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Mapping fisheries data used to support Status of Key Australian Fish Stocks Reports

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

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Executive Summary

The FRDC published the Status of Key Australian Fish Stocks Reports (SAFS) in 2012 and 2014, and are currently working on the 2016 edition. The SAFS provides a simple, robust tool to inform fishers, consumers and managers on the status of key wild-caught fish stocks around Australia. The 2014 edition included 68 species comprising 238 different stocks. Production of the SAFS is an enormous task, requiring cross- jurisdictional cooperation in determining assessments. This process highlighted differences in data collected between agencies in terms of quality, quantity and format, which greatly increased the effort required to prepare the collaborative reports. The cost of producing subsequent reports could be significantly reduced if data used to inform assessments became standardised across jurisdictions and made readily available through a fisheries data portal. Further, making some of the data publically available and open to queries through the website would increasing transparency and public trust, while reducing red tape and creating other efficiencies. Before this occurs we need a better understanding of the challenges involved in mapping fisheries data collected by different agencies. This study was commissioned to identify the different data sets reported in the SAFS and to describe the differences in data reported.

The objectives of this report are to: 1) Identify data collected by State, Commonwealth and other research agencies for each main South Australian and Northern Territory fish stock used to support the Status of Key Australian Fish Stocks Reports; 2) describe data sets identified including (but not limited to) assessment of data quality, fields collected, units, completeness, frequency of collection, privacy restrictions and storage format; and 3) undertake a gap analysis of data collected for each stock and develop a framework for rollout of a project for all fish stocks in the Status of Key Australian Fish Stocks Reports.

This project originally set out to describe data sets from South Australian (SA) and Northern Territory (NT) species reported in the 2012 SAFS. The FRDC requested this scope expand to include Queensland (Qld) SAFS species and to incorporate five additional species not previously reported in SAFS but recorded by Fisheries Queensland (FQ) in the SAFS format. SAFS and other assessment reports were used to identify main data sets reported for each stock, resulting in 637 different combinations of species x jurisdiction x data sets. Descriptive information about each dataset was obtained from available literature (e.g. assessment reports, management plans, survey reports) and from questionnaires sent to data custodians, facilitated by key contacts at South Australian Research and Development Institute Aquatic Sciences (SARDI), Northern Territory Department of Primary Industry and Fisheries (NT DPIF) and Fisheries Queensland (FQ). The gap analysis compared data reported in SAFS and assessment reports to grouped indicators for "target species" identified by FRDC Project 2014/008, *Health check for Australian Fisheries* from a review of 25 "indicator-based" fishery sustainability assessment schemes.

Confidentiality arrangements for SARDI, NT DPIF and FQ have been described. Information describing as many of data sets as possible that are used in assessment of each fish stock has been summarised in the form of a spreadsheet that has been provided to the FRDC. From those summaries, potential opportunities for streamlining SAFS reports through on-line data acquisition/warehousing are described for each of the section of the SAFS reports. The gap analysis revealed that for the most part, information is readily available to address the most common indications used by sustainability assessment programs. Of the indicators that are common to many different sustainability assessment programs, fishing mortality was included in SAFS reports the least. Most of the indicators that were not well addressed on the SAFS reports were not relevant to species assessments in the SAFS framework. Referencing indicators was poor for many stocks, and should be improved for the 2016 SAFS.

Keywords

[Status of Key Australian Fish Stocks Reports; data; catch and effort; data portal**]**

Introduction

In 2012 the FRDC released the Status of Key Australian Fish Stocks Reports to provide a simple, robust tool to inform fishers, consumers and managers on the status of key wild-caught fish stocks around Australia. The 2012 publication, a collaboration between the Australian Bureau of Agricultural and Resource Economics and Sciences and all government fisheries research agencies with marine fisheries in their jurisdiction, constituted an enormous task receiving cooperation from over 80 researchers. The collation of data from the 49 species (or species complexes) from around Australia required cross- jurisdictional cooperation in determining assessments. This process highlighted differences in data collected between agencies in terms of quality, quantity and format, which greatly increased the effort required to prepare the collaborative reports. In 2014 the FRDC prepared a second edition with an intent to release subsequent editions every two years. The number of species reported in 2014 edition increased to 68 comprising 238 different stocks, increasing the complexity and cost of preparing the report over the 2012 edition.

The cost of producing subsequent reports could be significantly reduced if data used to inform assessments became standardised across jurisdictions and made readily available through a fisheries data portal. Making this data publically available through the website would allow the public to run their own queries, increasing transparency and public trust (Mitchener, 2015) while reducing red tape and creating other efficiencies. Before this occurs we need a better understanding of the challenges involved in mapping fisheries data collected by different agencies. The large number of fisheries agencies around Australia and the variety of data they collect and/or generate has, as a matter of historical happenstance, led to some variety in the spatial and temporal resolution, units, and confidentiality arrangements attached to fish stock assessments. This study was commissioned to identify the different data sets reported in the SAFS and to describe the differences in data reported

In addition to simplifying the SAFS production and making data available to the public, sharing data has a number of other benefits: data from multiple research projects becomes available for meta-analyses, providing parameters for modelling and for verifying research results; new opportunities for collaborations may open up; publication citation rates may increase as data becomes more widely used; time and money are saved as data duplications are identified and ended; and the pace of research can increase as data becomes more readily available (Mitchener, 2015). However bringing together data from within a single agency, let alone many agencies across several jurisdictions, holds many challenges. The reasons for this are many including:

- concern their work will be used but not acknowledged (McManamay and Utz, 2014)
- non-standard data collection methods (Peters *et al*., 2014)
- data may contain sensitive information (particularly personally identifiable information) or protected by confidentiality arrangements or copyright such that sharing the data may constitute a breach of security or an ethical violation within an organisation (McManamay and Utz, 2014), particularly across international boundaries (Mitchener, 2015)
- concerns about the time and/or expertise required to use their data competently (Mitchener, 2015)
- the potential for misinterpretation and misuse of data (Mitchener, 2015)
- a lack of standardised metadata or a wholesale lack of metadata (Mitchener, 2015)
- poor descriptions of data collection and analyses (Peters *et al*., 2014)

Aggregating data to a level that either satisfies confidentiality arrangements (for example, so that each data point comprises information from at least 5 licences), resolves several of these issues and reduces the risk of misinterpretation. The level of aggregation requires careful consideration as the more generalised the data becomes the less detail (including spatial and temporal information) remains available, potentially reducing the value of the data for wider use.

A number of "data portals" make fisheries data available to the public, and a number of these are described below. The Queensland Government's QFish[1] allows presentation of commercial and recreational catch and effort data through the use of cubes and maps (Queensland Government, 2015). Cubes, or interactive tables are a data storage framework using a multidimensional form for reporting purposes. Cubes are easily queried, incorporate confidentiality rules, and perform calculations such as converting different product forms to whole weights. Data is updated weekly with new monthly data added at the beginning of each month. A four month delay in making each new month available ensures report data are as close to complete as possible. Data is displayed as either a pivot table or a map, and can be exported in a number of different forms including PDF, HTML or Excel. QFish adheres to the five boat rule, displaying "NA" in place of confidential data in tables and omitting sensitive information from maps. Commercial effort data excludes days where fishing effort resulted in no recorded catch.

While predefined queries are included, QFish also allows customised queries using the following fields for commercial catch: catch weight, effort, number of licences, fishing method, logbook grid; logbook type, region, species and time. Recreational fishing data are also made available from the National Recreational and Indigenous Fishing Survey and the more recent State-wide Recreational Fishing Survey that is based on the same methodology as the NRIFS. Predefined queries are included for recreational fishing data and QFish also allows customised queries including the following fields: catch number (total, retained and released), confidence level, number of licences, type of fishing, boat ownership, fishing club membership, avidity, residential location, depth, fishing method and waterbody name and type.

IMAS maintains a GeoNEtwork Open Access to Marine Data website aiming "to improve the accessibility of a wide variety of data, together with the associated information, at different scales and from multidisciplinary sources, organized and documented in a standard and consistent way" (IMAS, 2015). Each dataset's detailed metadata is reported in a standardised format. In some cases data downloads occur under a Commons License along with the metadata and published report. The format of the downloaded data varies between datasets, and are stand-alone files. Data is also available through the IMAS[2] and IMOS[3] data portals, allowing users to limit the temporal and spatial extent of data downloads and apply filters.

The Australian National Data Service[4] brings together data from a large number of providers, aiming to make more data available for Australian Research (ANDS, 2015). Each dataset contains a description, including spatial coverage, and a link to the data provider showing either standardised metadata or files for downloading.

Fisheries and Oceans Canada[5] make annual commercial fisheries catch data for main species available as pdfs aggregated at predefined levels including catch and value by species, gear type, year, district and week. Queries cannot be customised. Recreational catch is displayed as annual catch by statistical area for each year.

Norway's Institute of Marine Research support an online database called SJØMIL[6], making available aggregated time series of ICES stock assessment results (including recruitment, total and spawning stock biomass, fishing mortality, numbers by age), landings, fishery independent survey data and climate observations, through interactive graphics or text files.

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[1] http://qfish.fisheries.qld.gov.au
[2] http://data.imas.utas.edu.au/portal/home
[3] https://imos.aodn.org.au/imos123/home
[4] http://www.ands.org.au/
[5] http://www.pac.dfo-mpo.gc.ca/stats/index-eng.html
[6] http://www.imr.no/sjomil/index.html

NOAA Fisheries Service host the Species Information System Public Portal[7] website to collects and manages regional and national data across National Marine Fisheries Service program offices. Data in the system includes stock status, stock assessment results, catch and CPUE data. NOAA Fisheries Service also make monthly catch summaries available[8], allowing customised queries including species, year, temporal resolution (year or month), state and output format. Other portals making fisheries catch data available include the North Carolina Division of Marine Fisheries' Commercial Fisheries Landings Statistics Selection Tool[9] and the North Carolina Division of Marine Fisheries' Recreational Catch Query Tool[10].

Objectives

1. Identify data collected by State, Commonwealth and other research agencies for each main South Australian and Northern Territory fish stock used to support the Status of Key Australian Fish Stocks Reports

2. Describe data sets identified including (but not limited to) assessment of data quality, fields collected, units, completeness, frequency of collection, privacy restrictions and storage format

3. Undertake a gap analysis of data collected for each stock and develop a framework for rollout of a project for all fish stocks in the Status of Key Australian Fish Stocks Reports.

Method

Identify data collected

Fish stock included

This project originally set out to describe data sets from South Australian (SA) and Northern Territory (NT) species reported in the 2012 SAFS. The FRDC requested this scope expand to include Queensland (Qld) SAFS species and to incorporate five additional species not previously reported in SAFS but recorded by Fisheries Queensland (FQ) in the SAFS format. Leading scientists from South Australian Research and Development Institute Aquatic Sciences (SARDI), Northern Territory Department of Primary Industry and Fisheries (NT DPIF) and FQ were contacted to inform them of the project's intent and to request assistance in obtaining the necessary information. The species list was updated to include species reported in the 2014 SAFS (Figure 1**Error! Reference source not found.**), but data for species/stocks that are predominantly managed by the Commonwealth such as School Shark and Gummy Shark, were omitted.

Table 1. States, common names, species names and status assessment unit reported by the three states in the 2014 SAFS. State: South Australia (SA), Northern Territory (NT), Queensland (Qld); status assessment unit: biological stock (B), management unit (M), jurisdiction (J). Shaded species are those that were reported by FQ in the SAFS format, but were not reported in the 2014 SAFS.

State	Common name	Scientific name	Status assessment unit
SA	Australian Salmon	*Arripis truttaceus*	Western Australian (B)
	Australian Sardine	*Sardinops sagax*	Southern Australian (B)
	Balmain Bug	*Ibacus alticrenatus, I. brucei, I. chacei, I. peronii*	South Australia (M)

[7] https://www.st.nmfs.noaa.gov/sisPortal/
[8] https://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/monthly-landings/index
[9] http://portal.ncdenr.org/web/mf/statistics/comstat/
[10] http://portal.ncdenr.org/web/mf/statistics/recstat

	Blacklip Abalone	*Haliotis rubra*	South Australian Western Zone Fishery (M) South Australian Central Zone Fishery (M) South Australian Southern Zone Fishery (M)
	Blue Swimmer Crab	*Portunus armatus*	Gulf St Vincent (B) Spencer Gulf (B) West coast (B)
	Dusky Shark	*Carcharhinus obscurus*	South-western Australian (B)
	Giant Crab	*Pseudocarcinus gigas*	Southern Australian (B)
	Greenlip Abalone	*Haliotis laevigata*	South Australian Western Zone Fishery (M) South Australian Central Zone Fishery (M) South Australian Southern Zone Fishery (M)
	Gummy Shark	*Gummy Shark*	Southern Australian (B)
	King George Whiting	*Sillaginodes punctata*	Gulf St Vincent (B) Spencer Gulf (B) West coast—Eyre Peninsula (B)
	Pipi	*Donax deltoides*	South Australia (J)
	School Shark	*Galeorhinus galeus*	Southern Australian (B)
	Snapper	*Pagrus auratus*	South East Fishery (B) Northern Gulf St Vincent Fishery (B) Southern Gulf St Vincent Fishery (B) Southern Spencer Gulf Fishery (B) Northern Spencer Gulf Fishery (B) West Coast Fishery (B)
	Southern Calamari	*Sepioteuthis australis*	South Australia (J)
	Southern Rock Lobster	*Jasus edwardsii*	South-eastern Australia (B)
	Western King Prawn	*Melicertus latisulcatus*	Spencer Gulf Prawn Fishery (M) Gulf St Vincent Prawn Fishery (M) West Coast Prawn Fishery (M)
NT	Barramundi	*Lates calcarifer*	Barramundi Fishery (Northern Territory) (M)
	Blacktip Shark	*Carcharhinus tilstoni, C. limbatus, C. sorrah*	Gulf of Carpentaria (B) North and west coast (B)
	Coral Trout	*Plectropomus spp., Variola spp.*	Northern Territory (J)
	Crimson Snapper	*Lutjanus erythropterus*	Northern Australian (B)
	Goldband Snapper	*Pristipomoides multidens*	Northern Australian (B)
	Mud Crab	*Scylla serrata, S. olivacea*	Northern Australian (B)
	Red Emperor	*Lutjanus sebae*	Northern Territory (J)
	Saddletail Snapper	*Lutjanus malabaricus*	Northern Australian (B)
	Spanish Mackerel	*Scomberomorus commerson*	Northern Territory (J)
Qld	Saucer Scallop	*Amusium balloti*	East Coast Otter Trawl Fishery (M)
	Blue Swimmer Crab	*Portunus armatus*	North-eastern Australian (B)
	Mud Crab	*Scylla serrata, S. olivacea*	Northern Australian (B) East coast (B)
	Spanner Crab	*Ranina ranina*	East coast (B)
	Balmain Bug	*Ibacus alticrenatus, I. brucei, I. chacei, I. peronii*	East coast (M)
	Moreton Bay Bug	*Thenus australiensis, T. parindicus*	East Coast Otter Trawl Fishery (M)
	Tropical Rock Lobster	*Panulirus ornatus*	North-eastern Australian (B)
	Eastern King Prawn	*Melicertus plebejus*	Eastern Australian (B)

Endeavour Prawns	*Metapenaeus endeavouri, M. ensis*	East Coast Otter Trawl Fishery (Red and Blue Endeavour Prawn) (M)
School Prawn	*Metapenaeus macleayi*	Queensland (J)
Tiger Prawns	*Penaeus esculentus, P. semisulcatus*	East Coast Otter Trawl Fishery (Brown and Grooved Tiger Prawn) (M)
Western King Prawn	*Melicertus latisulcatus*	East Coast Otter Trawl Fishery (M)
White Banana Prawn	*Penaeus merguiensis*	East coast (M)
Blacktip Shark	*Carcharhinus tilstoni, C. limbatus, C. sorrah*	East coast (B) Gulf of Carpentaria (B) North and west coast (B)
Sandbar Shark	*Carcharhinus plumbeus*	Eastern Australian (B)
Barramundi	*Lates calcarifer*	Southern Gulf of Carpentaria (B) Northern Gulf of Carpentaria (B) Princess Charlotte Bay (B) North-east coast (B) Mackay (B) Central east coast (B)
Black Jewfish	*Protonibea diacanthus*	Gulf of Carpentaria (M) Queensland east coast (M)
Coral Trout	*Plectropomus spp., Variola spp.*	Coral Reef Finfish Fishery (M) Gulf of Carpentaria (M)
Mulloway	*Argyrosomus japonicus*	Queensland (J)
Murray Cod	*Maccullochella peelii*	Queensland (J)
Tailor	*Pomatomus saltatrix*	Eastern Australian (B)
Yellowtail Kingfish	*Seriola lalandi*	Eastern Australian (B)
Dusky Flathead	*Platycephalus fuscus*	Queensland (J)
Grey Mackerel	*Scomberomorus semifasciatus*	Central east Queensland (B) North-east Queensland (B) Gulf of Carpentaria (B)
Spanish Mackerel	*Scomberomorus commerson*	East coast (B) Gulf of Carpentaria (M)
Sea Mullet	*Mugil cephalus*	Eastern Australian (B)
Snapper	*Pagrus auratus*	East coast (B)
Yellowfin Bream	*Acanthopagrus australis*	Eastern Australian (B)
Crimson Snapper	*Lutjanus erythropterus*	Northern Australian (B) East coast Queensland (B)
Goldband Snapper	*Pristipomoides multidens*	Northern Australian (B) Queensland (M)
Golden Snapper	*Lutjanus johnii*	Gulf of Carpentaria (M) East coast (M)
Red Emperor	*Lutjanus sebae*	Gulf of Carpentaria (M) East coast Queensland (M)
Redthroat Emperor	*Lethrinus miniatus*	East coast Queensland (B)
Saddletail Snapper	*Lutjanus malabaricus*	Northern Australian (B) East coast Queensland (B)
Sand Whiting	*Sillago ciliata*	Queensland (J)
Stout Whiting	*Sillago robusta*	Eastern Australian (B)
Mangrove Jack	*Lutjanus argentimaculatus*	Gulf of Carpentaria management unit East Coast management unit
Pearl Perch	*Glaucosoma scapulares*	Qld management unit (RRFFF) (part of the Eastern Australian stock)
King Threadfin	*Polydactylus macrochir*	East coast Gulf of Carpentaria
Red Spot King Prawn	*Melicertus longistylus*	East Coast Otter Trawl Fishery (ECOTF) Management Unit
Spotted Mackerel	*Scomberomorus munroi*	Eastern Australian (Queensland)

The SAFS reports follow a standard format including the following sections: stock structure, stock status, and effects of fishing on the marine environment and environmental effects on each species. The stock structure sections are descriptive, using results of relevant studies to describe stocks by which SAFS assessments are reported. As no actual data are reported in stock structure sections and the data in report references are unlikely to be of interest to the general public, stock structure sections are not covered in this report. Stock status sections describe: information used in the weight of evidence approach to defining the status of each stock listed in Table 1, as well as in reporting longevity, maximum size, age and/or size at 50% maturity; the spatial distribution of the 2013 commercial catch by 1° grids; descriptive information recording gear used, management methods and markets, the number of active fishing vessels for each fishery, catch by fishery and sector and a time series of annual commercial catches by stock. This section provides nearly all data reported in the SAFS and forms the focus of this report. The two environmental sections refer to various data not used in stock assessment and so are not included here. At the FRDC's request, major datasets used by jurisdictions, but not referred to in the SAFS, are also included.

Descriptions of data

Information about datasets was collated from the available literature (e.g. assessment reports, management plans, survey reports) and from questionnaires sent to data custodians. Descriptions of data sets include field name, format, units (e.g. SI, species codes), extent, spatial resolution, recording medium (e.g. paper, e-logs, e-reporting) and frequency of capture (temporal resolution and frequency of submission). As well as describing the structure and format of the data reported in the SAFS, this project required metrics describing the "quality of the data". Rather than assessing whether data is of high or low quality, we describe metrics defining quality for each data set. These are largely based on the *Research and Science Information Standard for New Zealand Fisheries* (MoF, 2011) but other documents, including MRAG (2003), NOAA (2006) and Penney (2010). MoF (2011), include five key principles for science information quality — peer review, relevance, integrity, objectivity and reliability. While these principles relate to all aspects of quality of research and information they are also useful for developing metrics for measuring data quality.

Peer review *is the principal process used to ensure the quality of scientific methods, results and conclusions meet the accepted standards and best practices of the science community*. Peer review of the methods used to collect / generate data apply to the data set as a whole, rather than to individual fields. Responses regarding peer review could be: "yes the methods for this project have been peer reviewed"; "the methods for this project have not undergone peer review, but they are based on methods from other peer reviewed studies"; or "no, not peer reviewed".

Relevance refers *to whether the data addresses / contributes to answering the management questions and addresses management objectives*. While we are not assessing data collected against needs, it is useful to know: "Does the data have a "use-by date" or a time after which the data is no longer useful?" For example, time series of standardised catch rates which completely change when analyses are run with new data.

Integrity refers *to the security of information, and to the protection of information from inappropriate alteration, selective interpretation or selective presentation*. A number of metrics covered by this principle are relevant to this project and apply to data sets as a whole rather than to individual fields:

- Is meta-data included?
- What system / database is the data stored in?
- What is the physical location of the data (e.g. SARDI secured server)?
- What is the backup procedure for the data (frequency, method)?
- What data sharing / confidentiality arrangements exist?
- Who can make changes to the data?
- What is raw data recorded on (e.g. datasheets, e-logs, other electronic capture device)?

Objectivity refers *to whether the information presented is accurate, impartial and unbiased*. While this largely relates to interpretation of results it also includes ensuring the data and analyses are accurate and unbiased. Metrics used to describe this principle include:

- Who collected the data (e.g. scientist, fisherman, external contractor)?
- Do any conflicts of interest exist?

Reliability relates *to the accuracy and reproducibility of information*. For this project reliability relates to the verification and validation of data and the use of standard methods of data collection / generation. Metrics will include:

- Are there standard operating procedures (or equivalent) for data collection / generation?
- Are data collection / generation qa / qc procedures (or equivalent) in place?
- Are qa / qc procedures for error checking, data validation and data-grooming in place?
- How are data provided by people with conflict of interest (eg catch disposal records, compliance, observer) verified?
- Are catch weights estimates or measurements?
- Is equipment calibrated and certified in accordance with applicable technical protocols?
- How complete is the data?

Questionnaires for collecting information about each dataset in addition to data set attributes (Table 2) applied the principles outlined above. Not all questions were relevant for all data types (for example, the question "Are catch weights estimates or measurements?" is not relevant to age and growth data), so questionnaires were tailored to each data type. .

Research Chiefs at SARDI, NT DPIF and FQ appointed a single key contact in their organisations to facilitate collection of the information required. The key contacts were given a description of the project, a list of identified data-sets and questions specific to each data-type, and asked to contact data custodians to complete questionnaires. Ideally, data custodians would review descriptions of their data but the collection of the required information proved such an onerous task for time-poor staff that this step was skipped.

Table 2. Questionnaire to describe components of data quality.

Question
Species
Data collection program / data type
Name of data custodian
What is the unit of the field of interest in the raw data collected
Year of first data point
Year of last data point (or continuing)
How often is the data collected?
If different from the previous question, what is the timestep of data collected?
What is the spatial resolution of the data collected?
Have the methods used to collect / generate these data been peer reviewed?
Who collected the data (e.g. fisherman, observers, scientists, automatic collection)?
What is the main (primary) type of species code or name?
How is the raw data collected (e.g. datasheets, e-logs, other electronic capture device)?
Are there standard operating procedures (or equivalent) for data collection / generation? If so, please supply / reference.
Are there other quality assurance / quality control procedures (or equivalent) for data collection / generation? If so, please supply / reference.
Are there verification procedures for data provided by people with conflict of interest (e.g. Catch disposal Records, compliance, observers)?
Are catch weights estimates or measured weights?
Has equipment been calibrated and certified in accordance with applicable technical protocols for the equipment concerned?
What is the general completeness of the data?
How many records are there in the dataset?
What is the file format of the raw data?
What type of database is used to warehouse the data?
Is there meta-data for this data-set? If so, please supply with response.
What is the physical location of the electronic data?
What is the backup procedure for the data (frequency, how is it done)?

Who can make changes to the data-base?
If any, what are the data sharing / confidentiality arrangements?
What is the main use of the data?
How often is the data reported (formally or informally)?
What is the timestep of the data reported (what is the time period reported)?
What is the spatial resolution of the data reported?
What is the main (primary) type of species code or name in the reported data?
Please provide a brief description of the limitations of the data.
Is there a time after which the data is no longer valid / useful (e.g. until the next stock assessment)?
Are there quality assurance / quality control procedures (or equivalent) for error checking, data validation and data-grooming?
What is the unit of the field of interest in the data reported?
What type of error bars are reported for the field of interest?
What is the file format of the reported data?
Is the derived data completely re-calculated for every reporting period?
What is the physical location of the reported electronic data?
What is the backup procedure for the reported data (frequency, how is it done)?

Gap analysis

As a part of their FRDC Project 2014/008, *Health check for Australian Fisheries*, Hobday *et.al*. (In prep) reviewed indicators used by 25 "indicator-based" fishery sustainability assessment schemes. Indicators were categorised into biological, governance, social and economic categories, and into sub-categories — for example the biological category was sub-categorised into target species, bycatch species, protected species, habitats, ecological communities and environmental context. A general comparison between indicators identified by Hobday *et.al*. (In prep) and data reported in SAFS could highlight gaps in knowledge of fish stocks considered important in sustainability assessments. Because this report deals with the species / stock level rather than the fishery level, only indicator groups sub-categorised as "Target species" were included, along with three "Management tools" indicator groups applying directly to target species. Gap analysis uses indicator groups as described by Hobday *et.al*. (In prep) rather than specific indicators. For example, this means that to satisfy requirements for the "genetic structure", the genetic stock structure might be known, but the reduction of genetic diversity as required by the sustainability assessment scheme SeaChoice might not be known. Table 3 lists indicator groups and specific indicators included in those groups. Presence or otherwise of data for indicators was displayed using traffic light colors and notes describing those data. The absence of traffic light colors does not necessarily indicate an absence of data for that indicator - the data may exist but was not reported in the SASFs or jurisdictional stock assessments.

Table 3. Indicator groups and specific indicators included in those groups (adapted from Hobday *et al*., In prep.). Numbers in parenthesis indicate the number of sustainability assessment schemes that include specific indicators.

Indicator group	Specific indicators
Area overlap of species and fishery	Area occupied by species (1)
Bait use	Bait use (2)
Catch composition - trophic	Percentage predators (1)
	Trophic level of landings (1)
Catch composition - immature	Catch before maturity (1)
Catch composition -size	Catch structure (1)
	Size of fish in catch (1)
Catch value	Fish stock indicator: Catch landed value (1)
Catch weight	Catch (1)
	Fish stock indicator: Catch weight (1)
CPUE	Catch per unit effort (1)
Fishing mortality	Exploitation rate (2)
	Fishing mortality (3)
	"Fishing mortality does not threaten populations or impede the ecological role of any marine cv life (2)"
	Fishing pressure - fished vs unfished area (1)
	Fishing pressure (2)
	Inverse fishing pressure (1)
	Target species - fishing mortality (1)
Gear specificity	Selective gear (1)
Genetic structure stock	Genetic structure (1)
	Genetic structure of stock (2)
	Reduction of genetic diversity (1)

Nursery area not impacted	Fishery nursery (1)
Pre-catch mortality	Pre-catch mortality (1)
Range - collapse	Range collapse (1)
Recruitment variability	Recruitment variability of the exploited fish population (1)
Species list	Captured spp (1)
	Retained spp (3)
Stock - productivity	Percentage spawners per recruit (1)
Stock age distribution	Age of stock (3)
Stock composition - sex	Sex of stock (2)
Stock management	Harvest control rules & tools (1)
	Harvest strategy (1)
	Primary species - management strategy (1)
Stock monitoring	Information & monitoring (1)
	Primary species - information/monitoring (1)
Stock size	Relative abundance of target species (1)
	Size (1)
	Size of the stock (2)
Stock status	Target species - stock status (1)
	Stock status (5)
	Stock rebuilding (1)
	Stock management (1)
	Stock assessment (2)
	Status of wild stocks - management classification (1)
	Status of wild stocks - long term trends (1)
	Status of wild stocks - extent of overfishing (1)
	Status of wild stocks - current population relative to unfished level (1)
	Status of wild stocks - biological parameters (1)
	Primary species - outcome (1)
	Population biomass (1)
	Population biomass - model based (1)
	Percentage sustainable stocks (1)
	Impacts of the fishery on the stock in question (2)
	Health of the stock (2)
	Fish stock indicator: formal status of fishery (2)
	Exploitation status of fishery in relation to sustainable levels (1)
	Assessment of stock status (1)
	Abundance (4)
Stock vulnerability	Vulnerability (1)
	Target species - species biology (1)
	Migratory range of target fish (1)
	Mean length in catch (1)
	Life span (year) (1)
	Life history (1)
	Intrinsic vulnerability Index of fish species in the fishery (1)
	Inherent vulnerability of the stock (2)
Harvest strategy	Harvest strategy (2)
Logbook use	Use of logbook (1)
TAC managed	TAC (1)

Results, discussion and conclusion

Data used in SAFS

Data sets for each species referred to in the SAFS for SA, NT and Qld, are summarised in Table 4, Table 5 and Table 6 respectively. To obtain descriptive information about each dataset the following categories were applied: recreational and indigenous catch; fishery independent surveys; commercial and charter catch and effort; fishery dependent sampling; age frequency; CPUE / mean effort / catch size; and stock assessments and TACs / TACCs. A total 637 different combinations of species x jurisdiction x data sets resulted.

