway (T,S)
H72	Thermistor chain
H16	Transparency (eg transmissometer)
H17	Optics (eg underwater light levels)
H73	Geochemical tracers (eg freons)
D01	Current meters
D71	Current profiler (eg ADCP)
D03	Currents measured from ship drift
D04	GEK
D05	Surface drifters/drifting buoys

	MARINE BIOLOGY/FISHERIES
B01	Primary productivity
B02	Phytoplankton pigments (eg
	chlorophyll, fluorescence)
B71	Particulate organic matter (inc
	POC, PON)
B06	Dissolved organic matter (inc DOC)
B72	Biochemical measurements (eg
	lipids, amino acids)
B73	Sediment traps
B08	Phytoplankton
B09	Zooplankton
B03	Seston
B10	Neuston
B11	Nekton
B13	Eggs & larvae
B07	Pelagic bacteria/micro-organisms
B16	Benthic bacteria/micro-organisms
B17	Phytobenthos
B18	Zoobenthos
B25	Birds
B26	Mammals & reptiles
B14	Pelagic fish
B19	Demersal fish
B20	Molluscs
B21	Crustaceans

D06	Neutrally buoyant floats
D09	Sea level (incl. Bottom pressure & inverted echosounder)
D72	Instrumented wave measurements
D90	Other physical oceanographic measurements

	CHEMICAL OCEANOGRAPHY
H21	Oxygen
H74	Carbon dioxide
H33	Other dissolved gases
H22	Phosphate
H23	Total - P
H24	Nitrate
H25	Nitrite
H75	Total - N
H76	Ammonia
H26	Silicate
H27	Alkalinity
H28	PH
H30	Trace elements
H31	Radioactivity
H32	Isotopes
H90	Other chemical oceanographic measurements

B28	Acoustic reflection on marine organisms
B37	Taggings
B64	Gear research
B65	Exploratory fishing
B90	Other biological/fisheries measurements

	MARINE GEOLOGY/GEOPHYSICS
G01	Dredge
G02	Grab
G03	Core - rock
G04	Core - soft bottom
G08	Bottom photography
G71	In-situ seafloor
	measurement/sampling
G72	Geophysical measurements made
	at depth
G73	Single-beam echosounding
G74	Multi-beam echosounding
G24	Long/short range side scan sonar
G75	Single channel seismic reflection
G76	Multichannel seismic reflection
G26	Seismic refraction
G27	Gravity measurements
G28	Magnetic measurements
G90	Other geological/geophysical measurements

	MARINE CONTAMINANTS/POLLUTION
P01	Suspended matter
P02	Trace metals
P03	Petroleum residues
P04	Chlorinated hydrocarbons
P05	Other dissolved substances
P12	Bottom deposits
P13	Contaminants in organisms
P90	Other contaminant measurements

## Appendix B – Photographs



Figure 10: Short-beaked Common Dolphin (image credit: Eric Woehler, Birdlife Australia).



Figure 11: Crested tern (image credit: Eric Woehler, Birdlife Australia).



Figure 12: MNF and E&T personnel, crew members and science participants on board during IN2019\_V07 (image credit: Eric Woehler, Birdlife Australia).



Figure 13: Brenke sled deployment (image credit: Megan Dykman, MNF).