Table 4. Type of data used for assessments in SAFS reports for South Australian species.

Common name	Indicators	Key data sources	Other data presented / mentioned	Authors
Australian Salmon	*Catch* *Catch rates*	Commercial landings Commercial effort Commercial catch rate Catch, effort and CPUE performance indicators and reference points	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch	Anthony Fowler (SARDI)
Australian Sardine	*Exploitation rate* *Catch data*	Commercial landings Commercial effort Commercial catch rate Catch-at-age Assessment results – biomass Biomass reference point TACC Sex ratio- commercial Age frequency - commercial Length frequency - commercial	Longevity and maximum size Maturity (50%) Number of vessels	Tim Ward (SARDI)
Blacklip Abalone	*Catch* *CPUE*	Commercial landings Commercial effort Catch rate TACC Percent large FIS Abundance Assessment results – Egg production Mean length	Longevity and maximum size Maturity (50%) Number of vessels	Stephen Mayfield (SARDI)
Blue Swimmer Crab	*Fishery- independent legal-sized and pre- recruit abundance* *Catch* *CPUE*	Commercial landings Commercial effort Catch rate Fishery-independent pot surveys Fishery dependent pot sampling TACC	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch	Craig Noell (SARDI)
Dusky Shark	*Status based on Western Australian stock assessment*			Anthony Fowler (SARDI)
Giant Crab	*Percentage of egg production relative to unfished level (not in SA)* *CPUE* *Proportion of spawning stock protected by minimum size limits (not in SA)*	Commercial landings Commercial effort Catch rate TACC	Longevity and maximum size Maturity (50%) Number of vessels	Adrian Linnane (SARDI)
Greenlip Abalone	*CPUE* *Fishery- independent surveys – relative density*	Commercial landings Commercial effort Catch rate TACC Percent large FIS Abundance Assessment results – Egg production	Longevity and maximum size Maturity (50%) Number of vessels	Stephen Mayfield (SARDI)

Common name	Indicators	Key data sources	Other data presented / mentioned	Authors
		Mean length		
King George Whiting	**Catch* **CPUE* *age structure* **biomass*	Commercial catch Commercial effort Commercial catch rate Length age Movement - Tag-recapture Assessment results – biomass Assessment results – recruitment Assessment results – exploitation Commercial age structure Commercial length frequency	Stock structure Longevity and maximum size Maturity (50%) Number of vessels Recreational catch	Anthony Fowler (SARDI)
Pipi	*Fishery-independent relative abundance* *size frequencies*	Commercial catch Commercial effort Commercial catch rate Fishery Independent Survey – relative biomass Fishery Independent Survey – size frequency recreational catch and effort data	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch	Greg Ferguson
Snapper	*Catch* *CPUE* *age structures* *biomass*	Commercial catch Commercial effort Commercial catch rate population age structures recreational catch and effort data charter boat catch and effort data commercial length-frequency samples commercial catch-at-age samples Assessment results – biomass Yearly proportion of trips reaching 250 kg	Longevity and maximum size(non-SA refs) Maturity (50%) (non-SA refs) Number of vessels Recreational catch	Anthony Fowler (SARDI)
Southern Calamari	*Catch* *Effort* *CPUE trends*	Commercial catch Commercial effort Commercial catch rate	Longevity and maximum size(non-SA refs) Maturity (50%) (non-SA refs) Number of vessels Recreational catch	Michael Steer (SARDI)
Southern Rock Lobster	*Percentage of egg production relative to unfished level* *proportion of spawning stock protected by minimum size limits*	Commercial catch Commercial effort Commercial catch rate Commercial length frequency [15] Puerulus Settlement Index Fishery Independent Monitoring Survey Assessment results – egg production Assessment results – Biomass Assessment results – % virgin egg production Assessment results – % exploitation rate Assessment results – Recruitment TACC Pre-recruit abundance reference point	Longevity and maximum size (non-SA refs) Maturity (50%) Number of vessels	Adrian Linnane (SARDI)
Western King Prawn	*Survey catch rates*	Commercial catches Fishery Independent Survey – catch rate Fishery Independent Survey – Egg production Fishery Independent Survey – Recruitment index	Longevity and maximum size Maturity (50%) Number of vessels	Craig Noell (SARDI)

Common name	Indicators	Key data sources	Other data presented / mentioned	Authors
		Recruitment index reference point Total commercial catch reference point Mean commercial CPUE reference point Indices of future and current biomass reference point November recruitment index 209 shots reference point February recruitment index 209 shots reference point April recruitment index 209 shots reference point Egg production (×106 eggs.trawl-hour-1) reference point % of 20+ in the catch – November and December reference point % of 20+ in the catch – March to June reference point % of 16/20 in the catch – November and December reference point % of 16/20 in the catch – March to June Prawn size		

Table 5. Type of data used for assessments in SAFS reports for Northern Territory species

Common name	Indicators	Key data sources	Other data presented / mentioned	Authors
Barramundi	*Catch* *CPUE* *length and age frequencies* *harvest rate*	Commercial catch Commercial effort Commercial catch rate Tagging data Abundance surveys Length frequency – commercial Age frequency - commercial	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch Charter catch Indigenous catch	Thor Saunders (DPIF)
Blacktip Shark	*Catch* *mark recapture* *CPUE* *pup production*	Commercial catch Commercial effort Commercial catch rate Assessment results – Pup production Assessment results – Pup production Assessment results – Pup production MSY Assessment results – Harvest rate Assessment results – Harvest rate MSY Mark-recapture	Longevity and maximum size Maturity (50%) Number of vessels	Grant Johnson (DPIF)
Coral Trout	*Catch*	Commercial catch	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch	Thor Saunders (DPIF)
Crimson Snapper	*Catch*	Commercial catch	Longevity and maximum size	Julie Martin (DPIF)

Common name	Indicators	Key data sources	Other data presented / mentioned	Authors
	CPUE	Commercial effort	Maturity (50%)	
		Assessment (of Saddletail Snapper) – Egg production	Number of vessels	
		Assessment (of Saddletail Snapper) – Egg production	Recreational catch	
			Charter catch	
		MSY		
		Assessment results (of Saddletail Snapper)– Harvest rate		
		Assessment results (of Saddletail Snapper)– Harvest rate at MSY		
Goldband Snapper	*Catch*	Commercial catch	Longevity and maximum size (Non-NT refs)	Julie Martin (DPIF)
	CPUE	Commercial effort	Maturity (50%) (Non-NT refs)	
	SRA	Commercial catch rate	Number of vessels	
		Assessment– Egg production	Recreational catch	
		Assessment – Egg production	Charter catch	
		MSY		
		Assessment results – Harvest rate		
		Assessment results – Harvest rate at MSY		
Mud Crab	*Catch*	Commercial catch	Longevity and maximum size	Mark Grubert (DPIF)
	Effort	Commercial effort	Maturity (50%)	
	CPUE	Commercial catch rate	Number of vessels	
	Mortality (but not listed)	Assessment results – F	Recreational catch	
		Assessment results – M	Indigenous catch	
		Assessment results – Recruitment		
		Assessment results – Biomass		
Red Emperor	*Catch*	Commercial catch	Longevity and maximum size	Julie Martin (DPIF)
	Trigger		Maturity (50%)	
	Reference points (species composition of commercial catches)			
Saddletail Snapper	*Catch*	Commercial catch	Longevity and maximum size	Julie Martin (DPIF)
	CPUE	Commercial effort	Maturity (50%)	
	SRA –egg production (not listed)	Assessment results – Egg production	Recreational catch	
		Assessment results – Egg productionat MSY	Charter catch	
		Assessment results – Harvest rate		
		Assessment results – Harvest rate at MSY		
Spanish Mackerel	*Catch rate*	Commercial effort	Longevity and maximum size	Thor Saunders (DPIF)
	Egg production	Commercial catch rate	Maturity (50%)	
		Assessment results – EGGcur/EGG0	Recreational catch	
		Assessment results – Ucur/Umsy		

Table 6. Type of data used for assessments in SAFS reports for Queensland species. Shaded species are those that were reported by FQ in the SAFS format, but were not reported in the 2014 SAFS.

Common name	Indicators	Key data sources	Other data presented / mentioned	Authors
Saucer Scallop	*Catch* *CPUE*	Commercial catch Commercial effort Commercial catch rate Assessment results (MSY)	Longevity and maximum size Maturity (50%) Number of vessels	Brad Zeller (FQ)
Blue Swimmer Crab	*Catch* *CPUE* *fishery-independent juvenile abundance*	Commercial catch Commercial effort Commercial catch rate Fishery-independent recruitment surveys CPUE decile TAC	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch	Stephen Wesche (FQ)
Spanner Crab	*Target CPUE* *target fishery-independent CPUE*	Commercial catch Commercial effort Commercial catch rate Fishery-independent surveys TACC	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch Indigenous catch	Jason McGilvray (FQ)
Mud Crab	*Catch* *effort* *CPUE*	Commercial catch Commercial effort Commercial catch rate Assessment results – F, M, Z	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch Indigenous catch	Megan Leslie (FQ)
Balmain Bug	*Catch rates* *size structure (NSW)*	Commercial catch Commercial effort Commercial catch rate	Longevity and maximum size Maturity (50%) Number of vessels	Brad Zeller (FQ)
Moreton Bay Bug	*Catch* *CPUE*	Commercial catch Commercial effort Commercial catch rate	Longevity and maximum size Maturity (50%) Number of vessels	Brad Zeller (FQ)
Tropical Rock Lobster	*Biomass, fishing mortality*	Commercial catch Commercial effort Commercial catch rate Assessment results – Biomass, MSY TACC	Longevity and maximum size Maturity (50%) Number of vessels Indigenous catch	Anthony Roelofs (FQ)
Eastern King Prawn	*Biomass* *Catch* *Effort and CPUE relative to MSY reference points* *Fishery-independent index of recruit abundance*	Commercial catch Commercial effort Commercial catch rate Assessment results – Biomass, MSY TACC CPUE MSY reference points Effort at MSY	Longevity and maximum size Maturity (50%) Number of vessels	Andrew Prosser (FQ)
Endeavour Prawns	*Catch* *effort*	Commercial catch Commercial effort Commercial catch rate	Longevity and maximum size Maturity (50%) Number of vessels	Michelle Winning (FQ)
School Prawn	*Catch* *CPUE*	Commercial catch Commercial effort	Longevity and maximum size Maturity (50%)	Brad Zeller (FQ)

Common name	Indicators	Key data sources	Other data presented / mentioned	Authors
		Commercial catch rate ERA	Number of vessels	
Tiger Prawns	*Biomass* *Spawning stock size* *Catch* *Effort*	Commercial catch Commercial effort Commercial catch rate Assessment results – Biomass Assessment results – BMSY Assessment results – EMSY Percent of distribution subject to fishing	Longevity and maximum size Maturity (50%) Number of vessels	Brad Zeller (FQ)
Western King Prawn	*Catch*	Commercial catch Commercial effort Commercial catch rate Percent of distribution subject to fishing ERA	Longevity and maximum size Maturity (50%) Number of vessels	Brad Zeller (FQ)
White Banana Prawn	*Catch* *Stock assessments*	Commercial catch Commercial effort Commercial catch rate Assessment results - MSY Assessment results – Biomass ERA	Longevity and maximum size Maturity (50%) Number of vessels	Brad Zeller (FQ)
Blacktip Shark	*Catch*	Commercial catch Commercial effort	Longevity and maximum size Maturity (50%) Number of vessels	Anthony Roelofs (FQ)
Sandbar Shark	*Catch*	Commercial catch Commercial effort	Longevity and maximum size Maturity (50%) Number of vessels	Anthony Roelofs (FQ)
Barramundi	*Catch* *Length and age frequencies* *Mortality rates* *CPUE*	Commercial catch Commercial effort Commercial catch rate Length frequencies – commercial and recreational Age frequencies – commercial and recreational Natural mortality Total mortality	Longevity and maximum size Maturity (50%) Number of vessels Recreational / indigenous catch	Olivia Whybird (FQ)
Black Jewfish	*Catch*	Commercial catch	Longevity and maximum size Maturity (50%) Number of vessels	Anthony Roelofs (FQ)
Coral Trout	Quantitative stock assessment Catch CPUE	Commercial catch Commercial effort Commercial catch rate Assessment results – Biomass Assessment results – MSY TACC	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch Charter catch	Malcolm Keag (FQ)
Mulloway	*Catch*	Commercial catch	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch	Anthony Roelofs (FQ)
Murray Cod	*CPUE*	Stocking numbers	Longevity and maximum size	Steven Brooks (FQ)

Common name	Indicators	Key data sources	Other data presented / mentioned	Authors
	Age/size composition		Maturity (50%)	
Tailor	*Biomass*	Commercial catch	Longevity and maximum size	Lenore Litherland (FQ)
	Catch	Assessment results – Biomass	Maturity (50%)	
	Effort	Assessment results – MSY	Number of vessels	
	Fishery-dependent length and age frequency	TACC	Recreational catch	
		Length frequencies – commercial and recreational		
	Estimates of total mortality rate	Age frequencies – commercial and recreational		
Yellowtail Kingfish	*Commercial catch rates*	Commercial catch	Longevity and maximum size	Malcolm Keag (FQ)
	Fishing mortality		Maturity (50%)	
	Yield per recruit analysis		Number of vessels	
			Recreational catch	
Dusky Flathead	*Commercial catch and CPUE*	Commercial catch	Longevity and maximum size	Jason McGilvray (FQ)
	Length and age composition	Commercial effort	Maturity (50%)	
	Mortality rate (Z)	Commercial catch rate	Number of vessels	
		Length frequencies – commercial and recreational	Recreational catch	
		Age frequencies – commercial and recreational		
		Recreational effort		
		Z		
		F		
		M		
Grey Mackerel	*Quantitative stock assessment*	Commercial catch	Longevity and maximum size	Anthony Roelofs (FQ)
	Biomass	Commercial effort	Maturity (50%)	
	Fishing mortality	Commercial catch rate	Number of vessels	
	Catch	Assessment results – Biomass		
	Catch rate	Assessment results – MSY		
		TACC		
		Length frequencies – commercial		
		Age frequencies – commercial		
		Z		
		F		
		M		
Spanish Mackerel	*Biomass*	Commercial catch	Longevity and maximum size	Joanne Langstreth (FQ)
	Fishing mortality Catch and catch rate	Commercial effort	Maturity (50%)	
	Length and age structure	Commercial catch rate	Number of vessels	
	TAC	Assessment results – Biomass		
	Performance indicators	Assessment results – MSY		
		TACC		
		Length frequencies – commercial and recreational		
		Age frequencies – commercial and recreational		
		Z		
		F		
		M		
Sea Mullet	*Catch*	Commercial catch	Longevity and maximum size	Andrew Prosser (FQ)
	CPUE	Commercial effort	Maturity (50%)	
	Length and age frequencies	Commercial catch rate	Number of vessels	
		Length frequencies – commercial		
		Age frequencies – commercial		
		Z		

Common name	Indicators	Key data sources	Other data presented / mentioned	Authors
		F M		
Snapper	*Catch* *CPUE* *Fishing mortality* *Age composition*	Commercial catch Commercial effort Commercial catch rate Assessment results – Biomass Assessment results – MSY Length frequencies – commercial, recreational and charter Age frequencies – commercial, recreational and charter Z F M	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch Charter boat catch	Stephen Wesche (FQ)
Yellowfin Bream	*Commercial catch and CPUE* *Length and age* *Mortality rate*	Commercial catch Commercial effort Commercial catch rate Assessment results – MSY Length frequencies – commercial and recreational Age frequencies – commercial and recreational Z F M	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch	Jason McGilvray (FQ)
Crimson Snapper	*Catch* *CPUE*	Commercial catch Commercial effort Commercial catch rate	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch Charter boat catch	Malcolm Keag (FQ)
Goldband Snapper	*Catch* *Quota usage* *Performance indicators*	Commercial catch Commercial effort	Longevity and maximum size Maturity (50%) Number of vessels Charter boat catch	Malcolm Keag (FQ)
Golden Snapper	*Catch* *Standardised CPUE* *Observer surveys* *Performance indicators*	Commercial catch Commercial effort Commercial catch rate Observer surveys	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch Charter boat catch	Malcolm Keag (FQ)
Red Emperor	*Catch* *Standardised CPUE* *Observer surveys* *Performance indicators*	Commercial catch Commercial effort Commercial catch rate Observer surveys	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch Charter boat catch	Malcolm Keag (FQ)
Redthroat Emperor	*Catch* *CPUE* *Stock assessment*	Commercial catch Commercial effort Commercial catch rate Assessment results – Biomass Assessment results – MSY	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch Charter boat catch	Malcolm Keag (FQ)

Common name	Indicators	Key data sources	Other data presented / mentioned	Authors
Saddletail Snapper	*Catch* *CPUE*	Commercial catch Commercial effort Commercial catch rate	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch Charter boat catch	Malcolm Keag (FQ)
Sand Whiting	*Commercial catch and CPUE* *Length and age frequencies* *Mortality rate*	Commercial catch Commercial effort Commercial catch rate Length frequencies – commercial and recreational Age frequencies – commercial and recreational Z F M Recreational effort	Longevity and maximum size Maturity (50%) Number of vessels	Jason McGilvray (FQ)
Stout Whiting	*Standardised catch rate* *Catch-at-age frequencies*	Commercial catch Commercial effort Commercial catch rate Assessment results – Biomass Assessment results – BMSY Assessment results – Egg production Assessment results – EMSY Z Zref Length frequencies – commercial and recreational Age frequencies – commercial and recreational Z TACC	Longevity and maximum size Maturity (50%) Number of vessels	Darren Roy (FQ)
Mangrove Jack	*Catch* *Standardised CPUE* *Observer surveys* *Performance indicators*	Commercial catch Commercial effort Commercial catch rate Observer data Assessment results – Biomass	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch	
Pearl Perch	*Catch* *CPUE* *Fishery - dependent length age and mortality estimates*	Commercial catch Commercial effort Commercial catch rate Length frequencies – commercial, recreational and charter Age frequencies – commercial and recreational and charter Z F M	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch Charter catch	
King Threadfin	*Catch* *Catch rate*	Commercial catch Commercial effort Commercial catch rate	Longevity and maximum size Maturity (50%) Number of vessels	
Red Spot King Prawn	*Biomass* *Catch and catch rate*	Commercial catch Commercial effort	Longevity and maximum size Maturity (50%)	

Common name	Indicators	Key data sources	Other data presented / mentioned	Authors
	Fishing effort	Commercial catch rate Percent of distribution subject to fishing	Number of vessels	
Spotted Mackerel	*Biomass* *Catch and catch rate Fishery dependent* *length and age frequency* *Estimates of total mortality rate*	Commercial catch Commercial effort Commercial catch rate Assessment results – Biomass Length frequencies – commercial and recreational Age frequencies – commercial and recreational Z F M	Longevity and maximum size Maturity (50%) Number of vessels Recreational catch	

Data descriptions

Confidentiality arrangements

SARDI Aquatic Sciences

Section 124 of the Fisheries Management Act 2007 sets out SARDI's data confidentiality responsibilities, which states:

(1) *A person engaged or formerly engaged in the administration of this Act or the repealed Act must not divulge or communicate information obtained (whether by that person or otherwise) in the course of official duties except—*

(a) as required or authorised by or under this Act or any other Act or law; or

(b) with the consent of the person to whom the information relates; or

(c) in connection with the administration of this Act, the repealed Act or a corresponding law; or

(d) to a law enforcement, prosecution or administrative authority of a place outside this State, where the information is required for the proper administration or enforcement of a law of that place relating to fishing; or

(e) for the purposes of any legal proceedings arising out of the administration of this Act, the repealed Act or a corresponding law.

(2*) Subsection (1) does not prevent disclosure of statistical or other data that could not reasonably be expected to lead to the identification of any person to whom it relates.*

(3) Information that has been disclosed under subsection (1) for a particular purpose must not be used for any other purpose by—

(a) the person to whom the information was disclosed; or

(b) any other person who gains access to the information (whether properly or improperly and whether directly or indirectly) as a result of that disclosure.

(4) Despite any other law to the contrary, the Minister, the Director or any other person to whom a return is provided under this Act by the holder of a fishery licence or other authority cannot be required by subpoena or otherwise to produce to a court any information contained in such a return.

While the Act does not define "could not reasonably be expected to lead to the identification of any person to whom it relates", SARDI adopted an internal confidentiality policy called "the five boat rule", generally requiring that data be withheld unless aggregated so it comprises data from at least five licence holders (Vainickis, 2010). Confidential data are available to all SARDI Aquatic Sciences researchers for research and management with written approval of the relevant Science Program Area Leader, who is responsible for ensuring confidentiality is maintained during use, including presentation and reporting (Vainickis, 2010). Confidential data can be provided for external research on request to the Executive Director of SARDI or the Chief of Aquatic Sciences, but external researchers may be required to enter into a data confidentiality agreement with the Minister of Agriculture, Food, and Fisheries and maintain the confidentiality of those data.

NT Department of Primary Industries and Fisheries

Section 36 of the Northern Territory's Fisheries Act sets out their data confidentiality responsibilities as follows:

(1) Subject to this section, a person who is a member of the Police Force of the Northern Territory or an employee as defined in the Public Sector Employment and Management Act or a Fisheries Officer shall not, either directly or indirectly, except in the performance of their duty as a member or employee or Officer, as the case may be, and either while they are or after they cease to be a member or employee or Officer, make a record of or divulge or communicate to any person any information respecting the affairs of any other person disclosed or obtained under or pursuant to this Act or an Act repealed by this Act.

(2) For the purposes of subsection (1), the Director shall:

(a) hold all records and papers that could be the subject of an offence against subsection (1) in the Director's custody; and

(b) ensure that no employee or other person sees them or learns of their contents unless it is necessary or desirable that they do so for the purposes of the administration of this Act or of prosecuting a person for an offence against this Act.

(3) Without limiting the generality of subsection (2), the Director shall not allow a person to see a record or paper or learn of its contents by reason only that that person is:

(a) a Minister or other public official; or

(b) constituting a court or tribunal or exercising a judicial or administrative power or function.

Like SARDI, NT DPIF have implemented a "five boat rule" prohibiting the publication of data arising from fewer than five licence holders.

Department of Agriculture and Fisheries – Queensland Government

In most cases, FQ provides fisheries data at a resolution of 30 nm or 6 nm grids, aggregated so information comprises more than five boats. A data request procedure sees all requests forwarded through the assessment and monitoring unit's data coordinator. Access to non-aggregated data requires the approval of the Fisheries Data Coordinator and a confidentiality agreement.

Data collected as a part of Long Term Monitoring Programs (LTMP) can also be provided subject to a data agreement through the Fisheries Data Coordinator. Such agreements stipulate how to acknowledge data in publications and can include reporting restrictions. Copies of final reports using LTMP data must be provided to the Fisheries Data Coordinator.

Commercial catch and effort data

SARDI

The Information Systems and Database Support Program at SARDI Aquatic Sciences are responsible for managing catch, effort and value data collected from fisheries. Data is stored in an Oracle 10g database on a server managed by the PIRSA Information Communication Technology (ICT) group (Vainickis, 2010). This relational database allows for entry, update and extraction of large volumes of data by linking multiple tables while maintaining consistency between tables. Data from each fishery is recorded in its own system with customised data entry screens, validation routines and reports. These systems are described in detail in Vainickis (2010). The process linking catch and effort forms to making data available for report publication includes QA / QC processes described in detail in Vainickis (2010), but briefly comprises (Figure 1):

(i) fishers must report their activities on logbooks supplied and return completed forms within a specified timeframe;

(ii) (ii) forms are stamped upon receipt by SARDI Aquatic Sciences and registered in the relevant logbook register system, while forms not received on time are followed up;

(iii) (iii) forms are processed for completeness and accuracy, and any issues are followed up with the fisher via phone or mail;

(iv) (iv) data are keypunched, validation routines are applied and corrections made;

(v) (v) electronic data are stored on a secure servers that are run over mirror disks, and a backup cycle comprising daily, weekly and monthly routines is employed; and

(vi) (vi) reports are run to supply users with data. Species are entered using alpha codes or common name.

The database holds commercial catch and effort records going back to 1968, although this varies by species / fishery. Charter Boat fishery records go back to 2005. Fishers record catches on a daily basis, but submit logbooks monthly. Some fisheries use electronic logbooks (e.g. the Southern Rock Lobster and Western King Prawn fisheries). The reporting time-step varies between fisheries, and includes

shot start and end time (e.g. prawn fisheries, Sardine Fishery), day (e.g. Marine Scalefish and Lakes and Coorong fisheries) and a combination of day / dive number / diver (e.g. Abalone fisheries). Like-wise, spatial resolution varies between fisheries and incorporates: fishing area; grid or map code (at different scales for different fisheries; e.g. Blue Crab, Rock Lobster, Charter and Abalone fisheries); GPS locations (e.g. Sardine and Giant Crab fisheries); and distance from the Murray River mouth (e.g. Pipi Fishery). Catch and effort reporting maps are shown in Appendix 1. Catch weights are mostly estimated. The catches per shot for the Sardine and Western King Prawn fisheries are estimated but landed weights are measured. Landed Southern Rock Lobster, Australian Sardine, Blacklip Abalone, Greenlip Abalone and Blue Swimmer Crab weights reported in logbooks are compared to catch disposal records (CDR).

Data are analysed using Excel, R, Grapher and or Sigmaplot. Common QA / QC procedures undertaken during analyses include: comparing data extracts with previous extractions; repeating some fraction of analyses using different software and / or by a different person; comparison with outputs from previous years; and formal review by additional SARDI scientists (Fowler *et al*., 2013, Noell *et al*., 2014). The range of spatial resolutions and units of catch, effort and CPUE reported in SAFS and / or assessment reports are shown in Table 7.

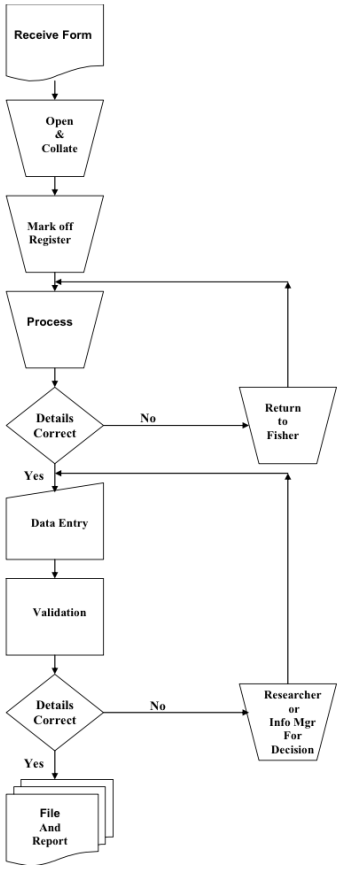


Figure 1. The information lifecycle used in SARDI Aquatic Sciences' Fishery Information Systems (reproduced from Vainickis, 2010).

Table 7. Spatial resolution, units and catch, effort and CPUE for South Australian species reported in SAFS or assessment reports. Where spatial resolution is different for CPUE, resolution indicated in parenthesis.

	Spatial resolution	Catch	Units of Effort	CPUE
Australian Salmon	MSF Fishing Areas, gear	t	fisher days	kg/fisherday
Australian Sardine	Fishery, region, fishing area	t	night sets	Tonnes/night and Tonnes/night set
Blacklip Abalone	Fishery, spatial assessment unit and mapcode	t	hrs and days, mean daily effort	Various (S.E.)
Blue Swimmer	Sector, map number	t	boatdays and potlifts	kg/potlift (S.D.)
Charter Fishery	Fishery and Region	Number		
Giant Crab	Zone	t, percent of TAC caught	potlifts	kg/potlift(S.D.)
Greenlip Abalone	Fishery, spatial assessment unit and mapcode	t, percent of TAC caught	hrs and days, mean daily effort	Various (S.E)
King George Whiting	State, stock, region, gear	t	fisherdays	kg/fisherday
Pipi	State, fishery, LCF, and distance from Murray Mouth (in 20km groups)	t	days and fisher days and fisher hours	kg/day and kg/fisher day (S.E.)
Snapper	State, region, gear, MSF Fishing Areas	t, proportion of trips catching >250 kg	fisherdays	kg/fisherday
Southern Calamari	State, gear, region	t	fisherdays	kg/fisherday
Southern Rock Lobster	Zone, region	t	potlifts	kg/potlift
Western King Prawn	Fishery, fishing block	t	hrs	kg/hr

NT Department of Primary Industries and Fisheries

NT DPIF warehouse commercial and charter catch and effort data in an ORACLE database. Internal documentation describes the processes and structures of the catch and effort database but this information is not publically available. Data is maintained by the Logbooks Coordinator located at Berrimah Farm DPIF. Data are submitted monthly through logbooks specific to each fishery, which include instructions for fishers to complete them. Data are backed up daily. Commercial catch and effort data for Barramundi go back as far as 1973. Where information was made available for other species, data goes back to 1983. Charter catch reporting started in 1994. Verification of data occurs through general compliance activities but also using CDRs for some fisheries (e.g. Timor Reef Fishery). Data are covered by the confidentiality arrangements described above but can be made available in cases covered by a formal data sharing contract.

Reported spatial and temporal scales differ between fisheries. For example, the Coastal Line Fishery reports location in latitude and longitude (degrees and minutes) and the date and time of each fishing session where the Barramundi Fishery reports in Grid Numbers (10 minute x 10 minute cells), Area or River and Start Date /Finish Date. Catch and effort reporting maps are shown in Appendix 1. Catch in the commercial fisheries is usually reported in kilograms but the number of fish is also recorded for some fisheries including the Spanish Mackerel Fishery, Coastal Line Fishery, Offshore Net and Line Fishery, Demersal Fishery and the Timor Reef Fishery. Number of fish is recorded for the Charter Fishery but weight of catch is not. Effort records vary between fisheries and gears, and may include hours (e.g. Charter Fishery, Coastal Net Fishery), number of traps/pots (e.g. Timor Reef Fishery, Mud Crab Fishery, Demersal Fishery), number of dropline shots (e.g. Timor Reef Fishery, Demersal Fishery), length of net (e.g. Barramundi Fishery, Offshore Net and Line Fishery), number of hooks (e.g. Offshore Net and Line Fishery), number of lines used (e.g. Spanish Mackerel Fishery), or shot duration (e.g. Fishfish Trawl Fishery). Common name is the primary species notation used in the database.

The number of records varies by species ranging from tens of thousands for Black Jewfish to millions of records for Barramundi. Data are extracted as .txt files using Access and most analyses and graphs are produced in Excel. Catch and effort are usually reported annually with an annual time-step. Units reported for catch are tonnes for most fisheries with numbers of fish used for the Charter Fishery. Units of effort vary between fisheries reflecting the range of effort units collected through logbooks.

Table 8. Spatial resolution, units and catch, effort and CPUE for Norther Territory species from the main fisheries in which they are catch (fishery shown in parenthesis). Where spatial resolution is different for CPUE. Kg/hmnd = kg / 100 metre net days.

		Units of		
	Spatial resolution	**Catch**	**Effort**	**CPUE**
Barramundi (BF)	Fishery	t	100 metre net days (hmnd)	Kg/hmnd
Blacktip Shark (ONLF)	Biological stock/ fishery	t	Boat days	Kg/day
Coral Trout (TRF)	State	t	Boat days	t/boat day
Crimson Snapper (DF)	Stock	t	Boat days	t/boat day
Goldband Snapper (TRF)	Stock	t	Boat days	t/boat day
Mud Crab (MCF)	Stock	t	Pot-lifts	Kg/pot-lift
Red Emperor (TRF)	State	t	Boat days	t/boat day
Saddletail Snapper (DF)	Stock	t	Boat days	t/boat day
Spanish Mackerel (NTSMF)	State	t	Boat days	Kg/boat day
Charter Fishery	State	Number of fish	Line hours	Number of fish per line hour

Queensland

Qld use SQL2008 to warehouse commercial and charter boat catch and effort data. Qld did not supply metadata for their catch and effort database but this is currently being documented (Nadia Engstrom, pers. comm.). The Fisheries Data - Standard Operating Procedure was requested but had not been finalised at the time of writing. Catch and effort data is maintained by FQ's Licensing and Fisheries Information section. DAFF IT staff can make changes to the database on request from FQ's Licensing and Fisheries Information section. Fishers submit logbooks, which feature instructions for filling out forms, monthly but report daily. Quota species may have more stringent reporting requirements. The East Coast Trawl Fishery has been given the option to use eLogs over the past 12 months. This option will soon be made available to other fisheries.

The catch and effort database holds records back to 1988. As of August 2015, the database held over 5.5 million records. The database is backed up daily (7am), while the Data Mining Environment is backed up twice weekly on Thursday and Sunday. The backup process makes a complete copy of the SQL database. Catch is verified using CRDs in some quota species. Anywhere accuracy issues with logbook data are suspected compliance activities are employed, such as obtaining supporting documents (e.g. sales documents) and on water logbook checks. Data are generally considered complete but some fields are occasionally omitted by fishers. Data are covered by the confidentiality arrangements described above (five boat rule) but can be made available under a formal data sharing contract. FQ's Licensing and Fisheries Information section staff perform verification at data entry and data check reports. Aggregated data is available online (http://qfish.fisheries.qld.gov.au/). The database uses CAAB codes, common names and scientific names.

Locations are reported as either latitude and longitude (degrees and minutes), or using 6 minute x 6 minute grids with both options available in most logbooks — the Stout Whiting Trawl Fishery, Gulf of Carpentaria Fin Fish Trawl logbook requires start and end latitude and longitude. The East Coast Trawl Fishery and Shark and Ray logbooks require only one position each day at the "Position of Maximum Catch". Catch and effort reporting maps are shown in Appendix 1, and shape files of the 6

minute x 6 minute grids can be downloaded[11]. Catch is usually reported in kg but exceptions to this include: numbers of baskets of scallops (e.g. Queensland East Coast Trawl logbook); number of fish (e.g. Queensland Net Fishery Gulf Of Carpentaria No. 2, Gulf Of Carpentaria Inshore Net And Crab Fisher logbooks); number of 17 kg boxes (e.g. Stout Whiting Trawl logbook); and number of fish for minor species (reported in the Gulf of Carpentaria Fin Fish Trawl Fishery logbook). Catch weight is generally estimated but measured weights (using certified scales) are obtained for some quota species through CDRs. Effort units also vary with species. Start and end time (e.g. Stout Whiting Trawl, Gulf of Carpentaria Fin Fish Trawl), number of shots and total hours trawled (e.g. Stout Whiting Trawl), day (e.g. Shark and Ray logbook), number of dillies and number of dilly lifts (e.g. Spanner Crab Fishery logbook, Gulf Of Carpentaria Inshore Net And Crab Fishery), net length in metres (e.g. Net Fishery (Gulf of Carpentaria No.2) logbook, Gulf Of Carpentaria Inshore Net And Crab Fishery), number of lines and total number of hooks (e.g. Queensland Reef Line Multi-Hook Fin Fish Fishery Logbook), number of dories and number of crew (e.g. Queensland Gulf Of Carpentaria Line Fishery logbook) and total hours fishing (Torres Strait Daily Tropical Rock Lobster Fishery logbook). Catch disposal forms apply to select quota fisheries including the Coral Reef Fishery, Spanish Mackerel Fishery, Tropical Rock Lobster Fishery and Spanner Crab Fishery, in which landed catch of each species is reported as either number of containers or number of pieces, and weight (kg).

Data is provided to analysts as either Excel spreadsheets or Access tables. Genstat or R are used in analyses. Graphs are produced in Excel or R. Catch, effort and CPUE are usually reported with an annual time-step, most often based on calendar year but sometimes applying financial year (e.g. Coral Trout, Charter catch of Spanish Mackerel). Catch is reported in SAFS and assessment report in tonnes, while a variety of units are reported for effort and CPUE with multiple effort units reported for some species.

[11] http://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={D2031325-ACA2-4979-A4E3-6DA814220B24}

Table 9. Spatial resolution, units and catch, effort and CPUE for Qld species. Where spatial resolution is different for CPUE, resolution indicated in parenthesis.

	Spatial resolution	Catch	Effort	Units of CPUE
Balmain Bug	Stock	t	day	kg/day
Barramundi	Stock	t	100 m of net	kg/100 m of net
Black Jewfish		t		
Blue Swimmer		t	Boat / day	kg/boat/day
Crab	Gear type/region			
Charter fishery	Region	t		
		t	Day per primary licence	Kg / Day per primary licence
			Day per dory	Kg / Day per dory
Coral Trout	Stock/gear type			Standardised
Crimson Snapper	Stock	t	Days	kg/day
	Stock (Gear	t	100 m of net	kg/day and kg/100m net
Dusky Flathead	type/region)			
Eastern King		t	Days	kg/day
Prawn	Region			
Endeavour		t	Days	kg/day
Prawns	Region			
Goldband Snapper	Stock/gear type	t	Days	kg/day
Golden Snapper		t	Days	kg/day
Grey Mackerel	Stock/gear type	t	100 m of net	kg/100m net
King Threadfin	Gear type/region	t	100 m of net	kg/100m net
Mangrove Jack	Stock/gear type	t	Days	kg/day
Moreton Bay Bug	Stock	t	Days	kg/day
Mulloway	State	t		
Murray Cod				
Red Emperor	Stock/gear type	t	Days	kg/tender day and kg/main vessel day
Red Spot King		t	Days	kg/day
Prawn	Region			
Redthroat		t	Days	kg/tender day and kg/day per primary licence
Emperor	Stock/gear type			
Saddletail		t	Days	kg/day
Snapper	Stock			
Sandbar Shark	State	t		
	Gear type/region	t	Days	kg/day and kg/100m net
Sand Whiting	(Region)		100 m of net	
Saucer Scallop	Stock	t	Fisher days	Baskets per vessel per day
School Prawn	Gear type	t	Days	kg/day
Sea Mullet	Sector (Fishery)	t	Days	kg/day
	Gear type	t	Days	kg/day
Snapper	(Fishery)			
Spanish Mackerel	Stock/gear type	t	Days	kg/tender day
Spanner Crab	Stock	t	Net-lifts	kg/day
Spotted Mackerel	Gear type	t	Days	kg/day
Stout Whiting	State	t		Standardised (95% CI)
		t	Days	kg/day and kg/100m net
Tailor	Stock		100m net	
	Region (Gear	t	Days	kg/day
Tiger Prawns	type)			
Tropical Rock		t		kg/tender day
Lobster	Stock			
Western King		t	Days	kg/day
Prawn	Stock			
White Banana		t	Days	kg/day
Prawn	Gear type/region			
	Gear type	t	Days	kg/day and kg/100m net
Yellowfin Bream	(Fishery)		100m net	
Yellowtail Kingfish	State	t		

Other data-sets

Descriptions of all datasets for which information was obtained have been provided to the FRDC as Attachment 1, an Excel file with worksheets for each data type. They are not described in this section due to the large quantity of information, much of which is not directly presented in the SAFS, but

either comprises the textual component of the Stock Status section, or is used by jurisdictions for their own stock assessments.

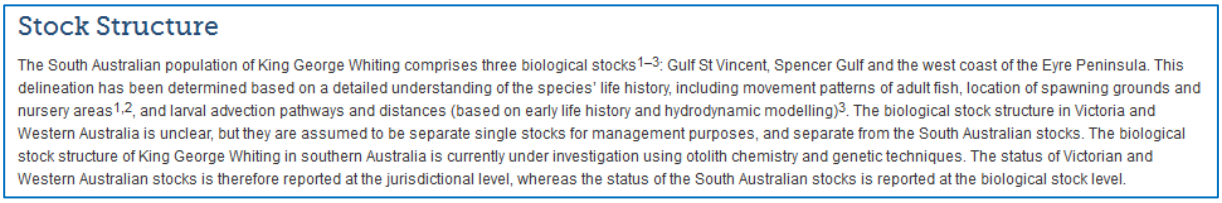
Opportunities for streamlining SAFS reports

The 2014 King George Whiting SAFS page was used as an example to describe opportunities for streamlining SAFS reports through on-line data acquisition in the following sections.

Stock structure

Stock structure is usually informed by ad-hoc research projects which can include: tagging; genetics; meristics; morphometrics; scale and otolith analysis; examination of life history characteristics; quantitative parasitology; otolith microchemistry; and an understanding of spawning behaviours and larval dispersal (Begg and Waldman, 1999). Stock structure is likely to remain constant for most species between SAFS updates. New information made available will likely be descriptive.

Because of the descriptive nature of the variables (Figure 2), the data on which the descriptions are based are meaningless to the general public and not required for compilation in the SAFS reports. A table containing descriptions of stock structure could be produced, with permissions for updating text given to either all authors, or one designated 'senior author'.



Stock Structure

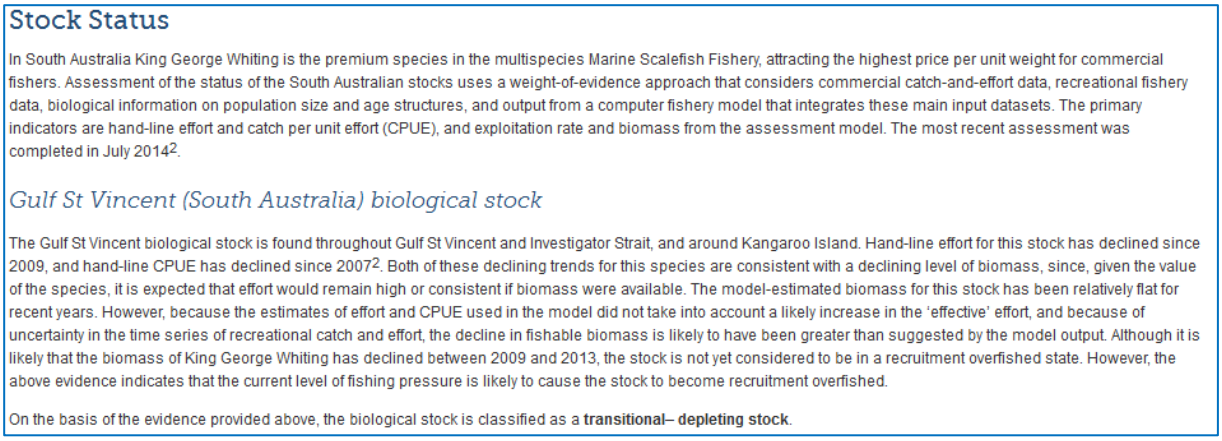
The South Australian population of King George Whiting comprises three biological stocks[1–3]: Gulf St Vincent, Spencer Gulf and the west coast of the Eyre Peninsula. This delineation has been determined based on a detailed understanding of the species' life history, including movement patterns of adult fish, location of spawning grounds and nursery areas[1,2], and larval advection pathways and distances (based on early life history and hydrodynamic modelling)[3]. The biological stock structure in Victoria and Western Australia is unclear, but they are assumed to be separate single stocks for management purposes, and separate from the South Australian stocks. The biological stock structure of King George Whiting in southern Australia is currently under investigation using otolith chemistry and genetic techniques. The status of Victorian and Western Australian stocks is therefore reported at the jurisdictional level, whereas the status of the South Australian stocks is reported at the biological stock level.

Figure 2. Description if stock status reported in the 2014 SAFS report for King George Whiting.

Stock status

A variety of indicators can be used to assess stock status even within a single species or stock. Because the SAFS uses a "weight of evidence" approach, stock status determinations are usually subjective, drawing on the most reliable, most detailed information available. Some data rich, high value species determinations are made by comparing objective indicators, such as stock assessment outputs and fishery independent surveys, to reference points. The diversity of information used for determinations likely leads to inconsistencies in the level of data provided — the extract below reports trends in biomass estimated by a stock assessment model for South Australian stocks with descriptions of catch and CPUE data (Figure 3), but the value for spawning potential ratio and trends in recruitment, catch and CPUE for this species were presented for the Western Australian stock, while no modelling results were referred to for the Victorian stock, relying instead on pre-recruit surveys and trends in catch, effort, CPUE and age and length structure.

SAFs stock status is largely textual, often with no data reporting at all (e.g. see Figure 3). When data are reported they are usually single datapoints — for example, the 2014 Stock status for the Western Australian stock of King George Whiting reports "*At current estimated levels of fishing mortality for King George Whiting, the spawning potential ratio (based on the spawning biomass per recruit) was estimated to be at a sustainable level (42 per cent)*". Some SAFS users would see value in accessing the data referred to, especially temporal trends in CPUE, biomass and recruitment. While references are provided, the size and detailed nature of assessment reports make finding information of interest time consuming. There is little value in proving an on-line data acquisition facility for the large variety of indicators used by SAFS authors, but providing facility for uploading hyperlinked images of time series data referred to in the SAFS might prove useful.



Stock Status

In South Australia King George Whiting is the premium species in the multispecies Marine Scalefish Fishery, attracting the highest price per unit weight for commercial fishers. Assessment of the status of the South Australian stocks uses a weight-of-evidence approach that considers commercial catch-and-effort data, recreational fishery data, biological information on population size and age structures, and output from a computer fishery model that integrates these main input datasets. The primary indicators are hand-line effort and catch per unit effort (CPUE), and exploitation rate and biomass from the assessment model. The most recent assessment was completed in July 2014[2].

Gulf St Vincent (South Australia) biological stock

The Gulf St Vincent biological stock is found throughout Gulf St Vincent and Investigator Strait, and around Kangaroo Island. Hand-line effort for this stock has declined since 2009, and hand-line CPUE has declined since 2007[2]. Both of these declining trends for this species are consistent with a declining level of biomass, since, given the value of the species, it is expected that effort would remain high or consistent if biomass were available. The model-estimated biomass for this stock has been relatively flat for recent years. However, because the estimates of effort and CPUE used in the model did not take into account a likely increase in the 'effective' effort, and because of uncertainty in the time series of recreational catch and effort, the decline in fishable biomass is likely to have been greater than suggested by the model output. Although it is likely that the biomass of King George Whiting has declined between 2009 and 2013, the stock is not yet considered to be in a recruitment overfished state. However, the above evidence indicates that the current level of fishing pressure is likely to cause the stock to become recruitment overfished.

On the basis of the evidence provided above, the biological stock is classified as a **transitional– depleting stock**.

Figure 3. Example description of stock status reported in the 2014 SAFS report for King George Whiting.

Biological data

Like stock structure data, longevity, maximum size and age and size at 50% maturity data are usually determined from ad-hoc research projects, and usually are not specific to the stock reported in the SAFS. The accepted values remain unchanged until either new research yields results or until the accepted values change (a range of different values from different research projects, jurisdiction and / or stocks often exists). For most species, these values will not change between SAFS reports (Figure 4).

The raw data used to derive / calculate these figures are unlikely of interest to the general public and in many cases is not available. Figures showing maturing curves (% of fish mature at age or length) might be of public interest. Likewise, while usually not referred to in SAFS reports, growth curves may be of interest (length at age). A diverse range of units of measure and/or measurement types are reported for these parameters (Table 10). A range of figures is often reported (see example highlighted in red in Figure 4), and figures are sometimes reported with text characters — for example: 30+ years; or ~ 10 kg. Maximum size weights are sometimes presented along with length. Different values for each sex are reported for some species and/or for different species within a species complex (e.g. Blacktip Shark). That sometimes lengths with more than more measurement type are presented (e.g. for Dusky Shark, maximum size for both total length and fork length are reported) adds a further complication. Rather than age at 50% maturity, age at first maturity is sometimes presented. The spatial scale of biological data also varies from species to species (for example for Southern Rock Lobster, one value of each parameter is presented for each species, for King George Whiting each jurisdiction has different values, while age and size at maturity for Tailor is reported by biological stock and sex). There are inconsistent uses of commas and semi-colons between values.

These differences in biological data are appropriate given the diversity of species included in the SAFS, and standardisation of reporting would be too difficult and unnecessary. The authors are the best people to decide the most informative spatial scale, measurement type, units of age, if a range of values should be used and any annotations required to either clarify values or provide an indication of uncertainty (ie ~). In this case, it is probably best to leave this table as a "free text" table, particularly as they are unlikely to change from year to year.

From a SAFS user's point of view, one problem I have with the way references are presented is that it is often difficult to match the reference with the value. For example in Figure 4, the references "1, 9–12" could include only of the 10 biological parameters displayed. When trying to match the value to the reference, it is often not obvious from the report title which state / stock the report includes, and in some case the full text of the references are not freely available online (e.g. from many scientific journals). I recommend that reference numbers are placed next to each value.

A suggested database structure and table are shown in

and Table 11, which could be made available to authors via online forms. Modified from Finn *et al.* (2015), I recommend the following author instruction for reporting of Biological data:

Table 2: [Standard fish name] biology

Longevity and Maximum size	X–Y years(reference number); X–Y mm TL(reference number)
Maturity (50%)	X–Y years(reference number); X–Y mm TL(reference number)

Footnote e.g. TL = total length — Spell out all acronyms from table 2 in full

- Provide references for all information in this table as superscript numerals at the end of each value. Note that reference ID numbers must be the unique ID, and will need to be substituted for chapter reference numbers prior to publication.
- Please ensure that age and size are separated by a semi-colon, and that there are spaces between values and units as shown
- The unit of size must be either mm and or kg
- The using age should either be years or months
- Please ensure that value ranges are separated by and "en dash" with no spaces
- Different values can be presented for different jurisdictions, stocks and / or sexes.
- Please ensure there is no space between a prefix and the value

Table 2: King George Whiting biology[1,9–12]

Longevity and maximum size	South Australia: 22 years; 590 mm TL Western Australia: 14 years; 620 mm TL Victoria: ≥6–11 years; 600 mm TL
Maturity (50%)	South Australia: 3–4 years; 300–350 mm TL Western Australia: 3–4 years; 410 mm TL Victoria: unknown

TL = total length

Figure 4. Table of biological data reported in the 2014 SAFS report for King George Whiting.

Table 10. Units and measurement types for biological data.

Parameter	Units	Measurement types	Number type
Longevity	year, months		Whole number, decimal (e.g. Southern Garfish)
Maximum size	mm, kg	TL, CL, CW, RCL, FL, SL	Whole number, decimal (e.g. School Shark)
Age at 50% maturity	year, months		Whole number, decimal (e.g. Sandbar Shark, Banded Morwong)
Size at 50% maturity	mm	TL, CL, CW, RCL, SL	Whole number, text (e.g. School Shark, Coral Trout)

TL (total length), CL (carapace length), CW (carapace width), RCL (rostral carapace length), FL (fork length), SL (standard length)

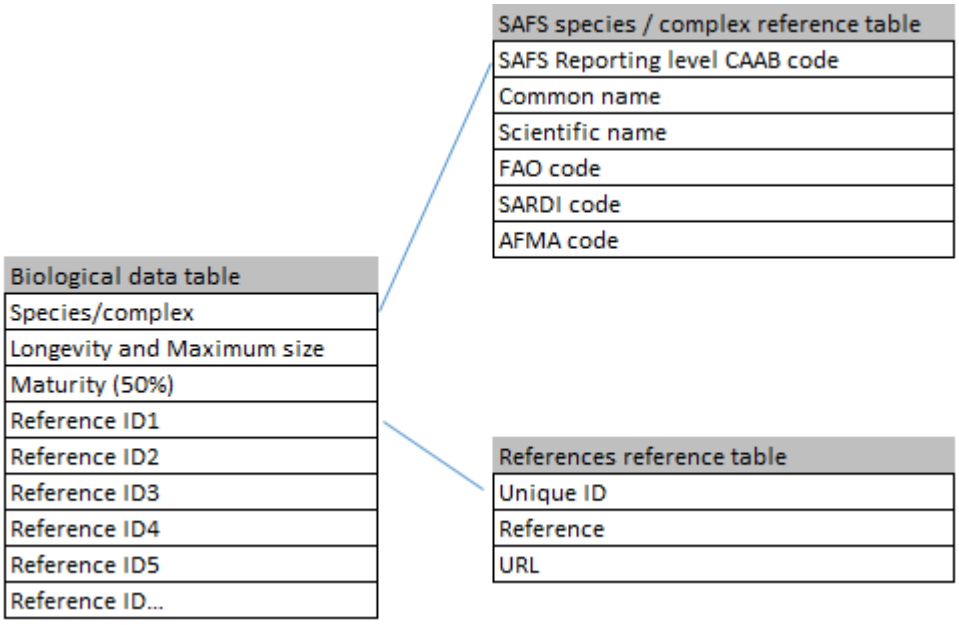


Figure 5. Example of structure of tables for recording biological data for SAFS.

Table 11. Example of table to record biological data for SAFS

Species / complex	Longevity and Maximum size	Maturity (50%)	Ref ID1	Ref ID2	Ref ID3	Ref ID4	Ref ID 5
37330001	South Australia: 22 years[1]; 590 mm TL[1] Western Australia: 14 years[9]; 620 mm TL[9] Victoria: ≥6–11 years[12]; 600 mm TL[12]	South Australia: 3–4 years[1]; 300–350 mm TL[1] Western Australia: 3–4 years[11]; 410 mm TL[11] Victoria: unknown	1	9	10	11	12

Spatial distribution of commercial catch

The spatial distribution of commercial catches is generally displayed in the SAFS as presence / absence using 1˚ grids by year following the format used in Georgeson *et al.*, (2014), without the heat map showing fishing effort intensity (Figure 7). For Murray Cod, catch distribution is recreational catch for the period 2006–2013 as no commercial fishery exists. Data are presented in the SAFS by calendar year for most species, but sometimes financial year (e.g. Coral Trout), fishing year (e.g. Southern Rock Lobster) or a combination of time steps (e.g. Australian Sardine) are used, as indicated in the figure caption. No benefits of presenting these data with different time steps seem obvious, however it is understood that this is often done to fit in with the timing of Jurisdictional stock assessments and / or lag in entering catch and effort data. For simplicity, these should be standardised to calendar year. It is anticipated that maps will be made dynamic, allowing the user to filtering by year, stock, jurisdiction, fishery and fishing method.

The most difficult part of getting the data to produce the maps is attributing the catch to a stock, a process that clearly needs to be done for the annual catch graph anyway. The diversity of spatial resolutions reported or aggregated by the different jurisdictions (see Table 7, Table 8 and Table 9) for each species poses a challenge to producing figures of spatial distribution of commercial catches (Rupert Summerson, ABARES, pers. comm.). This is further complicated when stock boundaries overlap (for example the two species pf Australian Salmon are reported in the SAFS chapter, and distribution overlaps either side of Port Phillip Bay). For past SAFS, data was sent to ABARES in a variety of formats. The easiest data to work with data came as clean, formatted spreadsheets with grid

numbers in one columns, and then a separate field of each species and a value of either 1 or 0 indicating reporting of catch in that grid or not (as in Table 12). Others send just a list of grid number for where each species was reportedly caught, or PDF maps with the grids where a certain species was caught. Data received in those formats obviously required significant manipulation (formatting, collating, keypunching…) and increased the chance of errors.

Table 12. Example of how some data was presented to ABARES for SAFS 2014.

Grid Number	Species 1	Species 2	Species 3	Species 4	Species 5
1023	0	0	1	0	1
1024	1	0	1	0	0
1025	1	1	1	0	1
1026	1	1	0	0	1
1027	1	0	0	0	0
1028	1	0	0	1	0
1029	1	0	1	1	0

To attribute catch to fish stocks, decision rules are required based on for example known boundaries of stock distribution or jurisdictional boundaries. These decision rules appear not to be published, and should be made available. Fishing location can be reported by fishing grid and / or latitude and longitude, and fishing grid maps vary between fisheries for some jurisdictions (see Figure 21Figure 31 for example). The process for applying decision rules to attribute a catch record with stock name and SAFS map grid number will need to done for each species separately. This process can also be used to standardise / add the data that will form the final output for the maps (species, year, stock name, fishery, jurisdiction, fishing method). While likely a laborious process the first time it is done, as long as stock boundaries and reporting grids remain constant, this process can be used each year. It is recommended that the chapter authors agree on the decision rules, but the process of applying decision rules and producing the final data for upload into the SAFS database be undertaken by a single person within each jurisdiction. The reason for this is that it is a repetitive task without requiring specialised knowledge of the species, it will be time efficient, and it reduces the risk of producing data that variers in formatting between species / stocks.

A suggested process is shown in Figure 6.

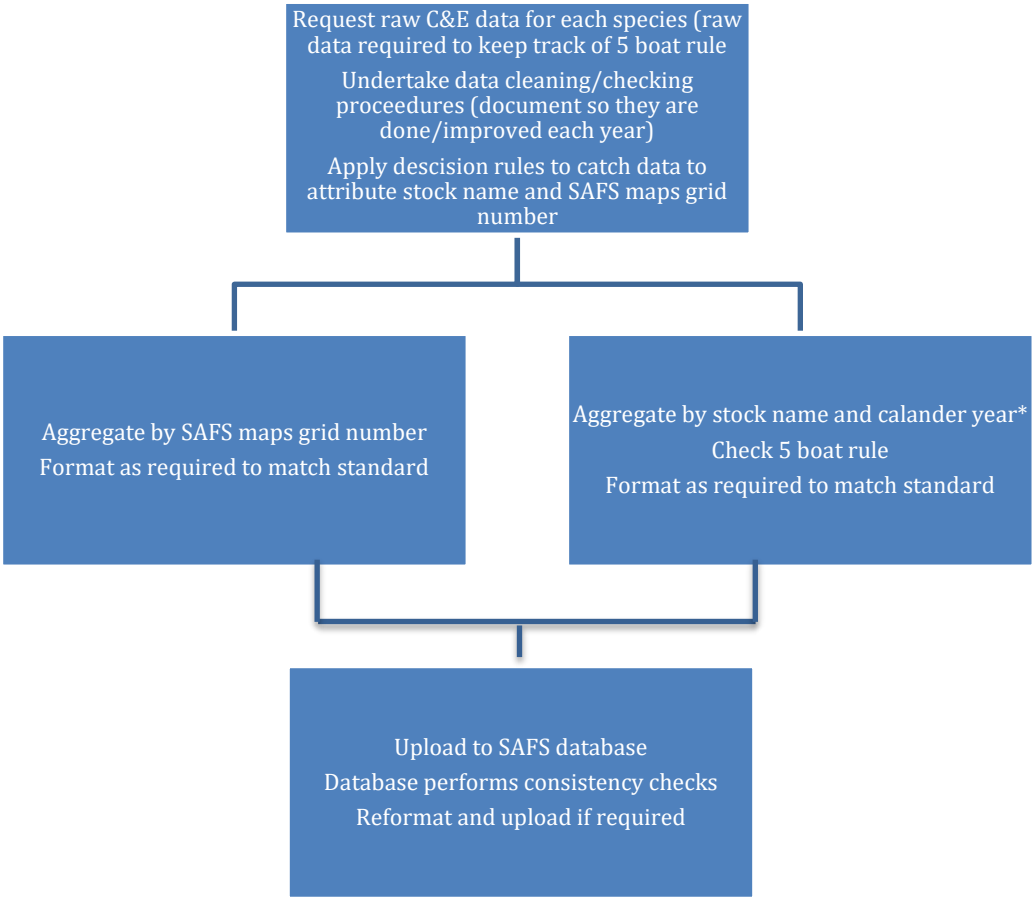


Figure 6. Workflow for producing formatted catch data for uploading into the SAFS database to produce maps and annual catches. *Produce data at other levels of aggregation as required.

Once the data is in the required format, it is uploaded into the SAFS database. During the upload, it is recommended that the database performs consistency checks to ensure that all of the data matches permitted values recorded in reference tables. If there are inconsistencies, the upload will be rejected and feedback given as to why. Based on the feedback, the data is reformatted and uploaded.

An example of a table to record presence of catch in 1˚ grids is shown in Table 13 and a possible database structure is shown in Figure 8. No catch information is required but the entry of a record indicates that a catch of that stock (or combination of factors) occurred in that map grid ID, in that year. The addition of a presence/absence field would require all permutations of species/complex, fishery, map grid ID and year be included, reducing data entry/processing efficiency. Using this structure will result in multiple records per Map Grid ID, however when the map is drawn, this will not cause an issue unless the cell shading is transparent (i.e. if they are not transparent they will draw over the top of each other).

Suggested instructions to authors:

1. Maps will display commercial fishing only
2. Maps will display the 2015 calendar year only
3. Data will be presented for each stock that is shown in Table 1
4. Map Grid ID must follow the Map Grid provided – in some cases it might be necessary to split reporting grids where they overlay multiple Map Grid IDs.
5. Decision rules to allocate catch to Map Grid ID are to be agreed by authors and documented
6. It is strongly recommended that for efficiency and consistency that data for all species at each jurisdiction are processed by a single person.

7. Authors should ensure to the best of their ability that data has been thoroughly error checked. These should be documented. Suggested minimum error checks include:
    a. Range checks (look for unlikely high catches)
    b. Catch of a fish stock should be checked against fishery and gear type – based on your knowledge/experience are they realistic
    c. Eyeball catch by Map Grid IDs (ideally, plot your own catch distribution map) – does it match with what you expect based on your knowledge/experience
8. Initially, aggregate catches by species/species complex, year, jurisdiction, stock, fishery and gear type. Standardise species/species complex names, year, jurisdiction names, stock names, fishery names and gear types in accordance with reference tables provided. From these data, three separate datasets are required. NOTE that we three separate datasets data will be lost during application of confidentiality rules.
    a. Map data is to be provided in user-ready form in accordance with the exact format shown in Table 13. Namely: Species (CAAB CODE – integer ########); Calendar year (yyyy - integer); Stock name (text); Fishery name (text); Jurisdiction (text); Gear type (text); Map Grid ID (integer). No catches are required.
    b. Detailed graph data with catches in tonnes (this can be decimal) will comply with confidentiality arrangements. Detailed graph data must be in user-ready form in accordance with the exact format shown in Table 18. Namely: Species (CAAB CODE – integer ########); Calendar year (yyyy - integer); Stock name (text); Fishery name (text); Jurisdiction (text); Gear type (text).
    c. Aggregated catch data at the level of species/species complex names, year, stock names. Catch is to be reported in tonnes (this can be decimal).Graph data must be in user-ready form in accordance with the exact format shown in Table 17. Namely: Species (CAAB CODE – integer ########); Calendar year (yyyy - integer); Stock name (text); Catch (decimal). It is requested that authors collaborate in applying confidentiality rules where stock boundaries cross jurisdictions, so that the data are as complete as possible.

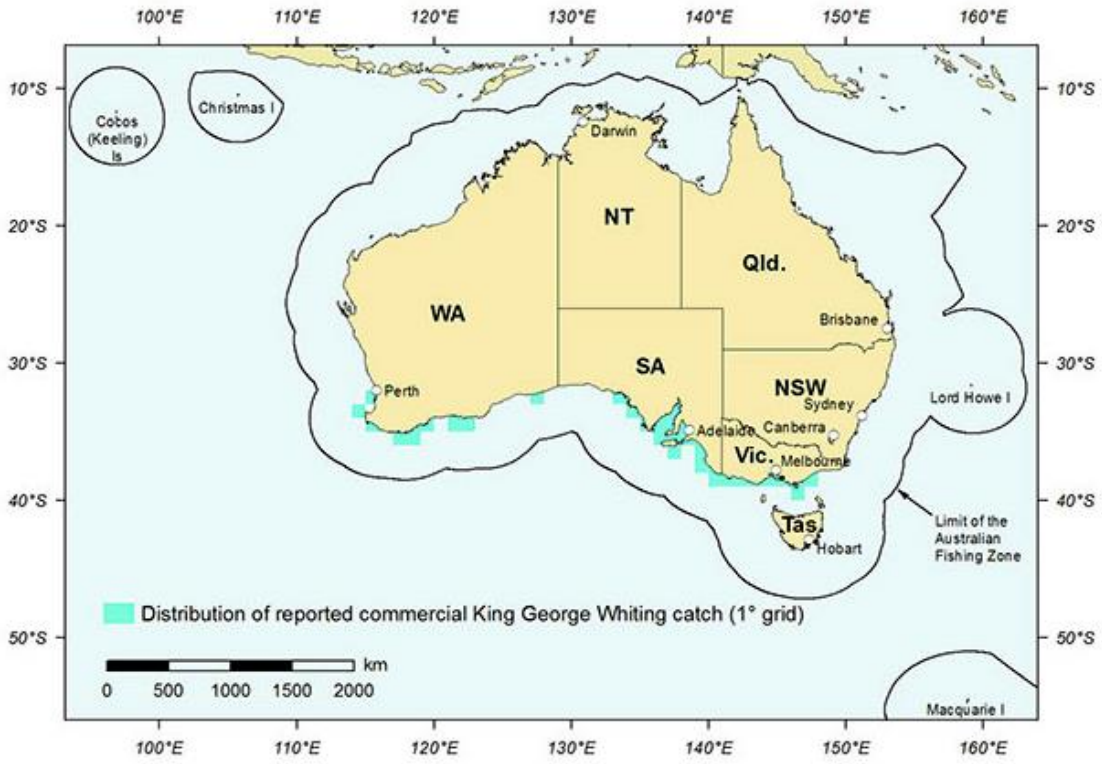


Figure 1: Main features and statistics for King George Whiting fisheries in Australia, 2013 (calendar year)

Figure 7. SAFS reporting of commercial catch of King George Whiting by 1° grids.

Table 13. Example of table to record presence of catch by species in 1° grids

Species	Calendar year	Stock name	Fishery name	Jurisdiction	Gear type	Map Grid ID
37330001	2015	Gulf St Vincent	MSF	SA	Hand line	1392
37330001	2015	Gulf St Vincent	MSF	SA	Gillnet	1395
37330001	2015	Victoria	PPBF	VIC	Haul seine	0896
37330001	2015	Victoria	OF	VIC	Hand line	0896
37330001	2015	Victoria	CIF	VIC	Ring seine	0891

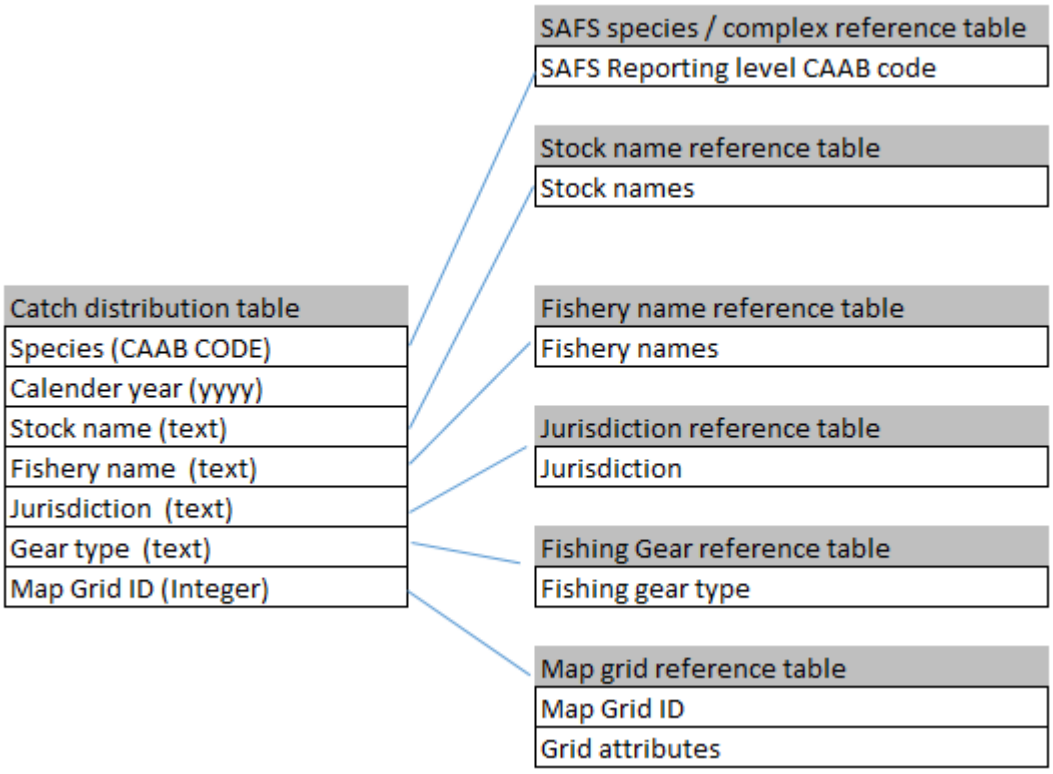


Figure 8. Example of structure of tables for recording distribution of catch for SAFS.

Fishing gear used

The 2014 SAFS reports the fishing gear by which each species is caught and management methods, separated by jurisdiction and commercial / recreational / indigenous sectors for 2013 (Figure 9 and Figure 10). For most species this won't change. The catch by gear-type could change for some byproduct species, and this can be informed by aggregated data produced for the for annual catch graph (see below).

Given most of these values will not change between SAFS, I recommend that these tables are completed by authors as online forms that are specific for each edition of the SAFS, with the previous year's values carried over. There would been to be the scope to add or remove rows for each category, with a list of acceptable value available from lookup tables. The presence of a record of a particular fishing method or measurement table will generate the tick mark in the report, so there doesn't need to a value for each record in the table. Suggested database structures are shown in Figure 11 and Figure 12.

Suggested instructions to authors are as follows:

Fishing methods

• Fishing methods should be listed Commercial, Recreational and Indigenous sectors

Using data generated for catch distribution map and graph and other information, in separate rows, list each method used to catch this species in Australia. Select fishing methods from those presented in the fishing method reference table. If there is a fishing method that does not match one of those in the table, please contact the SAFS co-ordinator.

• Under each jurisdiction name heading, use ticks to specify which jurisdictions use each fishing method.

Management methods

• Management methods should be listed Commercial, Recreational and Indigenous sectors

• In separate rows, list each management method used to manage this species in Australia. Management methods are to be selected from those presented in the fishing method reference table. If there is a fishing method that does not match one of those in the table, please contact the SAFS co-ordinator.

• Under each jurisdiction heading, use ticks to specify which jurisdictions use each of the management methods.

Active vessels

• List the number of commercial vessels that caught that for each fishery during 2015. Note that it is not the number of vessels in the fishery, it is the number of vessels that reported catch of that species.

• Fishery names are to be selected from those presented in the fishing method reference table. If there is a fishing method that does not match one of those in the table, please contact the SAFS co-ordinator.

• The format should follow that in Figure 13

Markets

• Please list the significant domestic and export markets for [standard fish name] caught in each jurisdiction

Table 3: Main features and statistics for King George Whiting fisheries in Australia, 2013 (calendar year)

Jurisdiction	South Australia	Western Australia	Victoria
Fishing methods			
Commercial			
Hand line	✓	✓	✓
Ring net	✓		✓
Gillnet	✓	✓	✓
Anchored longline	✓		
Haul seine		✓	✓
Beach seine		✓	✓
Recreational			
Rod and line	✓	✓	✓
Hand line	✓	✓	✓
Spearfishing	✓	✓	✓
Indigenous[a,b]			
Rod and line	✓	✓	✓
Hand line	✓	✓	✓
Spearfishing	✓	✓	✓

Figure 9. List of fishing gear reported for King George Whiting in the 2014 SAFS.

Management methods			
Commercial			
Limited entry	✓	✓	✓
Size limits	✓	✓	✓
Spatial restrictions and closures (nets)	✓	✓	✓
Temporal closures		✓	
Vessel restrictions		✓	
Gear restrictions	✓	✓	✓
Recreational			
Bag and boat limits	✓	✓	✓
Size limits	✓	✓	✓
Licensing (fishing from boat in Western Australia; recreational fishing in all waters in Victoria)		✓	✓
Indigenous[a,b]			
Bag and boat limits	✓	✓	✓
Size limits	✓	✓	✓

Figure 10. List of management measures reported for King George Whiting in the 2014 SAFS.

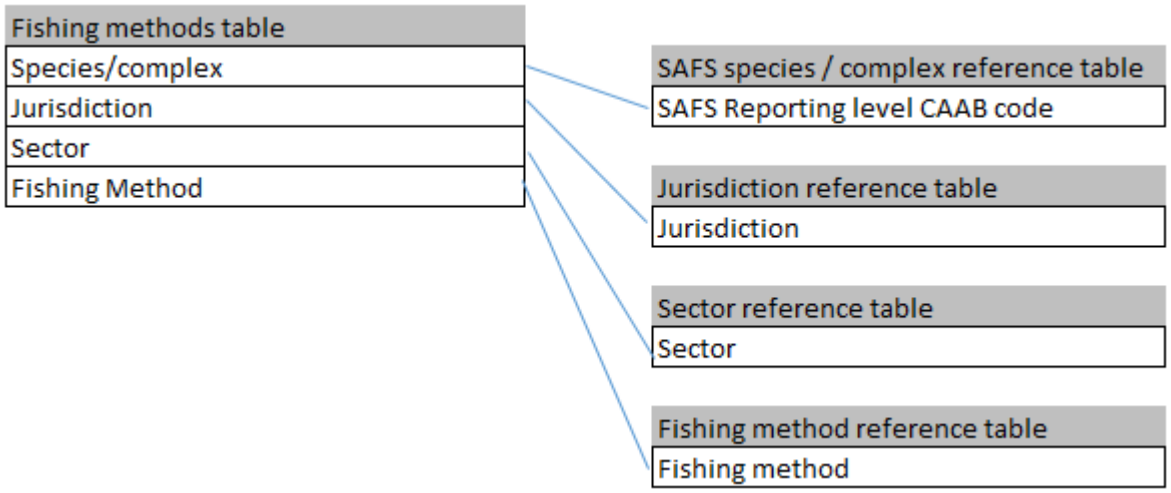


Figure 11. Example of structure of tables for recording fishing methods for SAFS.

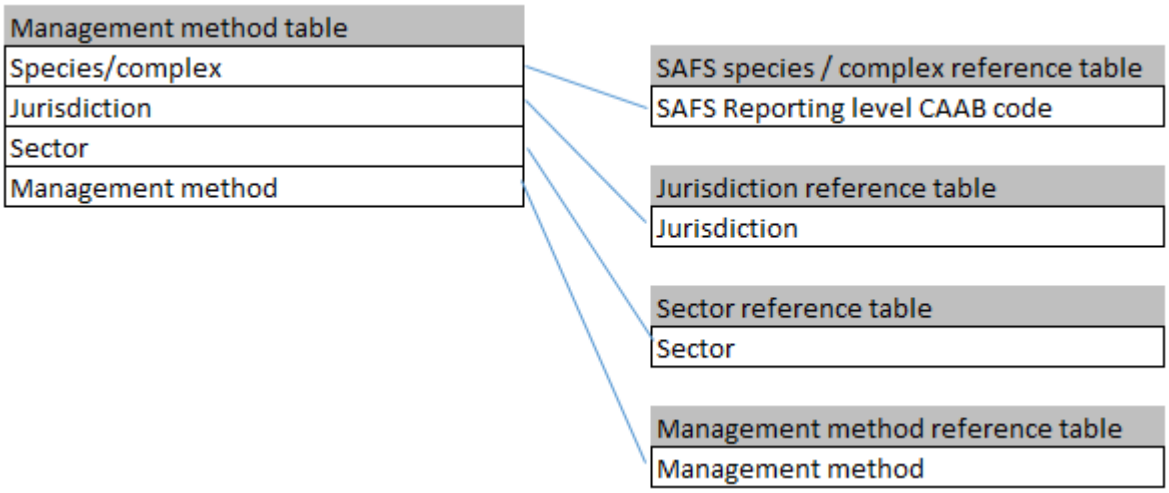


Figure 12. Example of structure of tables for recording management method of catch for SAFS.

Vessels active

The 2014 SAFS reports the number of active vessels operating in each fishery and jurisdiction catching each species (note that this figure is not just the number of active vessels in the fishery, but the number of vessels that caught that species) for 2013 (Figure 13). These figures will often change from year to year. A simple table recording number of active vessels in each year, populated by a simple standardised query run by catch and effort staff is sufficient. Examples of tables and database structures to record the number of active vessels are shown in Table 14 and Figure 14. Catch has been included to populate the next section (Recent annual catch).

Active vessels			
	244 in MSF 17 in NZRLF	20 in OA 21 in SCEMF 1 in WCDSIMF 4 in WCEIMF	18 in CIF 7 in GLF 11 in OF 32 in PPBF

Figure 13. List of number of active vessels for King George Whiting in the 2014 SAFS.

Table 14. Example of table to record the number of active vessels

Species / complex	Jurisdiction	Fishery name	Number of operators	Catch (t)	Calendar year
37330001	SA	MSF	244	284	2013
37330001	VIC	PPBF	32	47	2013
37330001	VIC	OF	11	37	2013

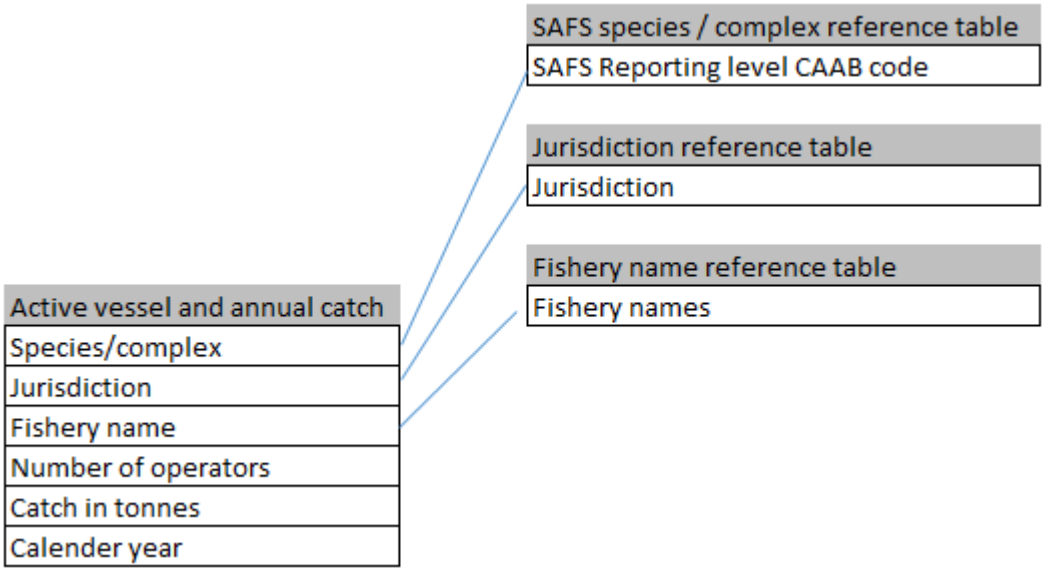


Figure 14. Example of structure of tables for recording the number of active vessels for SAFS.

Recent annual catch

Most recent annual commercial, recreational; and indigenous catches are reported in tables in the 2014 SAFS (Figure 15). Commercial catches are aggregated by jurisdiction and fishery. This can be populated by the tables shown in Table 14 and Figure 14, noting that catch in tonnes needs to be decimal. Catches are reported to 1 decimal place with smaller values reported as <0.1 t. This could use a process rule whereby: IF "catch" ISNOT "0" AND ROUNDED("catch") = "0.0" THEN "catch" = "<0.1".

Recreational, charter and indigenous catches are usually estimated on an ad-hoc basis but South Australia have moved to undertake regular recreational fishing surveys. This is complicated by the fact that survey methods have changed over time, so catch estimates might not be comparable over time. Henry and Lyle (2003) provide recreational and indigenous catch estimates for all jurisdictions, reporting in numbers of fish, while more recent surveys reported in both number of fish and weight in tonnes (e.g. Jones, 2009). Recreational and indigenous catch estimates would need a separate table from commercial catches, with facility to record references, catch in numbers and weight and annotations (for example see in Figure 15 "boat based only"). No time step can be prescribed as surveys are usually undertaken over a one year period (usually financial year), and catch estimates cover that entire period. In-table annotations and footnotes associated with recreational catches describing survey methods, data limitations or other information about the estimates feature often and are sometimes referenced.

An example of recreational and indigenous catch recording is shown in Figure 16 and Table 15. The table needs to record catch in both numbers and weight (tonnes). The year field may require text to allow free entry of the time span the survey covers. The field titled "Included or not?" refers to a yes/no field specifying whether that data point is to be included in the current SAFS. Alternatively, the field could be given a value specifying which version of the SAFS it should be included in.

Charter operators in some states (including SA, NT and Qld) are required to complete regular logbook returns. The data is entered into catch and effort systems. The level of data reported varies between states and species — for example, NT require catch in numbers, SA require catch by numbers for all species but estimated weight for King George Whiting and Snapper, and Qld require catch in numbers and weight. Because those data are continuously collected, and easily extracted they should occur in a

separate table from recreational and indigenous catch, receiving data from standardised queries from each jurisdiction. A suggested charter catch recording is shown in Table 16 and Figure 17.

Catch

- Commercial
  - From the commercial catch data used for the catch graph and map, aggregate the 2015 catch by jurisdiction and fishery.
  - Please report catch in tonnes by fishery. Fishery names are to be selected from those presented in the fishing method reference table. If there is a fishing method that does not match one of those in the table, please contact the SAFS co-ordinator.
  - International catches and discards from commercial fisheries should also be included as commercial catch.
  - Catches over 10 t should be rounded to whole numbers. Catches 0.1 t – 10 t should be rounded to one decimal. Catches less than 0.1 t should be reported as <0.1 t.
  - Where catches contravene confidentiality policies, catch should be reported as "Confidential". In the final table it should read for example "Confidential in OF"
- Recreational and indigenous
  - Where the species is important recreationally or to Indigenous fishers but catch information is not available this catch should be recorded as 'unknown'.
  - Please report catch in tonnes or number of fish.
  - If recreational or Indigenous catch is known to come from the area of a specific commercial fishery this should also be recorded (i.e. with the same formatting as that used in the commercial fishery catch data row).
  - Where the species is important recreationally or to Indigenous fishers but catch information is not available this catch should be recorded as 'unknown'
  - In many cases recreational catch data and Indigenous catch data will not be available for 2013 at the time of drafting. If historical recreational catch data or Indigenous catch data are available for some period, but not for 2013, the year the data represents should also be shown in brackets.
  - If known, charter fishery catches should be reported in same line as recreational catch
  - References should be supplied for recreational or indigenous catch estimates

Catch			
Commercial	284 t in MSF 8.3 t in NZRLF	3 t in OA 9 t in SCEMF <0.1 t in WCDSIMF 2 t in WCEIMF	37 t in CIF 0.1 t in GLF 2.2 t in OF 47 t in PPBF
Recreational	324 t (2007–08)[12]	26 t (2011–12)[13] (boat based only)	155 t (2006–07)[8,14]
Indigenous	Unknown	Unknown	Unknown

Figure 15. Recent annual catch by fishery, jurisdiction and sector.

Table 15. Example of table to record recreational and indigenous catches.

Species / complex	Jurisdiction	Recreational catch number	Recreational catch tonnes	Indigenous catch number	Indigenous catch tonnes	Year (needs to be text)	In table annotation	Include or not?	Footnote	Reference ID
37330001	SA	NA	324	NA	NA	2007-08	NA	Yes	NA	2153
37330001	VIC	NA	155	NA	NA	2006-07	NA	Yes	NA	1236
37330001	WA	NA	26	NA	NA	2011-12	boat based only	Yes	NA	3867

Table 16. Example of table to record the charter catches.

Species / complex	Jurisdiction	Catch number	Catch tonnes	Year	In table annotation	Footnote
37 346004	WA	2200	8	2013	NA	NA
37 346004	QLD	NA	13	2013	NA	NA

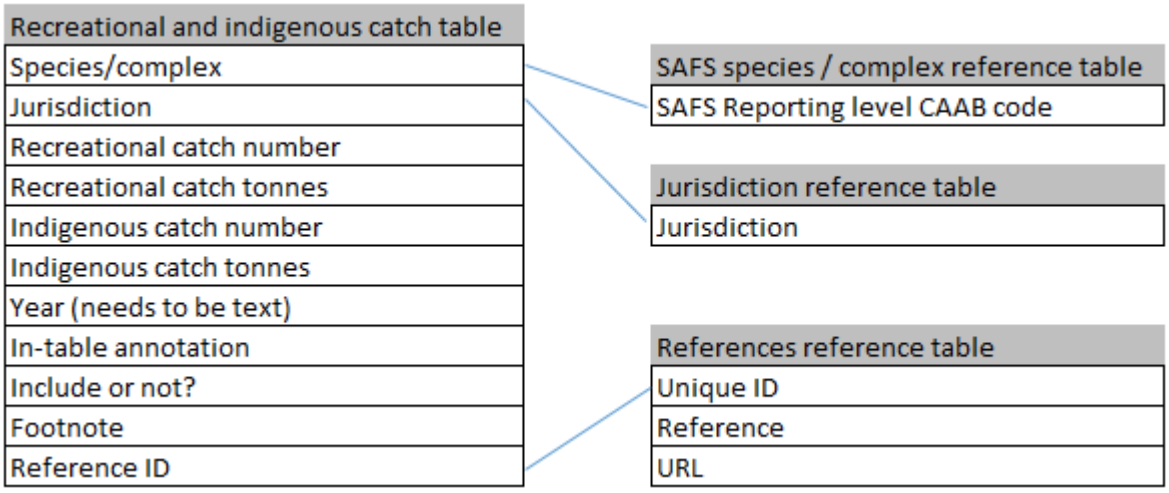


Figure 16. Example of structure of tables for recording recreational and indigenous catches for SAFS.

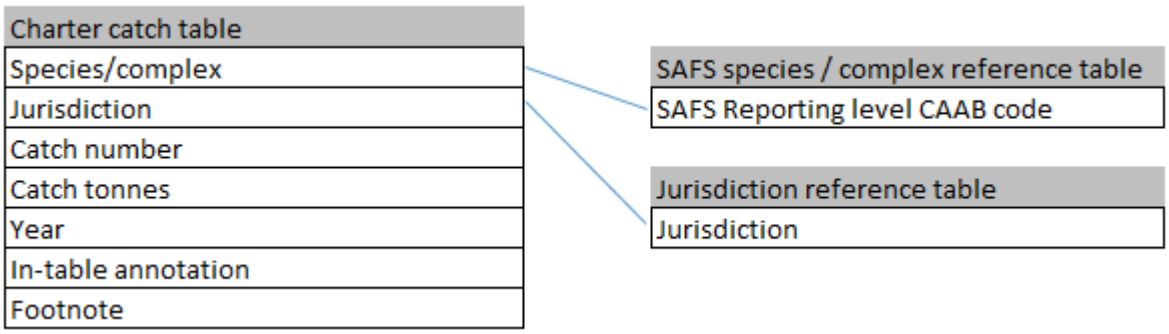


Figure 17. Example of structure of tables for recording charter catches for SAFS.

Annual commercial catch

Annual commercial catches are reported by calendar year and stock name (Figure 18). Given data is already presented in the SAFS in those aggregations, the jurisdictions have queries that provide data in the required format. As for the map showing distribution of fishing effort, the FRDC plan to make annual catch graphs dynamic, allowing the user to filtering by year, stock, jurisdiction, fishery and fishing method. A drawback of doing this is that every additional level you allow to the data to be disaggregated into, increases the risk of contravening confidentiality policies. This will vary between species, fisheries jurisdictions etc… For example, annual catch by stock and fishing method would result in many more returns of "insufficient data" than simply annual catch stock — if data was only stored in the database at the finest scale of aggregation, the sum of catches by, say species and jurisdiction, would be less than if catch was requested at that level of aggregation from the jurisdiction. It is very unlikely that jurisdictions would hand over raw data to the SAFS database, and leave it up to the FRDC to ensure no confidentiality breaches.

There are two ways of dealing with this problem:

1. Set predefined levels of aggregation levels, and aggregate catch data to those levels and keep them in separate tables in the database. Examples of levels of aggregation could be
    a. Calendar year x Stock name
    b. Calendar year x Stock name x Fishery
    c. Calendar year x Stock name x Gear type

2. Have two separate tables, one with the level of aggregation as shown in the 2014 SAFS, the other at the most detailed level of aggregation required:
    a. Calendar year x Stock name (see Figure 19 and Table 17)
    b. Calendar year x Stock name x Fishery x Jurisdiction x Gear type (see Table 18 and Figure 20) – this would often result in a large amount of missing data that would need to be noted in the figure title.

The workflow of getting the catch data into the SAFS database is shown in Figure 6. As it is the same initial processes to attributed stock name to catch, the task of applying decision rules and producing the final data for upload into the SAFS database be undertaken by a single person within each jurisdiction. An example of how recreational and indigenous catches could be recorded are shown in Table 17 and Figure 19.

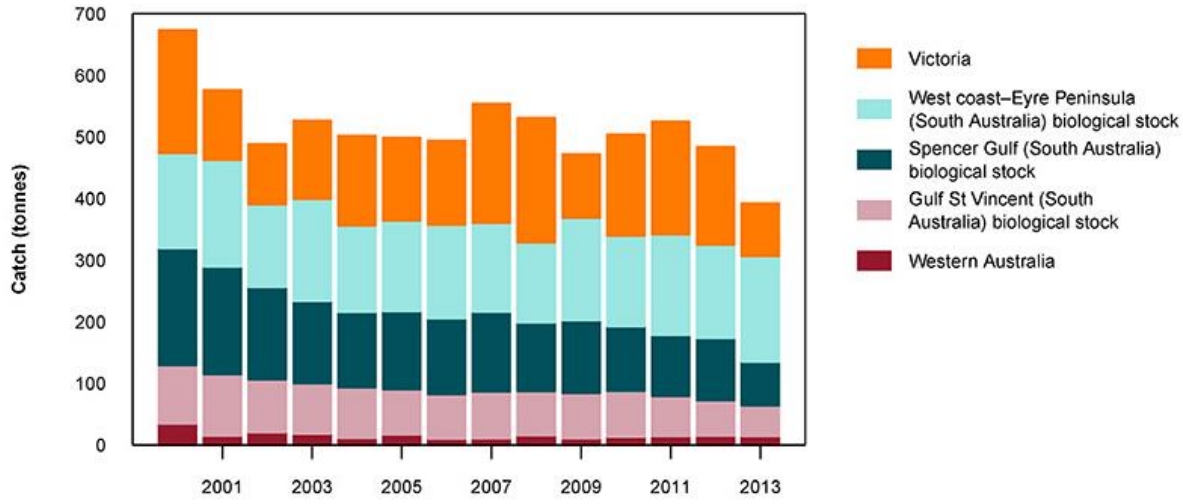


Figure 2: Commercial catch of King George Whiting in Australian waters, 2000 to 2013 (calendar years)

Figure 18. Annual catch by stock as reported in the 2014 SAFS.

Table 17. Example of table to report commercial catches of species aggregated to stock and year.

Species CAAB Code	Year	Stock	Catch tonnes
37330001	2013	VIC	350
37330001	2013	West coast	500
37330001	2013	Spencer Gulf	420
37330001	2013	Gulf St Vincent	280

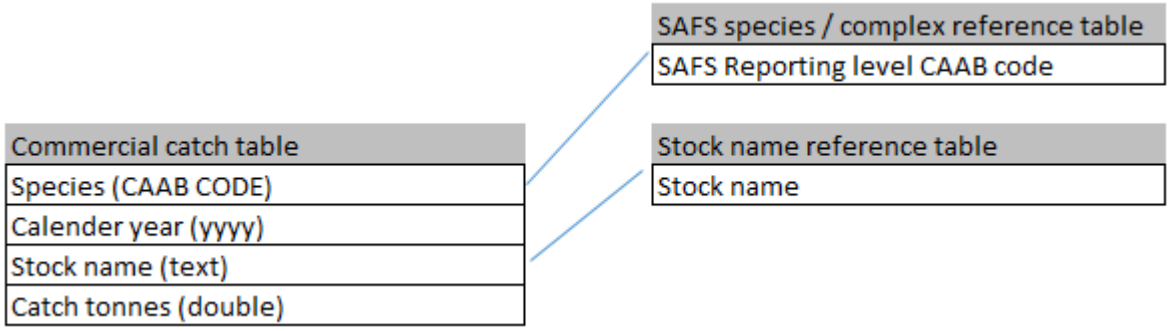


Figure 19. Example of structure of tables for recording commercial catches at the aggregation level of stock and year for SAFS.

Table 18. Example of table to commercial catches of species aggregated to year, stock, fishery, jurisdiction and gear type.

Species / complex	Year	Stock	Fishery	Jurisdiction	Gear type	Catch tonnes
37330001	2013	VIC	PPBF	VIC	Ring seine	85.1
37330001	2013	VIC	PPBF	VIC	Handline	30
37330001	2013	VIC	PPBF	VIC	Beach seine	212.8
37330001	2013	West coast	MSF	SA	Handline	393.6
37330001	2013	Gulf St Vincent	MSF	SA	Handline	255.6

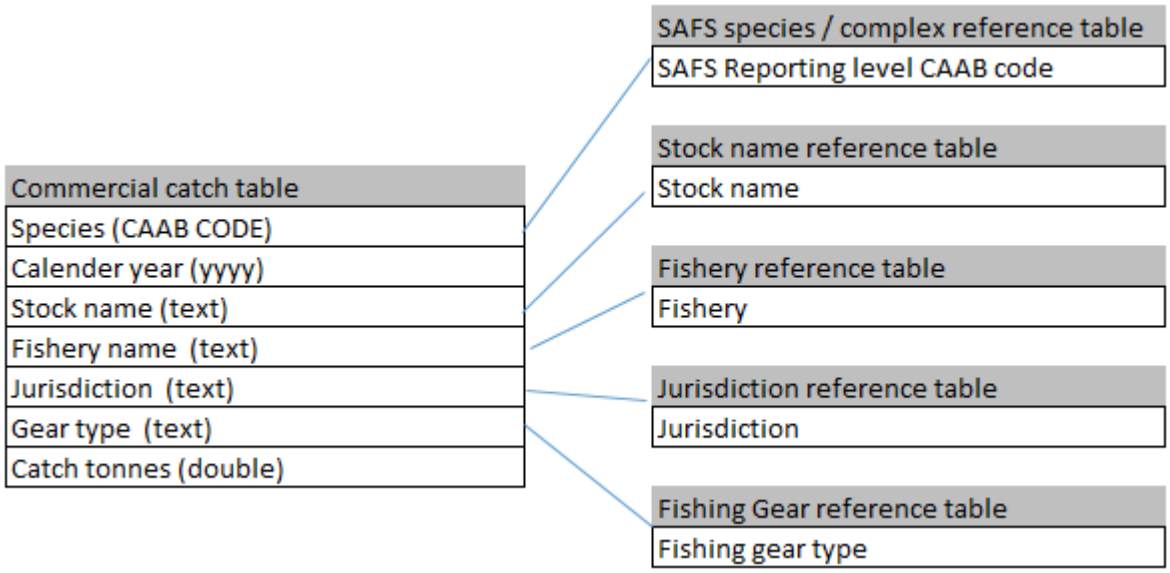


Figure 20. Example of structure of tables for recording commercial catches at the aggregation level of year, stock, fishery, jurisdiction and gear type.

Gap analysis

Indicator groups included in this study with the highest number of specific indicators used by accreditation schemes were: stock status (21); fishing mortality (12); and stock vulnerability (9) (Table 19). Being common to a large number of accreditation schemes demonstrates those indicators are considered most important in assessing sustainability of target species. It must also be kept in mind that indicators used here are for target species, and in many cases, the species reported in Table 19 might only be minor byproduct species for that fishery / jurisdiction. Being included in SAFS reports automatically satisfies the indicator group "stock status" for all species and for some (usually high value) species, quantitative stock assessment results or fishery independent survey data are also available for 36 fish stocks. Fishing mortality and/or natural and total mortality or harvest rate were reported in SAFS reports for 25 stocks. The indicator group "stock vulnerability" included information on the biology of the target species including life history characteristics (Table 3). Longevity, maximum size and age/size at maturity are reported in SAFS, satisfying this indicator group for all species.

There were six indicators that were not referred to at all in SA, NT and Qld SAFS reports; bait use, catch composition – trophic, catch value, nursery area not impacted, pre-catch mortality, stock composition – sex, stock management effectiveness. The absence of these indicators in SAFS reports reflects their lack of relevance in determining stock status rather than the information being available. For example

- bait use is reported by some fisheries (eg the Northern Territory's ONLF fishery);
- catch composition is available for all fisheries (to various degrees of accuracy) and trophic level of individual species can be obtained from global databases (such as Fishbase), and the average trophic level of species exploited by the fishery could be calculated[12].
- catch value is routinely collected by fisheries management agencies
- there are seasonal and or spatial closure in place right around Australia
- sex is usually recorded when sampling catches to length frequency and / or otoliths
- stock management effectiveness is not relevant in the SAFS assessments.

Some form of stock monitoring likely occurs for most species but was only referred to for 48 of the 100 stocks. Genetic structure is reported as unknown for 18 stocks, and there is some information with some uncertainty for 22 stocks. SAFS reports for many species are poorly referenced. While references are supplied for life history characteristics, it can be difficult to match individual references with the reported values.

[12] As described at http://www.indiseas.org/more-information#ecological-indicators (accessed on 23/12/2015)

Table 19. Twenty five biological and three management tool assessment indicators used by global sustainability assessment programs identified by REF, showing where species / fisheries included in this study collect data addressing each criteria. Green = addresses category and referenced, light green = addresses category but still some uncertainty; yellow = addresses category but not referenced, red = does not address criteria. Numbers refer to notes shown in Table 20. The number of different accreditation schemes that use each indicator is shown in the second row.

			Area overlap of species and fishery	Bait use	Catch composition - trophic	Catch composition - immature	Catch composition -size	Catch value	Catch weight	CPUE	Fishing mortality	Gear specificity	Genetic structure stock	Nursery area not impacted	Pre-catch mortality	Range - collapse	Recruitment variability	Species List	Stock - productivity	Stock age distribution	Stock composition - sex	Stock management	Stock monitoring	Stock size	Stock status	Stock vulnerability	Harvest strategy	Logbook use	TAC managed	Area overlap of species and fishery
Number of Accreditation Scheme x indicators			2	2	2	1	2	1	2	1	12	1	4	1	1	1	1	4	1	3	2	3	2	4	21	9	2	1	1	2
State	**Fishery**	**Species**																												
SA	Australian Salmon	Western Australian (B)							1	1			1													1	1			
SA	Australian Sardine	Southern Australian (B)									1		1									1		3	5	1, 2	1	1		1
SA	Balmain Bug	South Australia (M)											4													5	1			
SA	Blacklip Abalone	South Australian Western Zone Fishery (M)								1			5									1				1	1	1		1
SA	Blacklip Abalone	South Australian Central Zone Fishery (M)								1			5									1				1	1	1		1
SA	Blacklip Abalone	South Australian Southern Zone Fishery (M)								1			5									1				1	1	1		1
SA	Blue Swimmer Crab	Gulf St Vincent (B)				1			1				1									1, 3		1, 2	2	1, 3	1	1		1
SA	Blue Swimmer Crab	Spencer Gulf (B)				1			1				1									1, 3		2	2	1, 3	1	1		1
SA	Blue Swimmer Crab	West coast (B)							1				1													5	1			
SA	Dusky Shark	South-western Australian (B)											1													1	1			
SA	Giant Crab	Southern Australian (B)							1	1			1													1	1			1
SA	Greenlip Abalone	South Australian Western Zone Fishery (M)								1			1									1		1, 2	2	1, 3	1	1		1
SA	Greenlip Abalone	South Australian Central Zone Fishery (M)								1			1									1		2	2	1, 3	1	1		1
SA	Greenlip Abalone	South Australian Southern Zone Fishery (M)											1									1				5	1	1		
SA	King George Whiting	Gulf St Vincent (B)								1			1												1	1, 2	1			

			Area overlap of species and fishery	Bait use	Catch composition - trophic	Catch composition - immature	Catch composition -size	Catch value	Catch weight	CPUE	Fishing mortality	Gear specificity	Genetic structure stock	Nursery area not impacted	Pre-catch mortality	Range - collapse	Recruitment variability	Species List	Stock - productivity	Stock age distribution	Stock composition - sex	Stock management	Stock monitoring	Stock size	Stock status	Stock vulnerability	Harvest strategy	Logbook use	TAC managed	Area overlap of species and fishery
Number of Accreditation Scheme x indicators			2	2	2	1	2	1	2	1	12	1	4	1	1	1	1	4	1	3	2	3	2	4	21	9	2	1	1	2
State	**Fishery**	**Species**																												
SA	King George Whiting	Spencer Gulf (B)								1			1												1	1, 2	1			
SA	King George Whiting	West coast—Eyre Peninsula (B)							1	1	1		1				1								1	1, 2	1			
SA	Pipi	South Australia (J)							2				2									2		2	1	1, 3	1			1
SA	Snapper	South East Fishery (B)							1	1			2				2			1				1		1	1			
SA	Snapper	Northern Gulf St Vincent Fishery (B)							1	1			2				2			1				1	1	1, 2	1			
SA	Snapper	Southern Gulf St Vincent Fishery (B)							1	1			2				2			1				1	1	1, 2	1			
SA	Snapper	Southern Spencer Gulf Fishery (B)							1	1			2				2			1				1	1	1, 2	1			
SA	Snapper	Northern Spencer Gulf Fishery (B)							1	1			2				2			1				1	1	1, 2	1			
SA	Snapper	West Coast Fishery (B)											2				2			1				1		5	1			
SA	Southern Calamari	South Australia (J)							1	1			2													1	1			
SA	Southern Rock Lobster	Southern Australian (B)								1			1						1			1				1	1	1		1
SA	Western King Prawn	Spencer Gulf Prawn Fishery (M)							1				1				3					1		2	2	1, 3	1	1		
SA	Western King Prawn	Gulf St Vincent Prawn Fishery (M)							1				1											2	2	1, 3	1			
SA	Western King Prawn	West Coast Prawn Fishery (M)							1				1											2	2	1, 3	1			
NT	Barramundi	Barramundi Fishery (M)					1		1	1	1		1				3			1				1, 4	2	1, 3	1			
NT	Blacktip Shark	Gulf of Carpentaria (B)											4													5	1			
NT	Blacktip Shark	North and west coast (B)									1		4				1		1					4	1	1, 2	1			
NT	Coral Trout	Northern Territory (M)							1				4													5	1			
NT	Crimson Snapper	Northern Australian (B)							1		1, 2		1						1			4			6	1, 2	1			2
NT	Goldband Snapper	Northern Australian (B)							1		1, 2		2						1			4			6	1, 2	1			1
NT	Mud Crab	Northern Australian (B)					1		1	1	2		1				1			1				1, 4	1	1, 2	1			
NT	Red Emperor	Northern Territory (J)							1				2					1				1				5	1	1		2
NT	Saddletail Snapper	Northern Australian (B)							1				1						1			4			1	1, 2	1			2

			Area overlap of species and fishery	Bait use	Catch composition - trophic	Catch composition - immature	Catch composition -size	Catch value	Catch weight	CPUE	Fishing mortality	Gear specificity	Genetic structure stock	Nursery area not impacted	Pre-catch mortality	Range - collapse	Recruitment variability	Species List	Stock - productivity	Stock age distribution	Stock composition - sex	Stock management	Stock monitoring	Stock size	Stock status	Stock vulnerability	Harvest strategy	Logbook use	TAC managed	Area overlap of species and fishery
Number of Accreditation Scheme x indicators			2	2	2	1	2	1	2	1	12	1	4	1	1	1	1	4	1	3	2	3	2	4	21	9	2	1	1	2
State	**Fishery**	**Species**																												
NT	Spanish Mackerel	Northern Territory (J)								1	2		1						1			4			1	1, 2	1			
Qld	Saucer Scallop	East Coast Otter Trawl Fishery (M)	1						1	1			1									4, 5			1	1, 2	1			
Qld	Blue Swimmer Crab	North-eastern Australian (B)	1						1				1				3					1				1	1	1		
Qld	Mud Crab	Northern Australian (B)					1		1		2		1						2	1				1		1	1			
Qld	Mud Crab	East coast (B)	1						1	1	2		1													1	1			
Qld	Spanner Crab	East coast (B)								1			1									1		2	2	1, 3	1	1		1
Qld	Balmain Bug	East coast (M)							1	1		1	5													1	1, 2			
Qld	Moreton Bay Bug	Queensland (M)	1						1	1		1	3													1	1, 2			
Qld	Tropical Rock Lobster	North-eastern Australian (B)							1	1			1									4			1	1, 2	1			1
Qld	Eastern King Prawn	Eastern Australian (B)							1	1			1				3					4, 1		2	1	1, 2	1			
Qld	Endeavour Prawns	East Coast Otter Trawl Fishery (Red and Blue Endeavour Prawn)(M)							1	1			5													1	1			
Qld	School Prawn	Queensland (J)							1	1			2													1	1, 2			
Qld	Tiger Prawns	East Coast Otter Trawl Fishery (Brown and Grooved Tiger Prawn)(M)	1						1	1	2		5									4				1	1, 2			
Qld	Western King Prawn	East Coast Otter Trawl Fishery (M)	1						1	1			3													1	1, 2			
Qld	White Banana Prawn	East coast (M)							1				3									4				1	1, 2			
Qld	Blacktip Shark	East coast (B)											4													5	1			2
Qld	Blacktip Shark	Gulf of Carpentaria (B)											4													5	1			
Qld	Sandbar Shark	Eastern Australian (B)							1				1													5	1			
Qld	Barramundi	Southern Gulf of Carpentaria (B)	1				1			1	2		1				2			1				1		1	1			
Qld	Barramundi	Northern Gulf of Carpentaria (B)							1	1			1													1	1			
Qld	Barramundi	Princess Charlotte Bay (B)	1						1	1			1													1	1			
Qld	Barramundi	North-east coast (B)	1				1		1		2		1							1				1		1	1			
Qld	Barramundi	Mackay (B)	1						1	1			1													1	1			

			Area overlap of species and fishery	Bait use	Catch composition - trophic	Catch composition - immature	Catch composition -size	Catch value	Catch weight	CPUE	Fishing mortality	Gear specificity	Genetic structure stock	Nursery area not impacted	Pre-catch mortality	Range - collapse	Recruitment variability	Species List	Stock - productivity	Stock age distribution	Stock composition - sex	Stock management	Stock monitoring	Stock size	Stock status	Stock vulnerability	Harvest strategy	Logbook use	TAC managed	Area overlap of species and fishery
Number of Accreditation Scheme x indicators			2	2	2	1	2	1	2	1	12	1	4	1	1	1	1	4	1	3	2	3	2	4	21	9	2	1	1	2
State	**Fishery**	**Species**																												
Qld	Barramundi	Central east coast (B)	1				1		1				1							1						1	1			
Qld	Barramundi	South-east coast (B)											1													5	1			
Qld	Black Jewfish	Gulf of Carpentaria (M)					2		1				3												7	5	1			
Qld	Black Jewfish	Queensland east coast (M)							1				3													5	1			
Qld	Coral Trout	Coral Reef Finfish Fishery (M)							1				4									4			1	1, 2	1			
Qld	Coral Trout	Gulf of Carpentaria (M)											4													5	1			
Qld	Mulloway	Queensland (J)							1				3													1	1			
Qld	Murray Cod	Queensland (J)							1				1											5	7	5	1			
Qld	Tailor	Eastern Australian (B)					1		1	1	2		1				2			1		4, 1		1	1	1, 2	1	1		
Qld	Yellowtail Kingfish	Eastern Australian (B)							1				1													5	1			
Qld	Dusky Flathead	Queensland (J)					1		1	1	2		3				2			1				1		1	1			
Qld	Grey Mackerel	Central east Queensland (B)					1		1		2		1				2			1		4		1	1	1, 2	1			1
Qld	Grey Mackerel	North-east Queensland (B)					1		1		2		1				2			1		4		1	1	1, 2	1			1
Qld	Grey Mackerel	Gulf of Carpentaria (B)								1	1		1									4			1	1, 2	1			
Qld	Spanish Mackerel	East coast (B)							1	1	2		1			1	2					4, 1		1	1	1, 2	1	1		1
Qld	Spanish Mackerel	Gulf of Carpentaria (M)							1	1			1				2			1				1		1	1			
Qld	Sea Mullet	Eastern Australian (B)					1		1				1				2			1				1		1	1			
Qld	Snapper	East coast (B)							1	1	2		1												1	5, 2	1			
Qld	Yellowfin Bream	Eastern Australian (B)	1				1		1	1	2		1				2			1				1		1	1			
Qld	Crimson Snapper	Northern Australian (B)							1				1													1	1			
Qld	Crimson Snapper	East coast Queensland (B)	1						1				1													5	1			2
Qld	Goldband Snapper	Northern Australian (B)											2													1	1			
Qld	Goldband Snapper	Queensland (M)							1	1			2					2								5	1		1	2
Qld	Golden Snapper	Gulf of Carpentaria (M)					3		1	1			3													5	1			
Qld	Golden Snapper	East coast (M)							1				3													5	1			

			Area overlap of species and fishery	Bait use	Catch composition - trophic	Catch composition - immature	Catch composition -size	Catch value	Catch weight	CPUE	Fishing mortality	Gear specificity	Genetic structure stock	Nursery area not impacted	Pre-catch mortality	Range - collapse	Recruitment variability	Species List	Stock - productivity	Stock age distribution	Stock composition - sex	Stock management	Stock monitoring	Stock size	Stock status	Stock vulnerability	Harvest strategy	Logbook use	TAC managed	Area overlap of species and fishery
Number of Accreditation Scheme x indicators			2	2	2	1	2	1	2	1	12	1	4	1	1	1	1	4	1	3	2	3	2	4	21	9	2	1	1	2
State	**Fishery**	**Species**																												
Qld	Red Emperor	Gulf of Carpentaria (M)				2				1			2											6		5	1			
Qld	Red Emperor	East coast Queensland (M)	1						1	1	2		2													5	1			2
Qld	Redthroat Emperor	East coast Queensland (B)							1				1									4		1	1	1, 2	1			
Qld	Saddletail Snapper	Northern Australian (B)							1				1													1	1			
Qld	Saddletail Snapper	East coast Queensland (B)	1						1,2				1													5	1			2
Qld	Sand Whiting	Queensland (J)					1		1	1	2		3				2			1				1		1	1	1		
Qld	Stout Whiting	Eastern Australian (B)					1		1	1	2		1						1	1		4, 1		1	1	1, 2	1			1
Qld	Mangrove Jack	Gulf of Carpentaria management unit					3		1	1			3									4		6		5	1			2
Qld	Mangrove Jack	East Coast management unit											3													5	1			
Qld	Pearl Perch	Qld management unit (RRFFF)(part of the Eastern Australian stock)					1		1	1	2		3							1				1		1	1			
Qld	King Threadfin	East coast							1	1			2													5	1			
Qld	King Threadfin	Gulf of Carpentaria							1	1			2													5	1			
Qld	Red Spot King Prawn	East Coast Otter Trawl Fishery (ECOTF)Management Unit	1						1	1			3													1	1			
Qld	Spotted Mackerel	Eastern Australian (Queensland)					1		1				1							1		4		1		1	1			

Table 20. Reference table for numbers in Table 19.

Indicators	1	2	3	4	5	6	7
Area overlap of species and fishery	1. Percent of stock / effort within spatial, seasonal closures						
Bait use							
Catch composition - trophic							
Catch composition - immature	1. Abundance of pre-recruits - Fishery independent survey	2. Some information from past observer work					
Catch composition -size	1. Size and or age composition from catch sampling	2. Proportion of mature fish	3. Some information from past observer work				
Catch value							
Catch weight	1. Catch weight	2. Recreational catch number or number					
CPUE	1. Trnd in catch per unit effort						
Fishing mortality	1. Assessment results - Harvest rate	2. Z, M and / or F					
Gear specificity	1.TEDs, BRDs						
Genetic structure stock	1. Stock structure known	2. Some information of the genetic structure of stock, although species not entirely delineated	3. Stock structure unknown	4. Species complex, some uncertainty	5. Species complex, stock structure unknown	6. fisheries comprise a large number of small, independent populations	
Nursery area not impacted pre-catch mortality							
Range - collapse	1. Contraction of spawning aggregations						
Recruitment variability	1. Assessment results - recruitment/pup production	2. Recruitment from age structure	3. Fishery independent surveys - relative abundance of pre-recruits				
Species List	1. performance indicators relate to species composition of the catch	2. Species reporting in logbooks					
Stock - productivity	1. Assessment results – Egg / pup production	2. Information on growth rate and fecundity					

Indicators	1	2	3	4	5	6	7
Stock age distribution	1. Age frequency (or otoliths collected) - commercial and / or recreational						
Stock composition - sex							
Stock management	1. Harvest control rules & tools such as reference points Performance Measurement Systems	2. Performance measures	3. Management Plan	4. Harvest rate for MSY	5. Rotational management system		
Stock monitoring							
Stock size	1. Fishery dependent (Catch) sampling	2. FIS	3. DEMP	4. Mark-recapture	5. Stocking data	6. Past observer program	
Stock status	1. Assessment results - Biomass and or Eggcur/Egg0 or pup production	2. FIS - Biomass, abundance, relative abundance or CPUE	3. FIS - Recruitment abundance	4. Past FIS	5. DEMP	6. Assessment results - Biomass and or Eggcur/Egg0 or pup production for proxy species	7. Unreferenced mention of relative stock size from unknown source
Stock vulnerability	1. SAFS stock status	2. Assessment results	3. FIS - Abundance or juvenile abundance	4. DEMP	5. Undefined / negligable		
Harvest strategy	1. Species biology	2. ERA					
Logbook use	1. Harvest strategy or Performance Measurement System with indicators and performance measures or similar	2. Harvest strategy or Performance Measurement System with indicators and performance measures or similar - included as "other species" or "target and bycatch" or "All shark"					
TAC managed	1. Use of logbook						

Recommendations and further development

This report focussed on data-sets from three jurisdictions: South Australia, Northern Territory and Queensland. Lessons learnt during this project could be used to improve collection of information from other jurisdictions if required. These lessons included:

- Key contacts at each jurisdiction were not funded – state fisheries agencies are often considered underfunded, and this is particularly the case for Queensland and South Australia compared to other jurisdictions (MRAG, 2014). Without funding, key contacts understandably prioritised their work on core tasks. Funding key contacts within each jurisdiction may have increased the rate of information collection and the level of detail made available.
- The number of species and data sets was overwhelming – the original proposal for this project was restricted to South Australian and Northern Territory species. At the request of the FRDC, this expanded to include Queensland — increasing the number of species included from 22 to 63. This resulted in 637 different combinations of species/data sets reported in the SAFS alone. With the over-arching need to inform development of a data portal to facilitate more efficient production of the SAFS, data types more likely to be used in such a data portal should have been prioritized and those unlikely to be used omitted.
- Suspicion about what the information would be used for – the scope of the project changed after initial proposal and contact with research heads. This led to a misunderstanding of what the outcomes would be, causing some apprehension about sharing information. This was particularly problematic in attempting to access internal documents describing data collection/warehousing processes.
- Key contacts at each jurisdiction should have been involved in refining the scope of the project – this would have reduced the number of datasets included and may also have resulted in a more efficient process and increased support.
- Collection of information was somewhat repetitive – because data collection programs usually include more than one species, collecting information by species resulted in repeated collection of the same information. For example, the same data collection programs are used in South Australia's fisheries from Blacklip Abalone and Greenlip Abalone.

The following processes should be used if information about data sets is to be collected from other jurisdictions:

1. Request a key contact from each jurisdiction and include their time in the budget. That person should have a good knowledge across all fisheries and of fisheries data collection programs.
2. At the outset, consult with the FRDC and key contacts to describe the scope of the project clearly, including species and data types to be included, defining what information to compile for each dataset and outlining the form outputs should be presented. Work within that scope throughout the project
3. Working with each key contact, list the data collection programs covering each of the data set x species combinations within the scope of the project, so that instead of a long list of data set x species combinations, the target list is for data collection programs.
4. The key contacts should interview staff responsible for implementing each data collection program and request any meta-data and standard operating procedures to get the information required.
5. If requested, information about data collection programs should be made available to the staff member interviewed for comment.

Extension and Adoption

Sections of this report including Attachment 1 (which contains the detailed descriptions of all datasets for which information was obtained) have been provided to the FRDC. The FRDC have been using this information to guide development of a data portal to streamline compilation of the 2016 SAFS reports.

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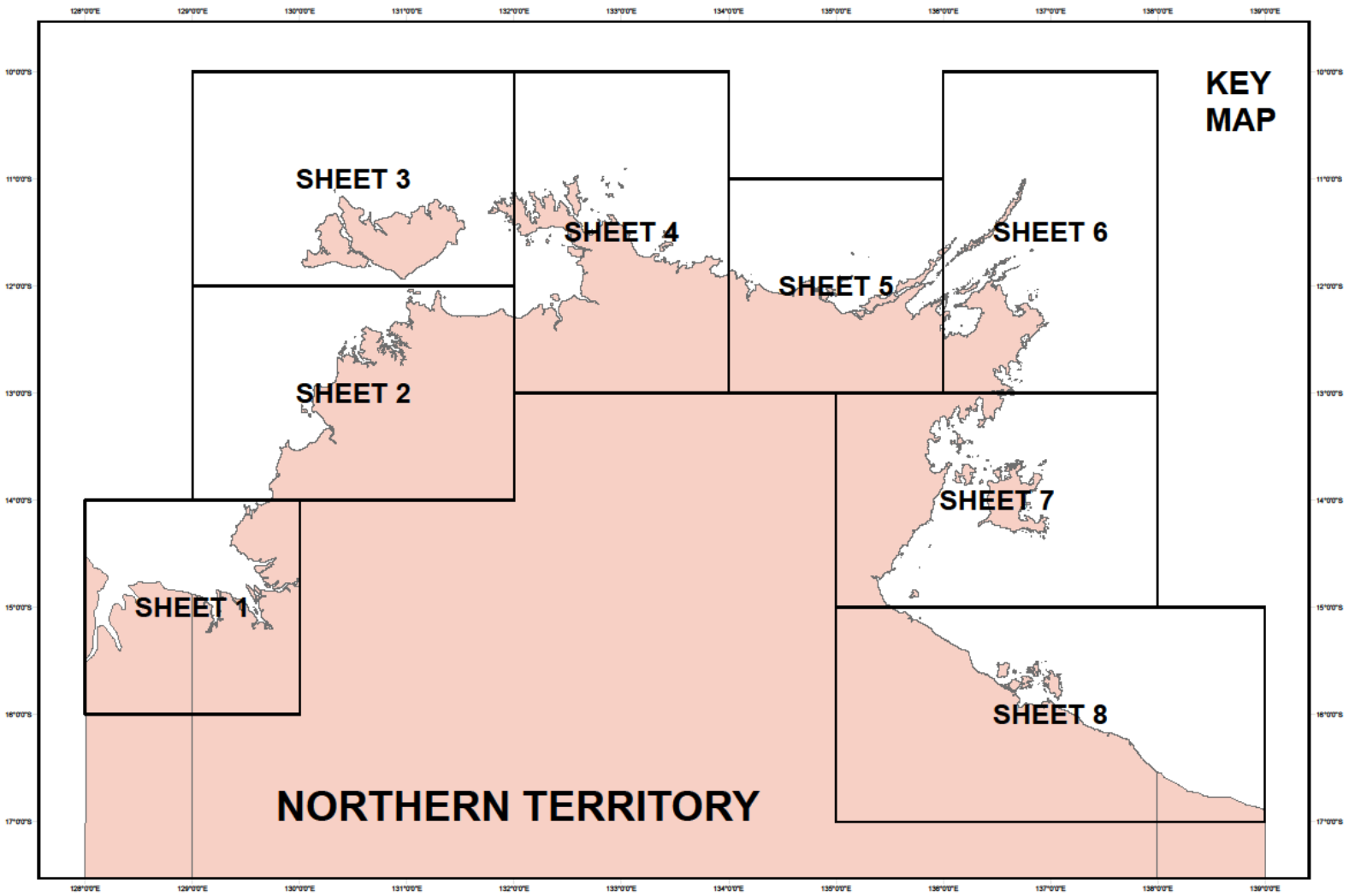
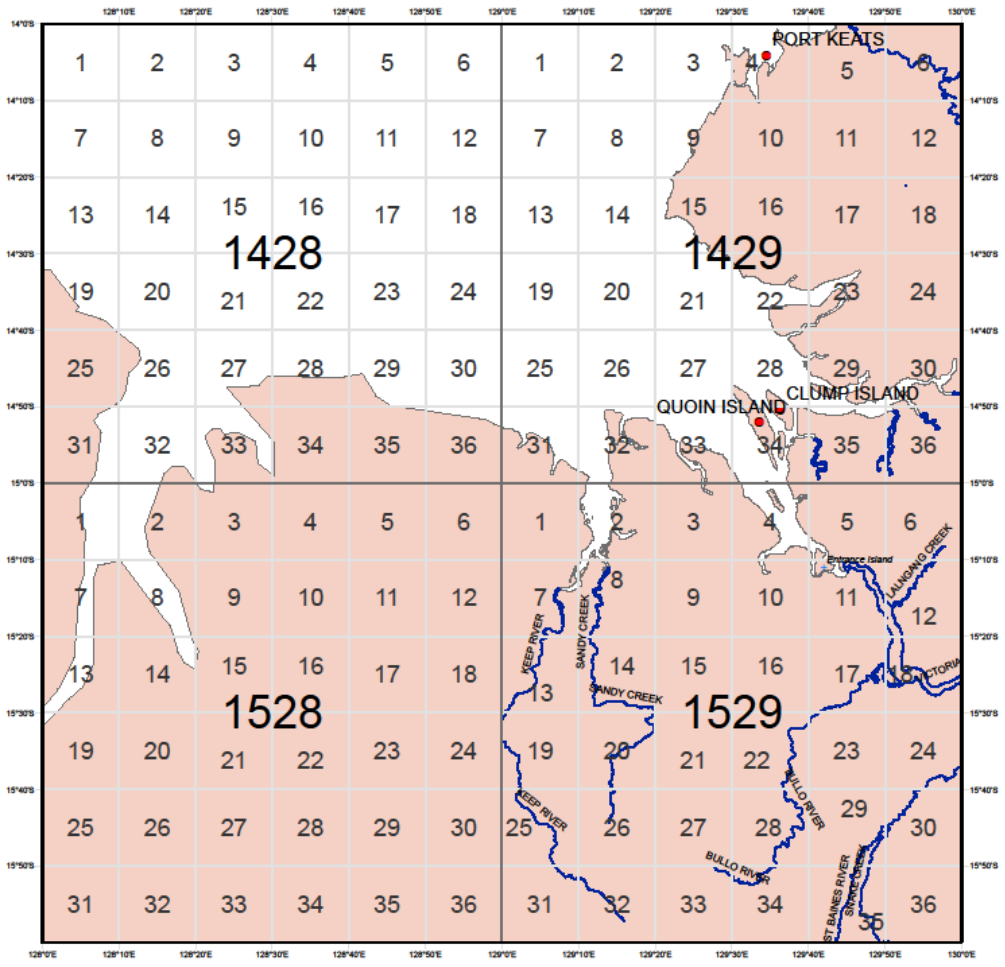
Appendix 1 – Catch reporting grid maps

Northern Territory

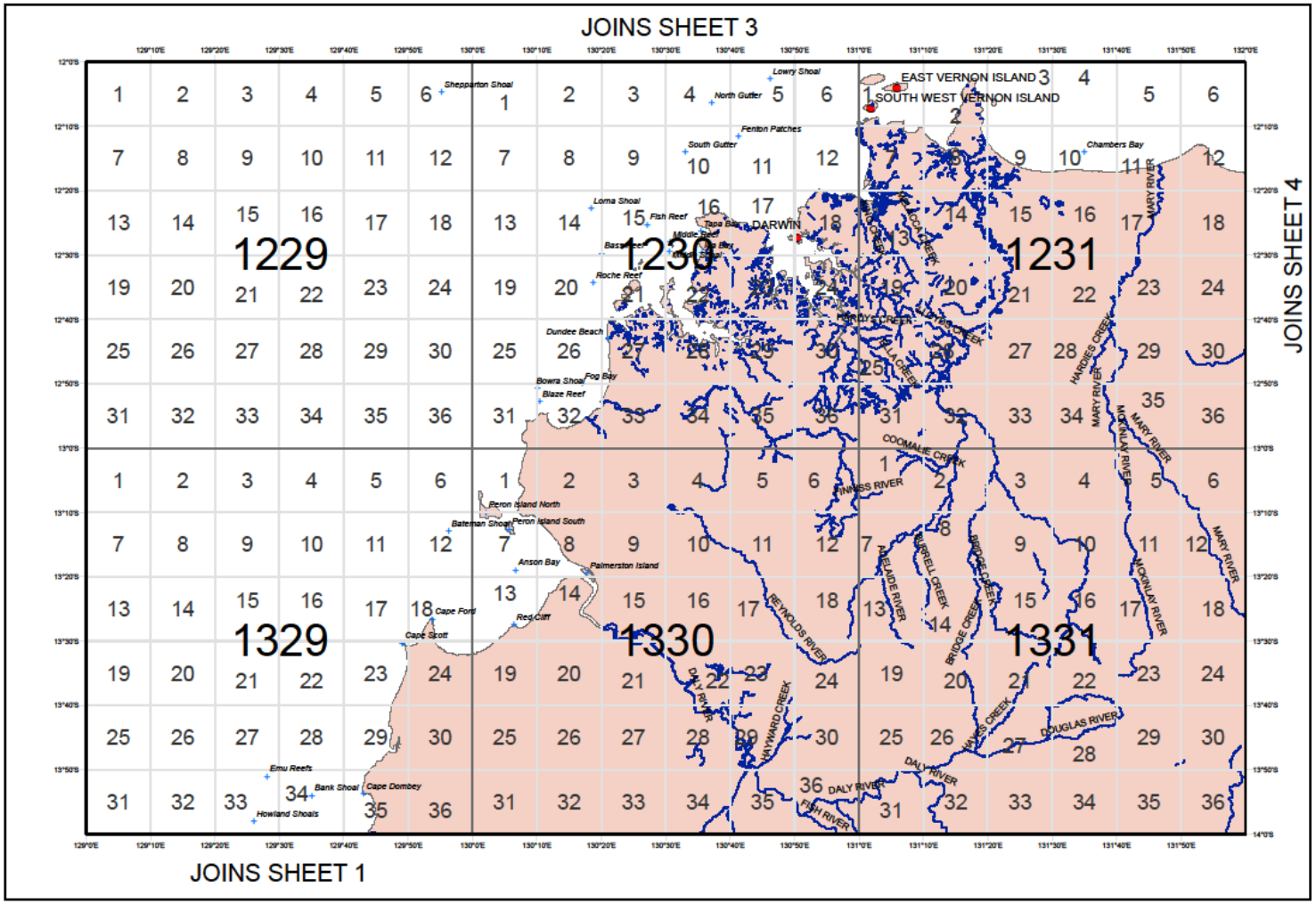
NT catch reporting grids are shown below. They are also available from: www.nt.gov.au/d/Fisheries/index.cfm?newscat1=&newscat2=&header=Logbook%20Returns%20Forms


KEY
MAP
SHEET 1
SHEET 2
SHEET 3
SHEET 4
SHEET 5
SHEET 6
SHEET 7
SHEET 8
NORTHERN TERRITORY

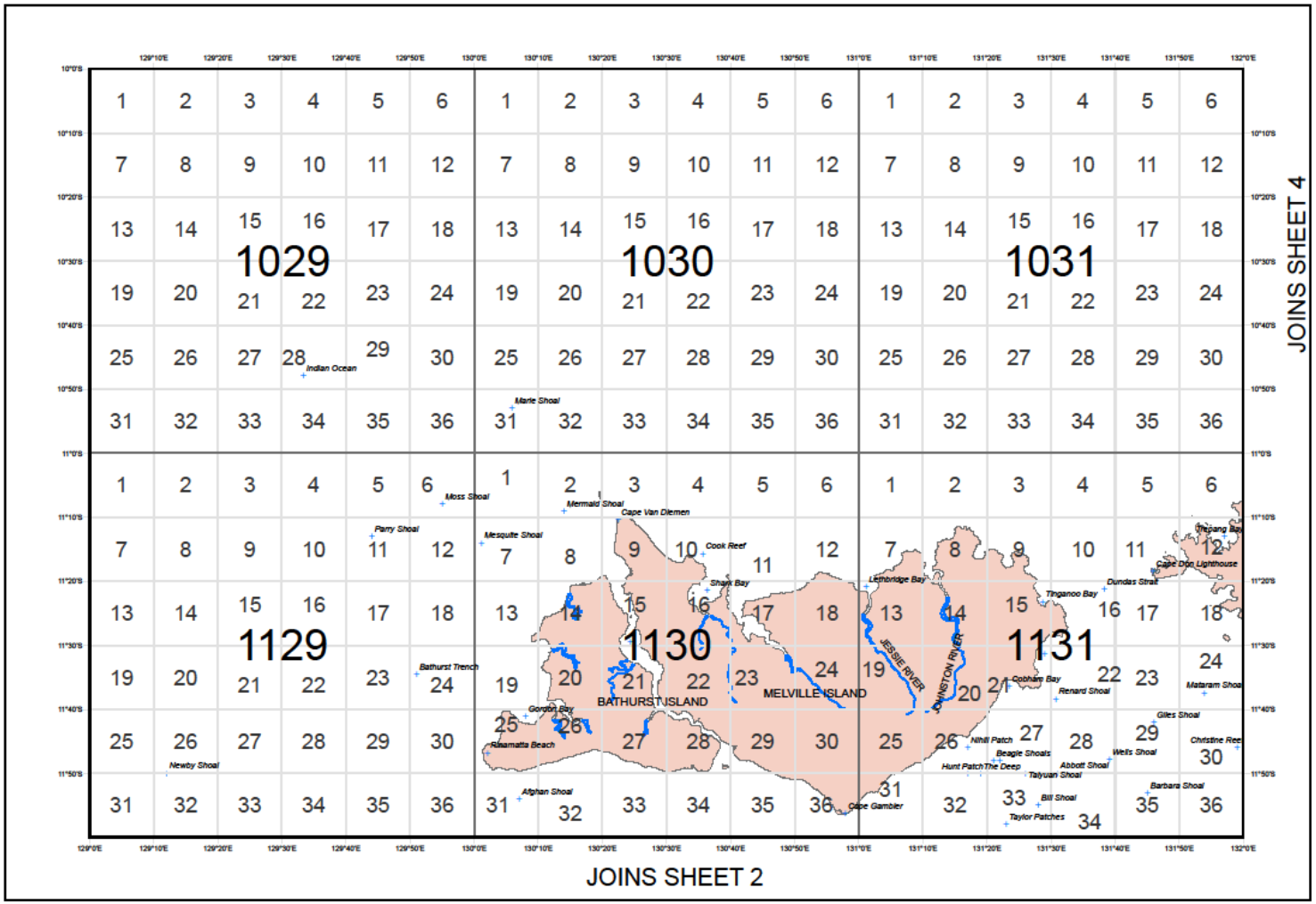
JOINS SHEET 2



SHEET 1


JOINS SHEET 3
JOINS SHEET 4
JOINS SHEET 1
1229
1230
1231
1329
1330
1331
DARWIN
EAST VERNON ISLAND
SOUTH WEST VERNON ISLAND
Shepparton Shoal
Lowry Shoal
North Gutter
Fenton Patches
South Gutter
Chambers Bay
Loma Shoal
Fish Reef
Tapa Bank
Middle Reef
Roche Reef
Dundee Beach
Fog Bay
Bowra Shoal
Blaze Reef
Peron Island North
Peron Island South
Bateman Shoal
Anson Bay
Palmerston Island
Cape Ford
Red Cliff
Cape Scott
Emu Reefs
Bank Shoal
Cape Dombey
Howland Shoals
COOMALIE CREEK
FINNISS RIVER
HARRIES CREEK
MARY RIVER
MCKINLAY RIVER
ADELAIDE RIVER
BURRELL CREEK
BRIDGE CREEK
REYNOLDS RIVER
DALY RIVER
FISH RIVER
DOUGLAS RIVER

SHEET 2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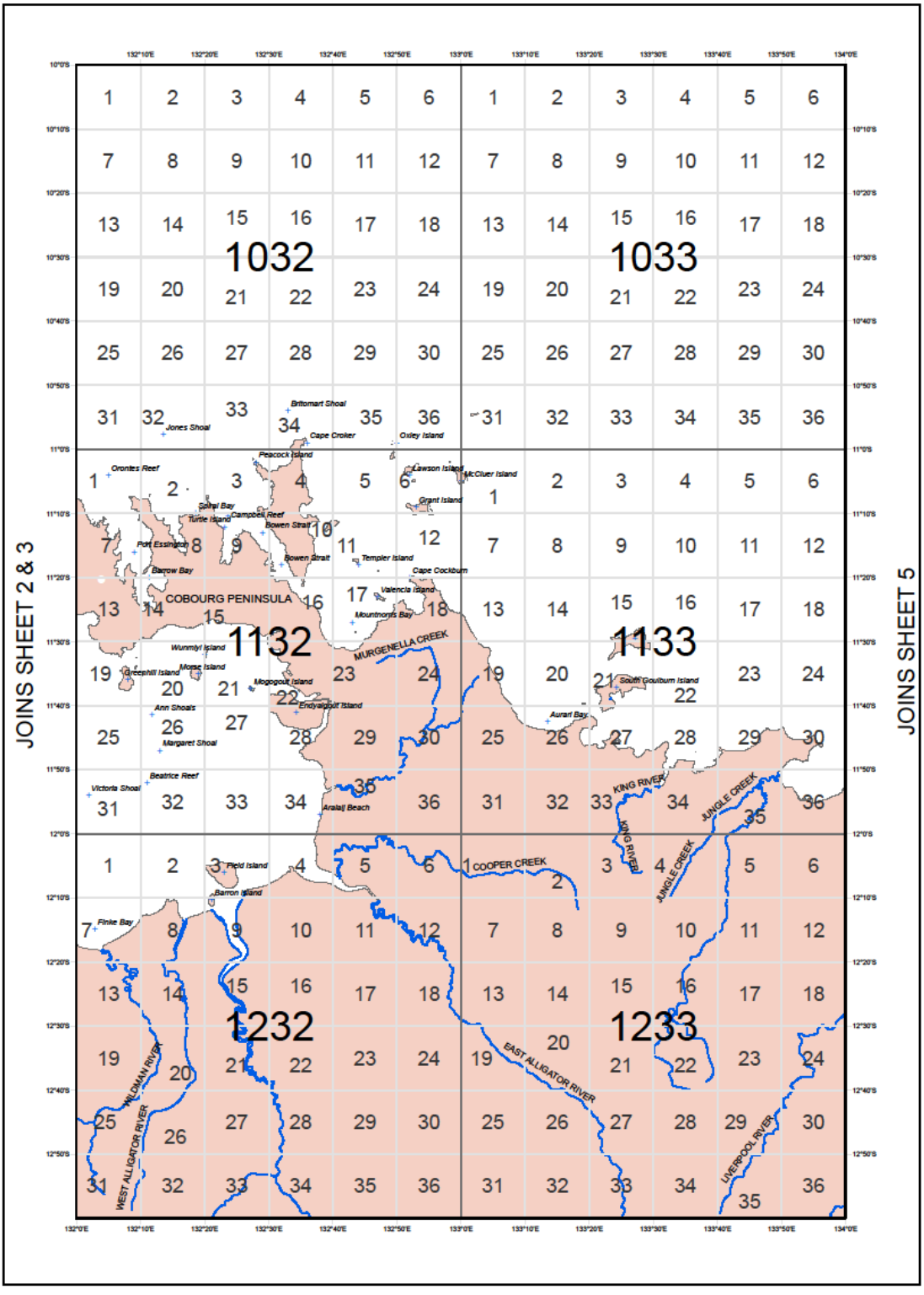
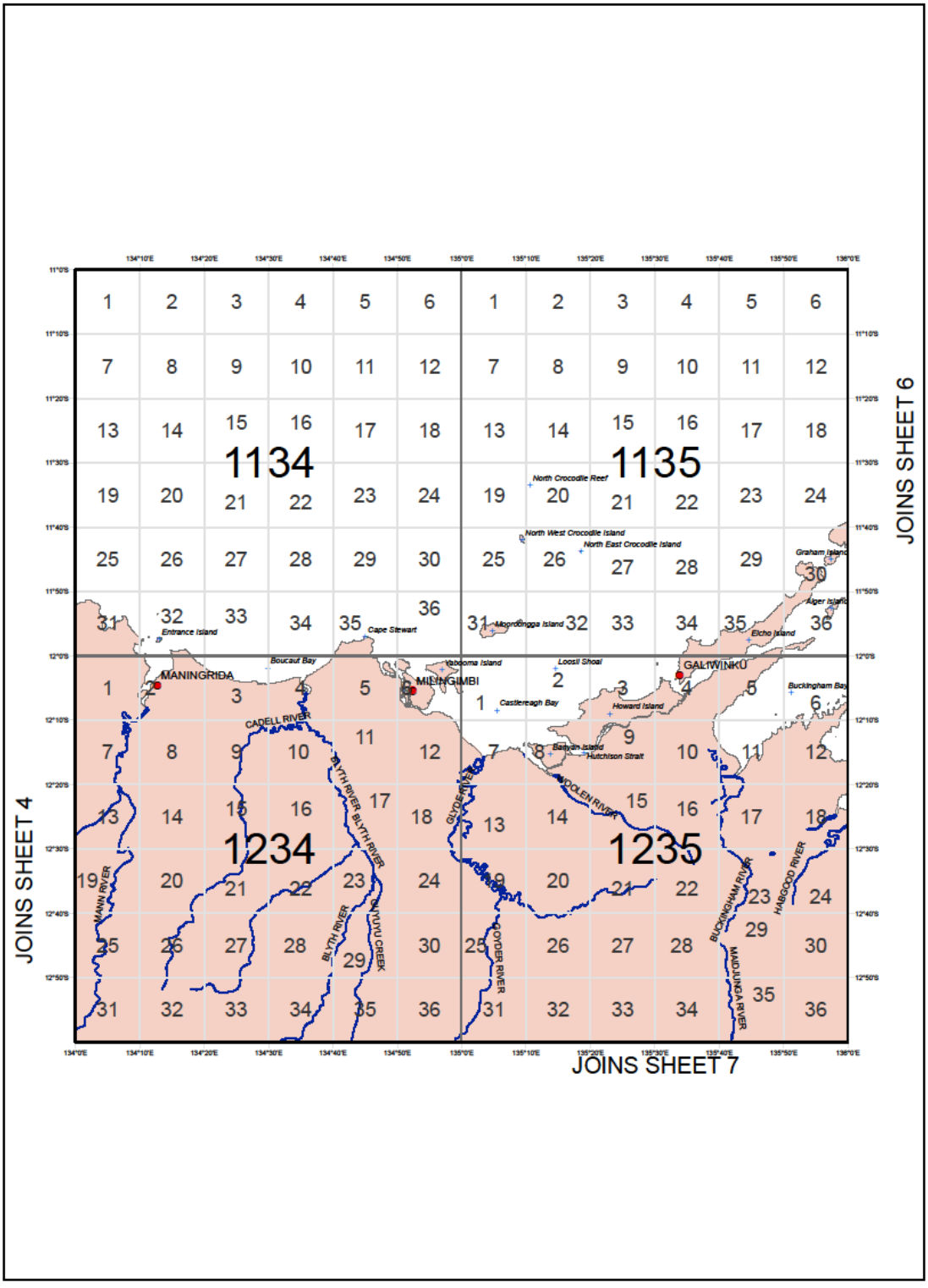
1030
1031
1129
1130
1131
BATHURST ISLAND
MELVILLE ISLAND
JESSIE RIVER
JOHNSTON RIVER
Indian Ocean
Marie Shoal
Moss Shoal
Mermaid Shoal
Cape Van Diemen
Parry Shoal
Mesquite Shoal
Cook Reef
Shark Bay
Lethbridge Bay
Tinganoo Bay
Dundas Strait
Cape Don Lighthouse
Thejang Bay
Bathurst Trench
Gordon Bay
Rinamatta Beach
Newby Shoal
Afghan Shoal
Cape Gambier
Cobham Bay
Renard Shoal
Mataram Shoal
Giles Shoal
Christine Reef
Nihill Patch
Beagle Shoals
Hunt Patch
The Deep
Tatyuan Shoal
Abbott Shoal
Wells Shoal
Barbara Shoal
Bill Shoal
Taylor Patches
JOINS SHEET 4
JOINS SHEET 2

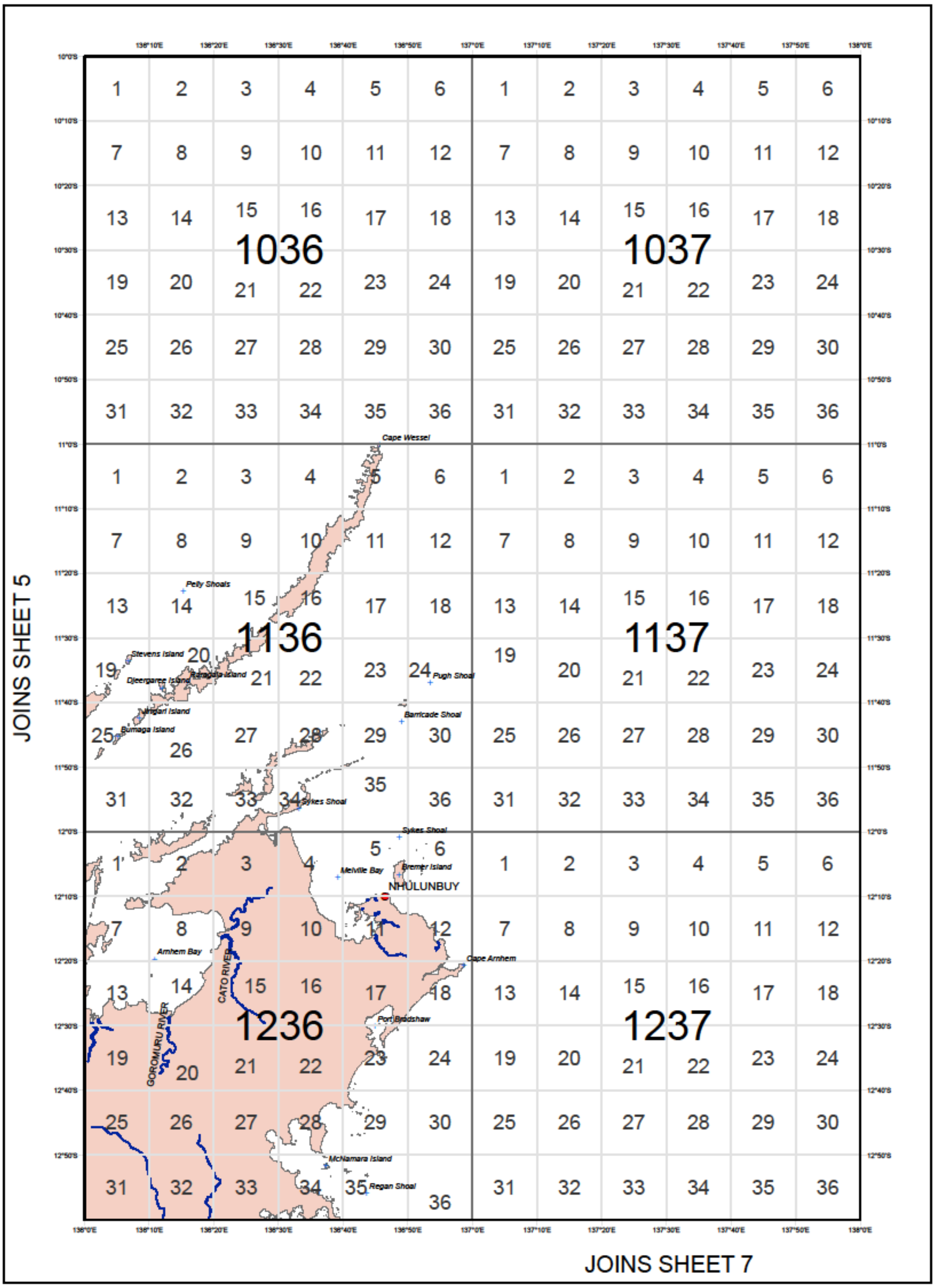
SHEET 3


JOINS SHEET 2 & 3
JOINS SHEET 5
1032
1033
1132
1133
1232
1233
COBOURG PENINSULA
MURGENELLA CREEK
COOPER CREEK
KING RIVER
JUNGLE CREEK
EAST ALLIGATOR RIVER
WEST ALLIGATOR RIVER
LIVERPOOL RIVER
HOLMAN RIVER
Britomart Shoal
Jones Shoal
Cape Croker
Oxley Island
Peacock Island
Orontes Reef
Lawson Island
McCluer Island
Grant Island
Port Essington
Bowen Strait
Templer Island
Cape Cockburn
Valencia Island
Mountnorris Bay
Wunmiyi Island
Greenhill Island
Mogogoul Island
Endyalgout Island
Aurari Bay
South Goulburn Island
Ann Shoals
Margaret Shoal
Victoria Shoal
Beatrice Reef
Araiaij Beach
Field Island
Barron Island
Finke Bay

SHEET 4

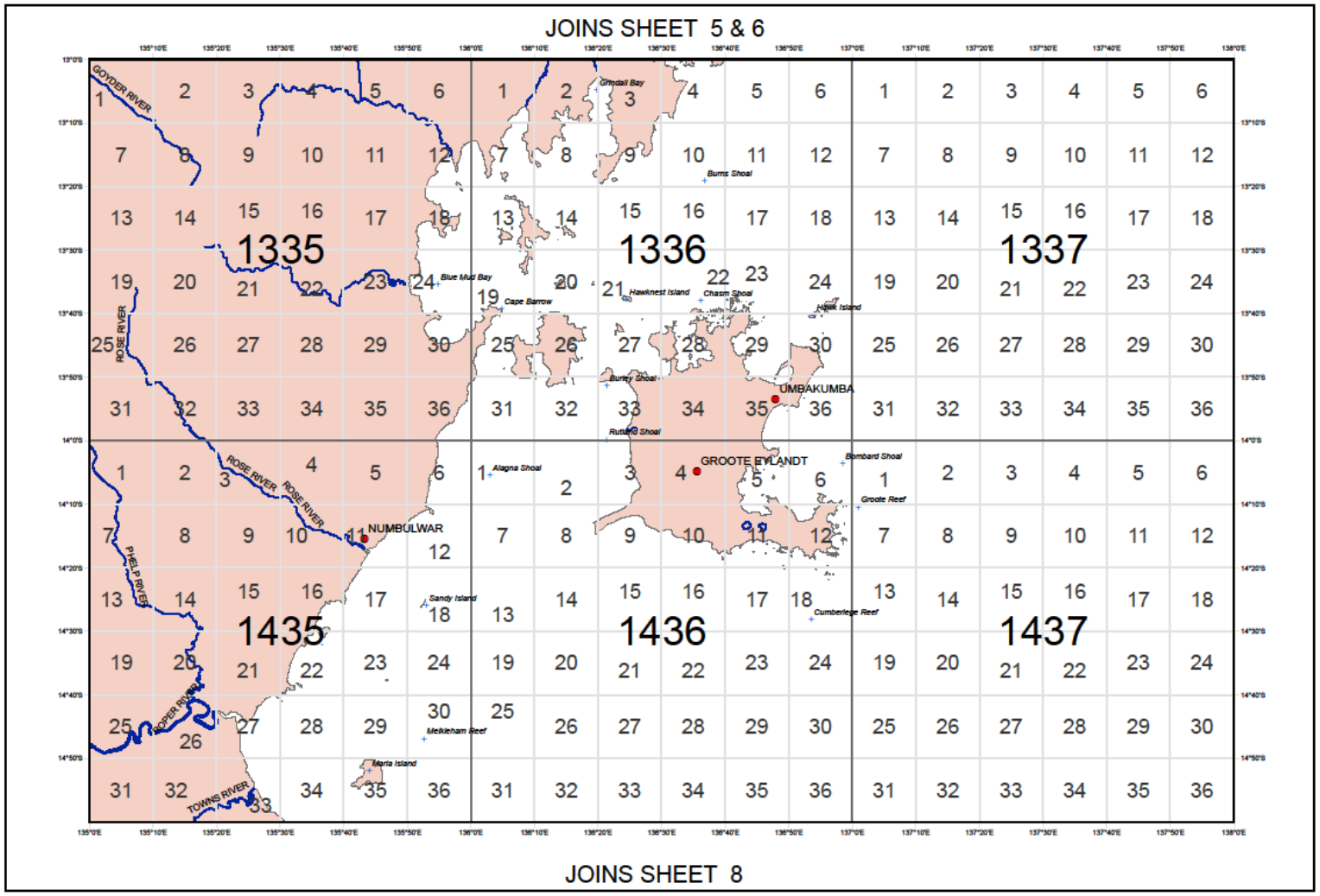

1134
1135
1234
1235
MANINGRIDA
MILINGIMBI
GALIWINKU
CADELL RIVER
BLYTH RIVER
GLYDE RIVER
GOYDER RIVER
MANN RIVER
BUCKINGHAM RIVER
HABGOOD RIVER
MADJUNGA RIVER
North Crocodile Reef
North West Crocodile Island
North East Crocodile Island
Graham Island
Alger Island
Entrance Island
Cape Stewart
Mogordingga Island
Echo Island
Boucaut Bay
Yabooma Island
Loosil Shoal
Castlereagh Bay
Howard Island
Buckingham Bay
Badgan Island
Hutchison Strait
JOINS SHEET 4
JOINS SHEET 6
JOINS SHEET 7

SHEET 5

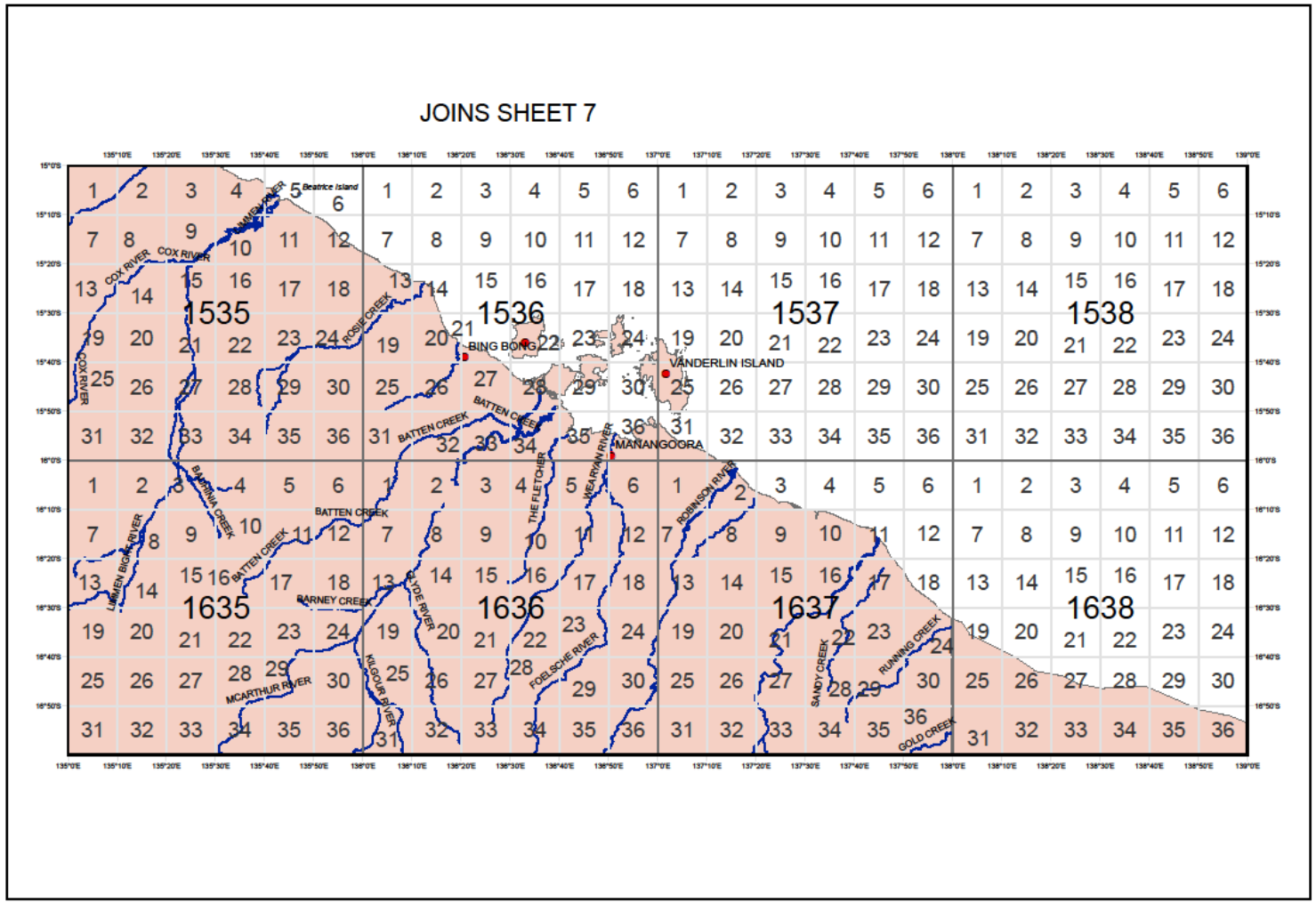


1036
1037
1136
1137
1236
1237
Cape Wessel
Pelly Shoals
Stevens Island
Djeergaree Island
Pugh Shoal
Barricade Shoal
Burnaga Island
Sykes Shoal
Melville Bay
Bremer Island
NHULUNBUY
Arnhem Bay
Cape Arnhem
CATO RIVER
GOROMURU RIVER
Port Bradshaw
McNamara Island
Regan Shoal
JOINS SHEET 5
JOINS SHEET 7

SHEET 6


JOINS SHEET 5 & 6
GOYDER RIVER
ROSE RIVER
PHELP RIVER
ROPER RIVER
TOWNS RIVER
1335
1336
1337
1435
1436
1437
Grindall Bay
Burns Shoal
Blue Mud Bay
Cape Barrow
Hawknest Island
Chasm Shoal
Hawk Island
Bunny Shoal
UMBAKUMBA
Rutland Shoal
Alagna Shoal
GROOTE EYLANDT
Bombard Shoal
Groote Reef
NUMBULWAR
Sandy Island
Cumberlege Reef
Melkleham Reef
Maria Island
JOINS SHEET 8

SHEET 7


JOINS SHEET 7
1535
1536
1537
1538
1635
1636
1637
1638
BING BONG
VANDERLIN ISLAND
MANANGOORA
COX RIVER
LIMMEN RIVER
BATTEN CREEK
BARNEY CREEK
ROBINSON RIVER
MCARTHUR RIVER
KILGOUR RIVER
FOELSCHE RIVER
SANDY CREEK
RUNNING CREEK
GOLD CREEK
CLYDE RIVER
ROSIE CREEK
BAMYINA CREEK
THE FLETCHER
WEARYAN RIVER
LIMMEN BIGHT RIVER

SHEET 8

South Australia

SA use different catch reporting grids for different fisheries. They are reported in Vainickis (2010) are shown below.

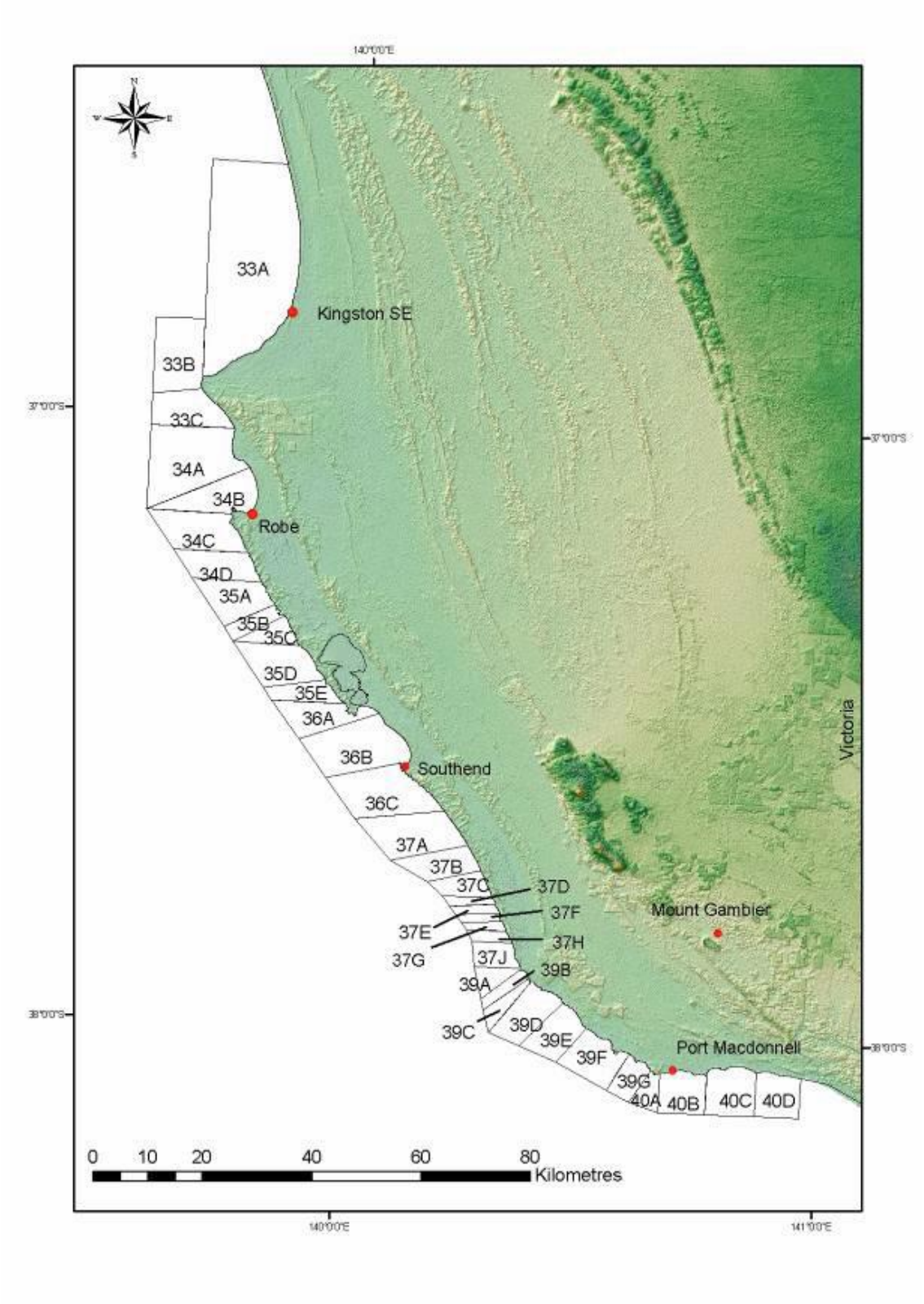


Figure 21. South Australian Abalone Fishery fishing areas for the Southern Zone (from Vainickis, 2010).

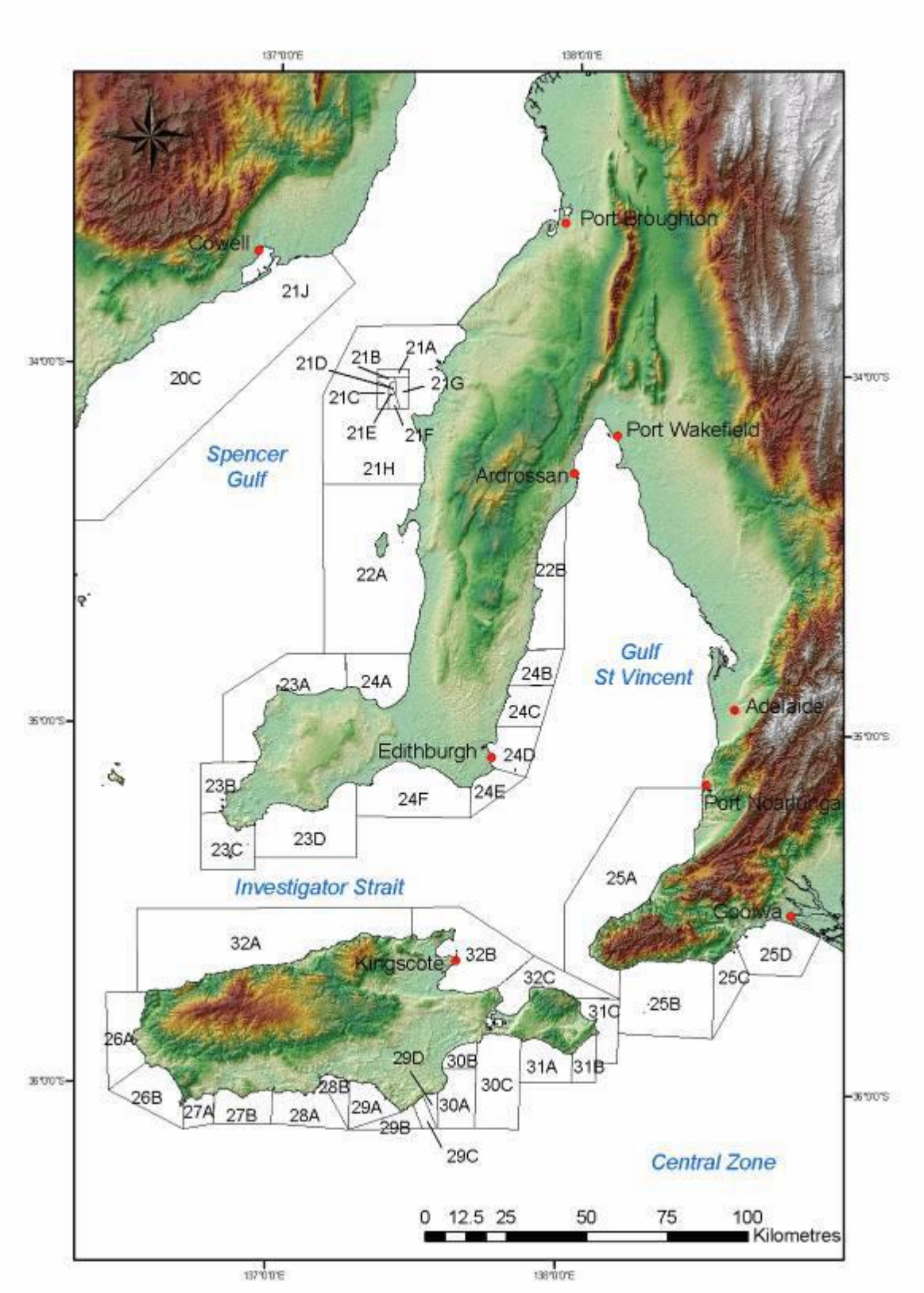


Figure 22. South Australian Abalone Fishery fishing areas for the Central Zone (from Vainickis, 2010).

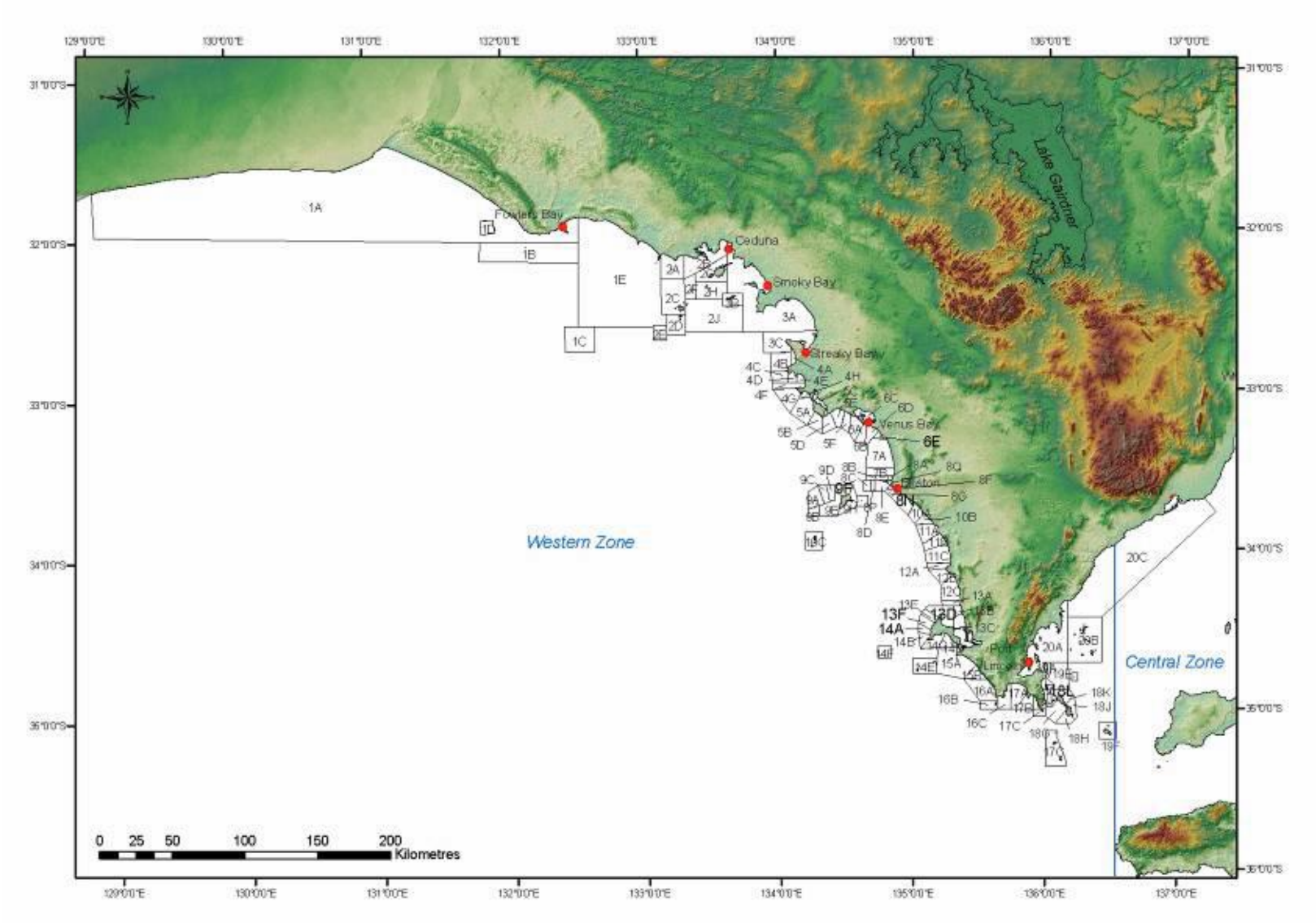


Figure 23. South Australian Abalone Fishery fishing areas for the Western Zone (from Vainickis, 2010).

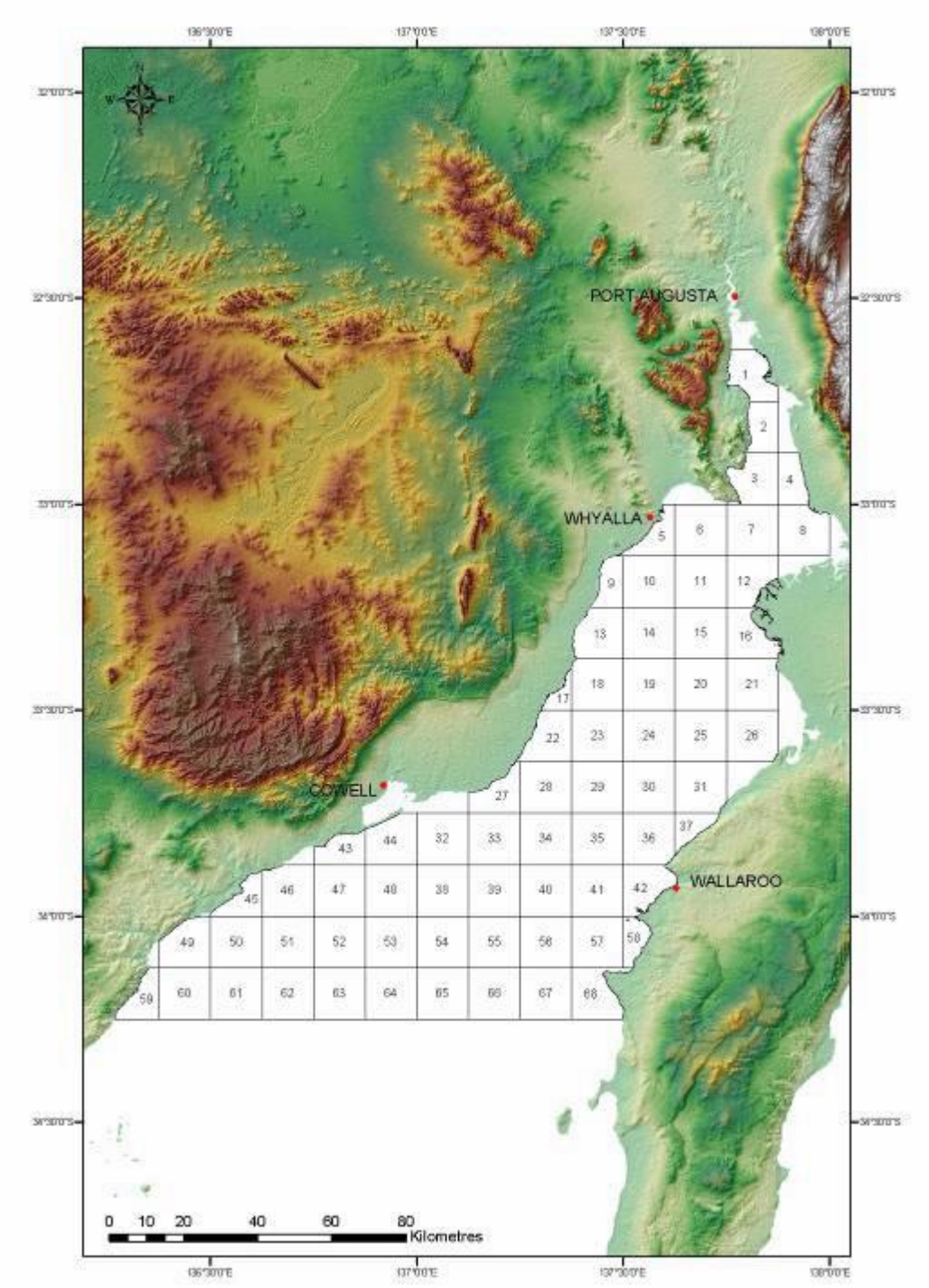


Figure 24. South Australian Spencer Gulf Blue Crab Fishery fishing areas (from Vainickis, 2010).

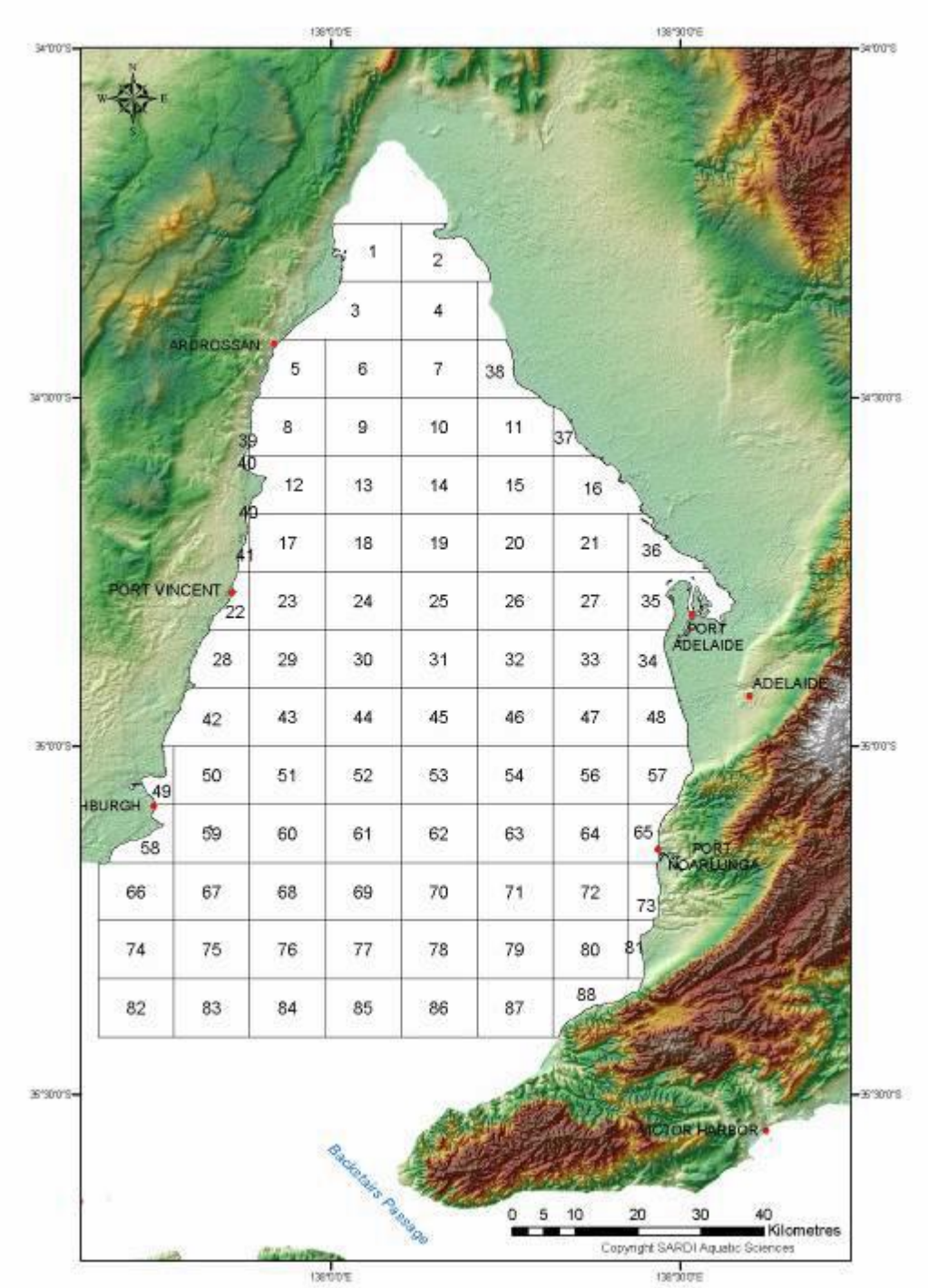


Figure 25. South Australian Gulf St Vincent Blue Crab Fishery fishing areas (from Vainickis, 2010).

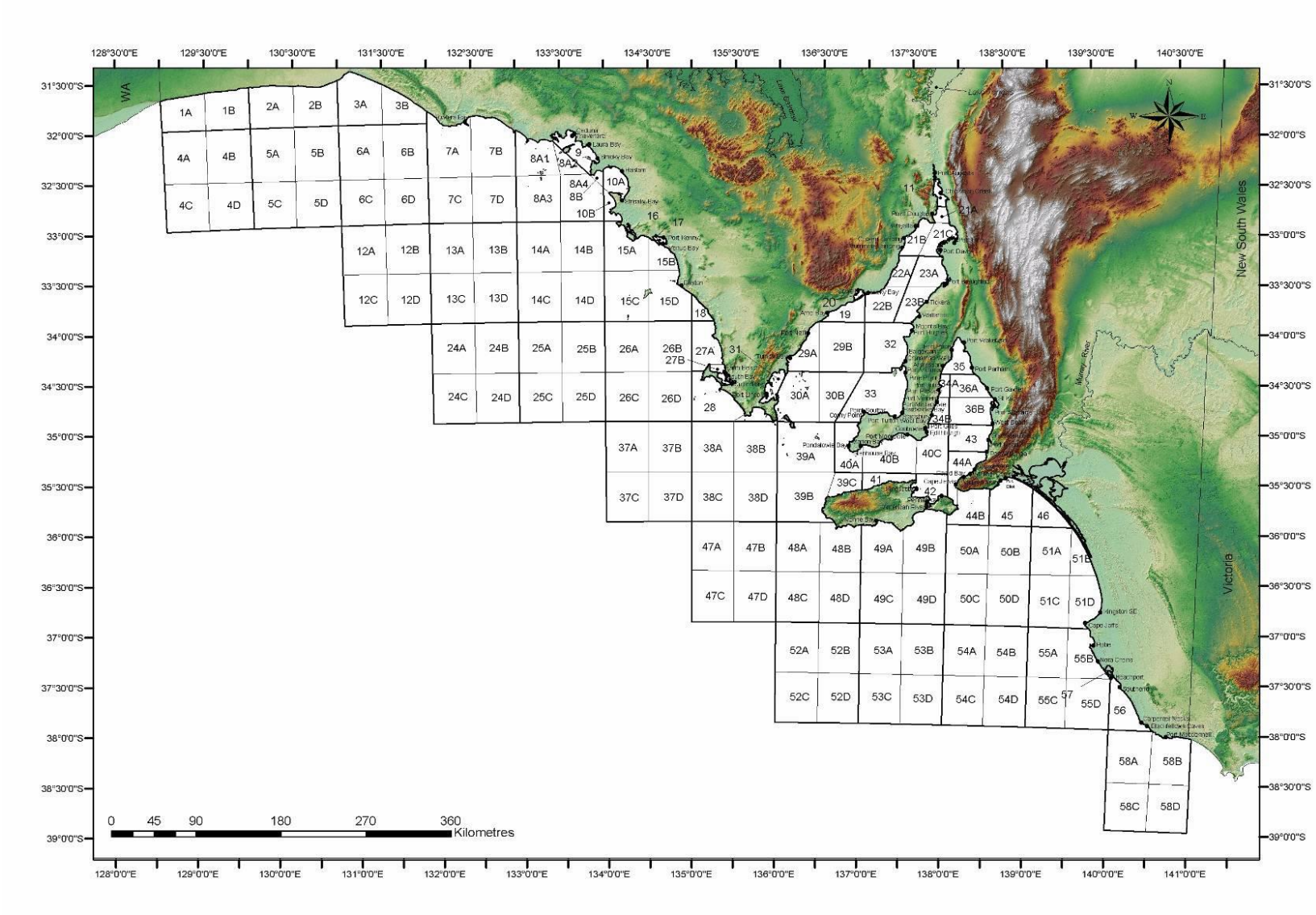


Figure 26. South Australian Charter Boat Fishery fishing areas (from Vainickis, 2010).

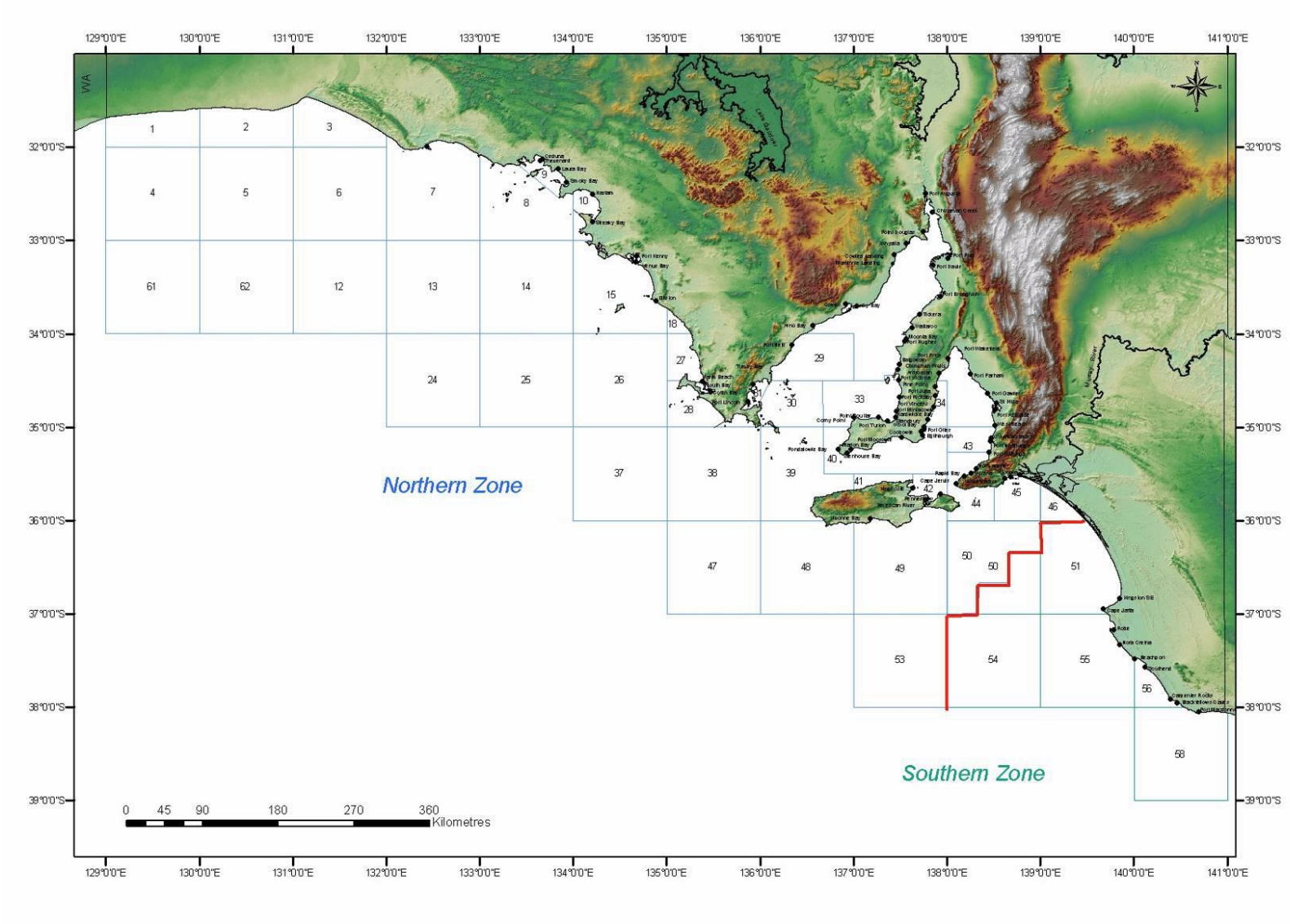


Figure 27. South Australian Giant Crab Fishery and Rock Lobster Fishery fishing areas (from Vainickis, 2010).

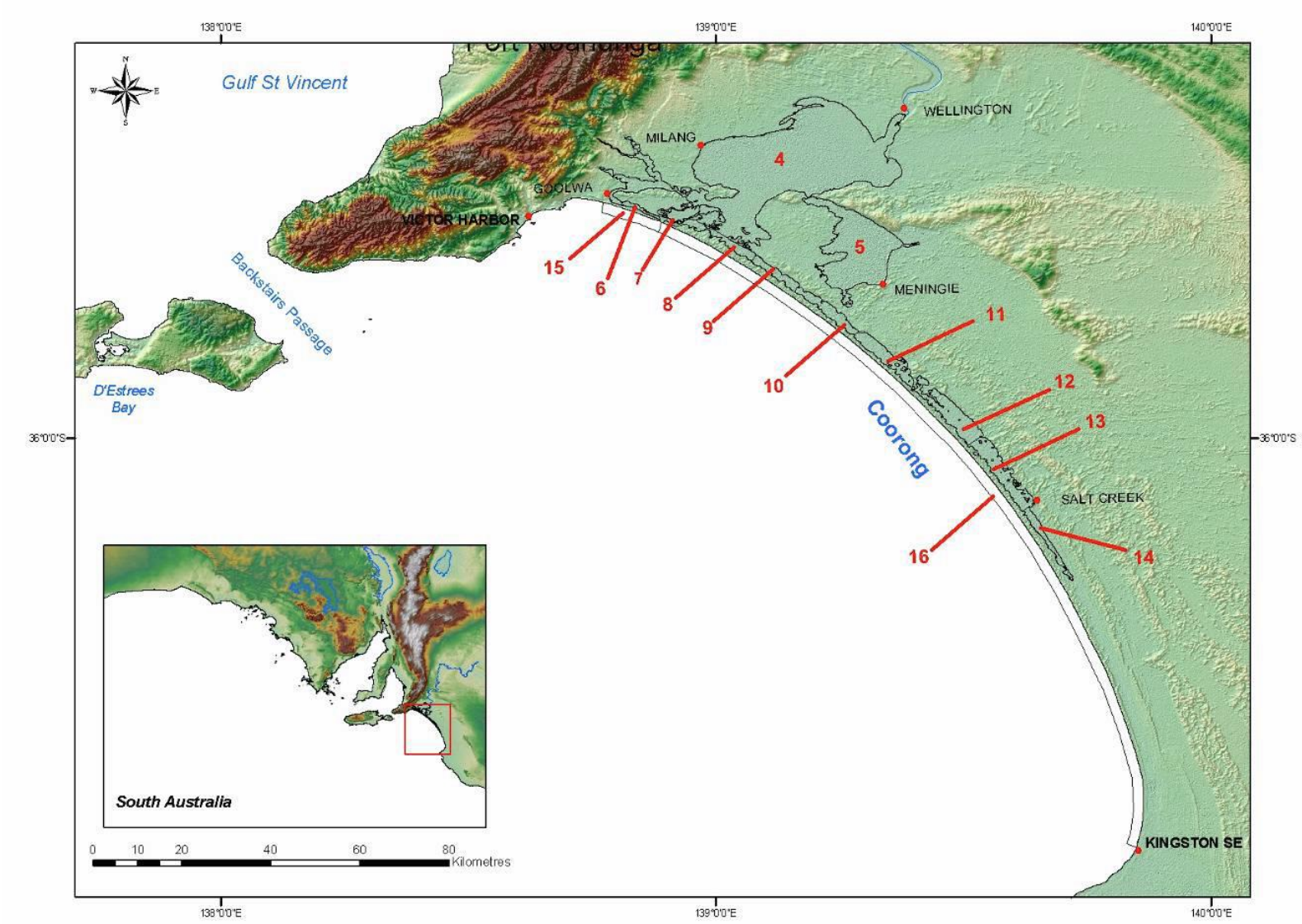


Figure 28. South Australian Lakes and Coorong Pipi Fishery areas (from Vainickis, 2010).

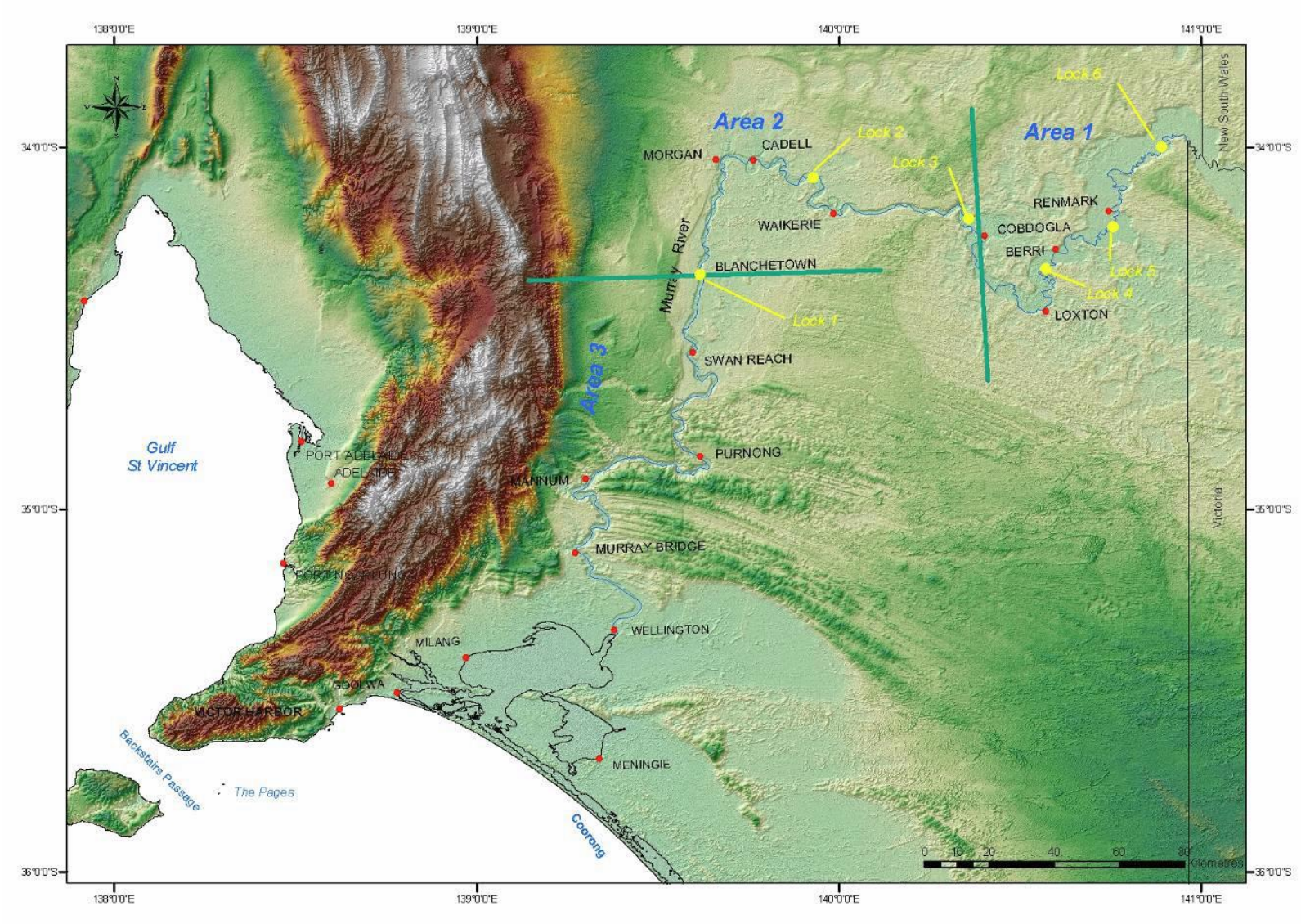


Figure 29. South Australian River Fishery fishing areas (from Vainickis, 2010).

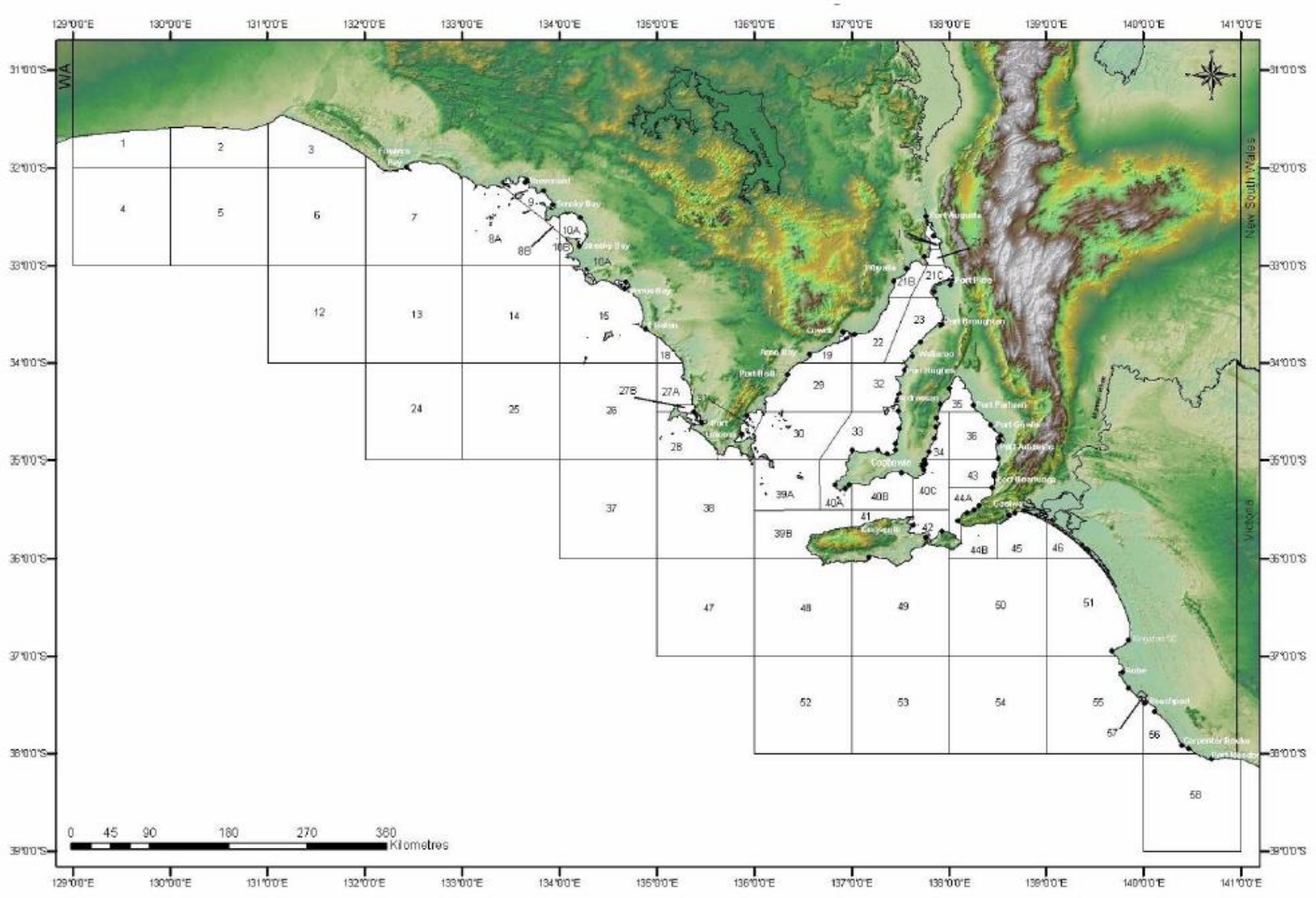


Figure 30. South Australian Marine Scalefish Fishery and Sardine Fishery fishing areas (from Vainickis, 2010).

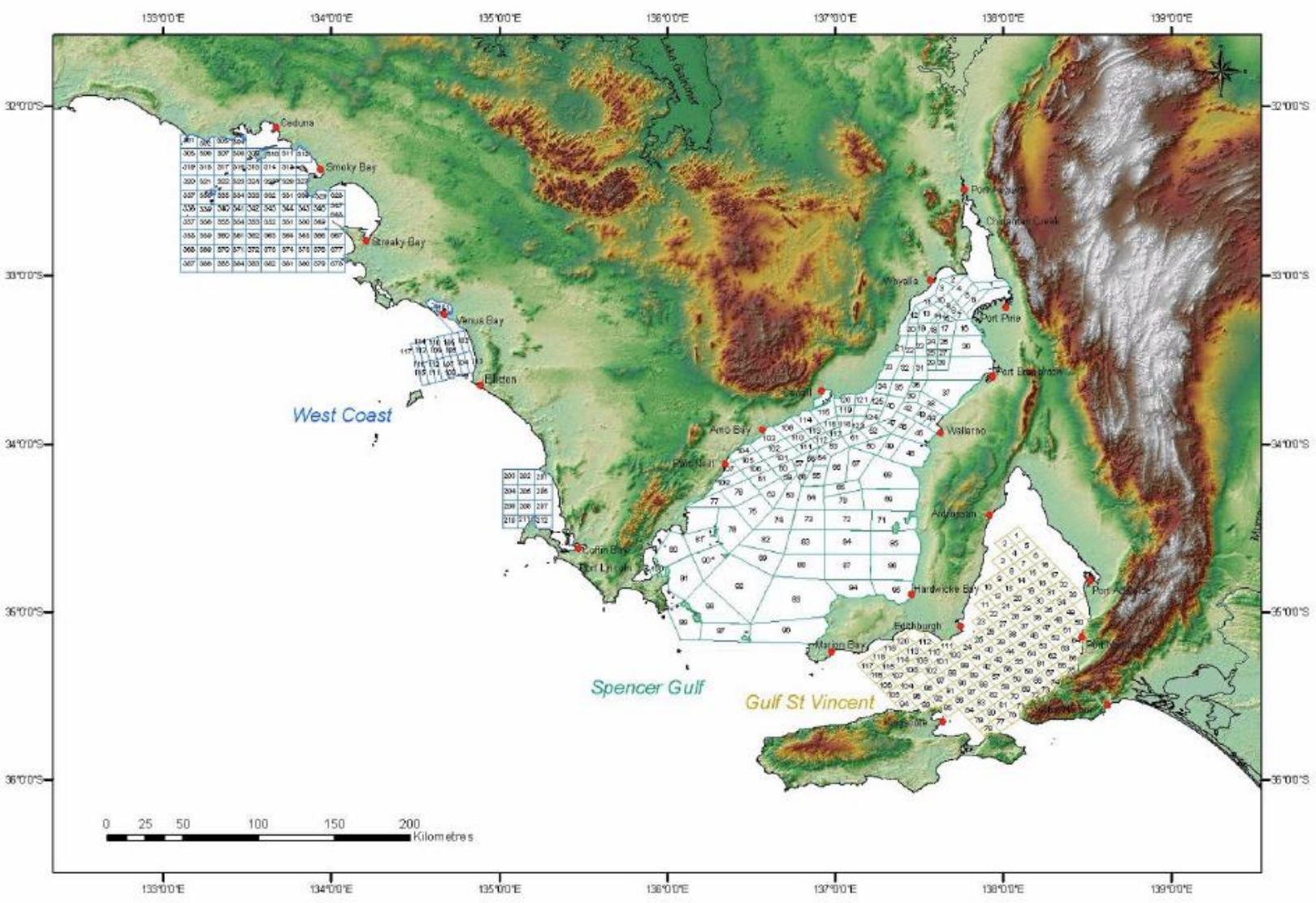
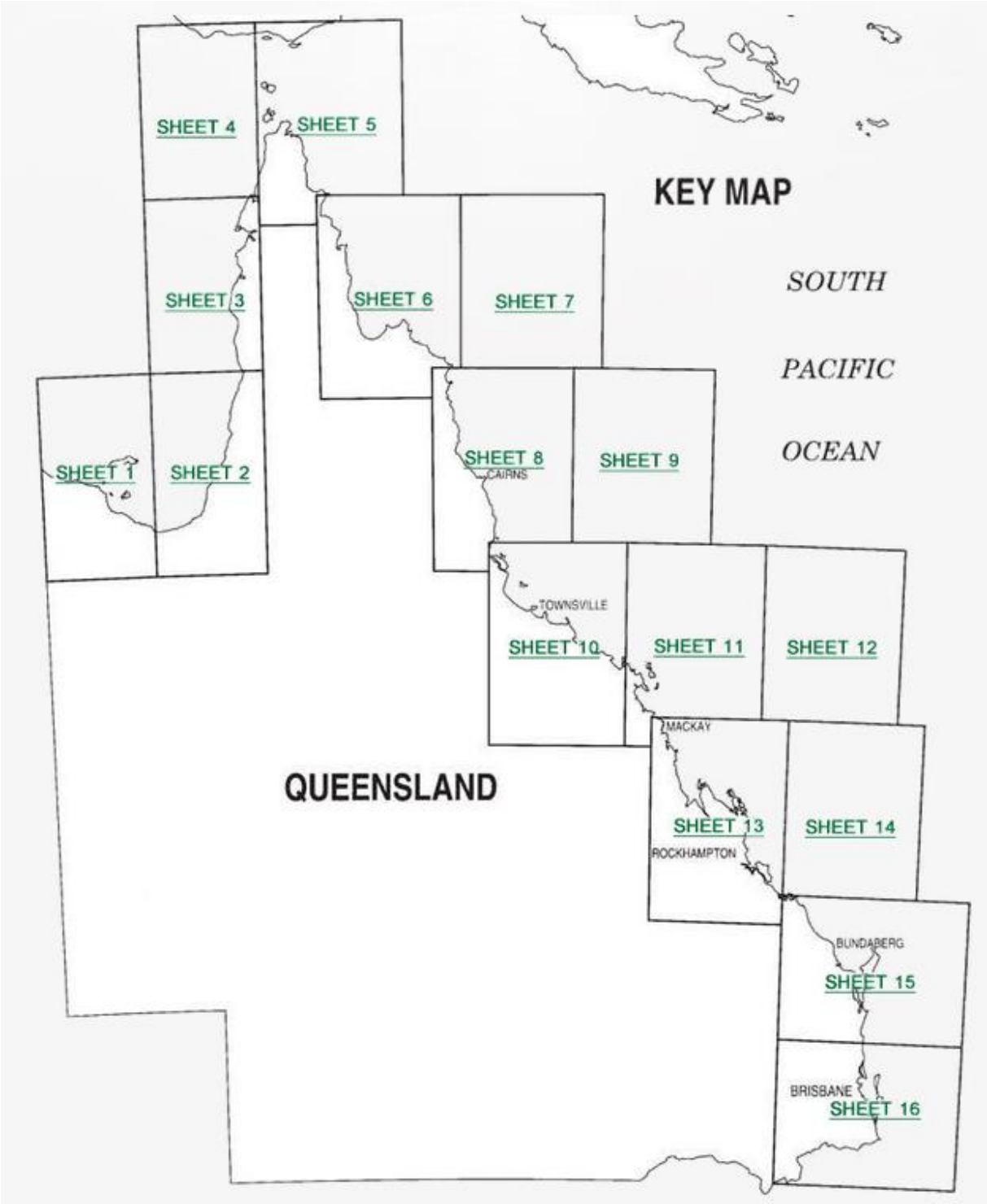
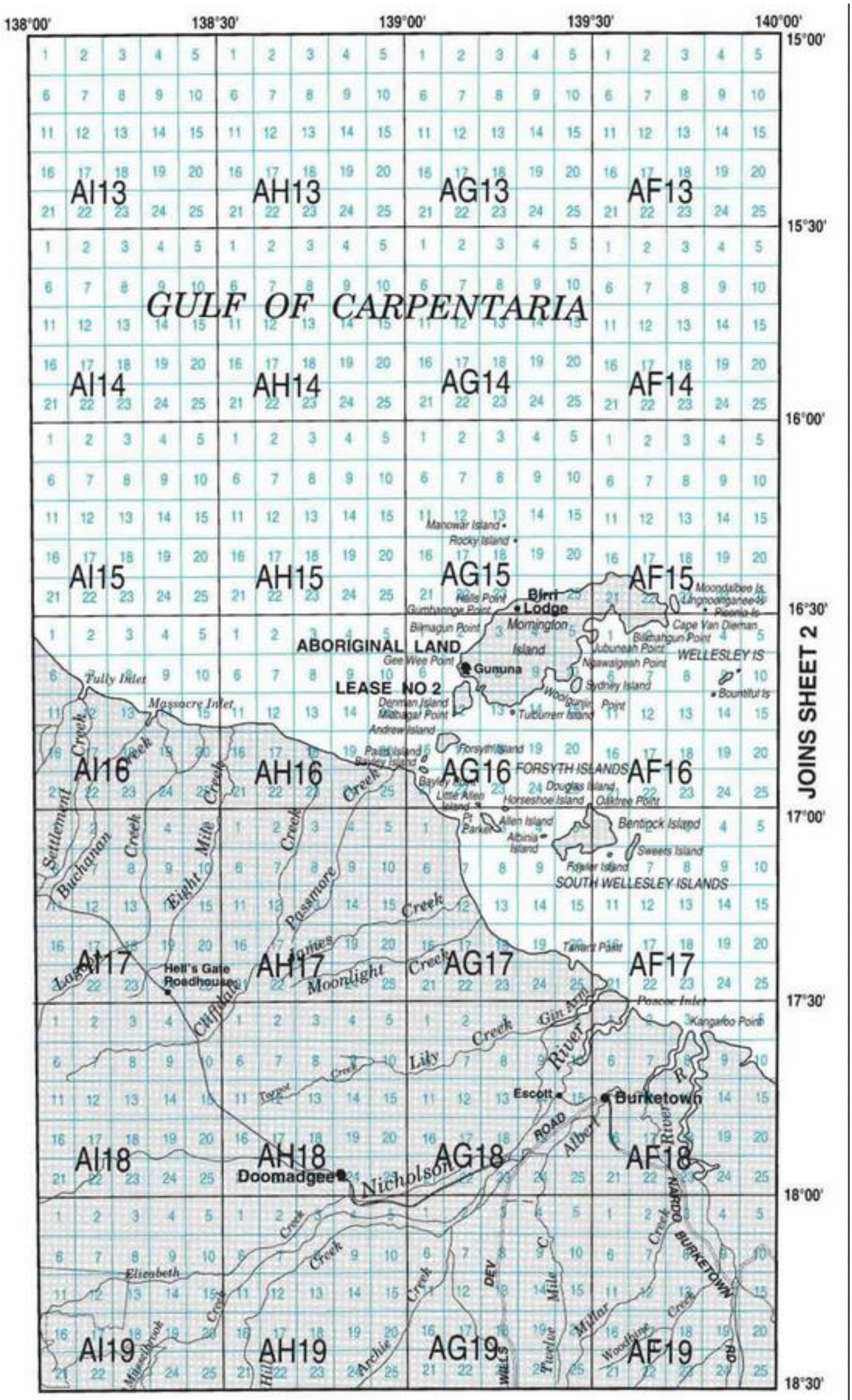


Figure 31. South Australian West Coast Prawn Fishery, Spencer Gulf Prawn Fishery and Gulf St Vincent Prawn Fishery fishing areas (from Vainickis, 2010).

Queensland

Qld use standard catch reporting grids for different fisheries that are shown below. They are also available at www.business.qld.gov.au/industry/fisheries/commercial-fishing/monitoring-and-reporting/reporting-commercial-fishers/queensland-logbook-maps.

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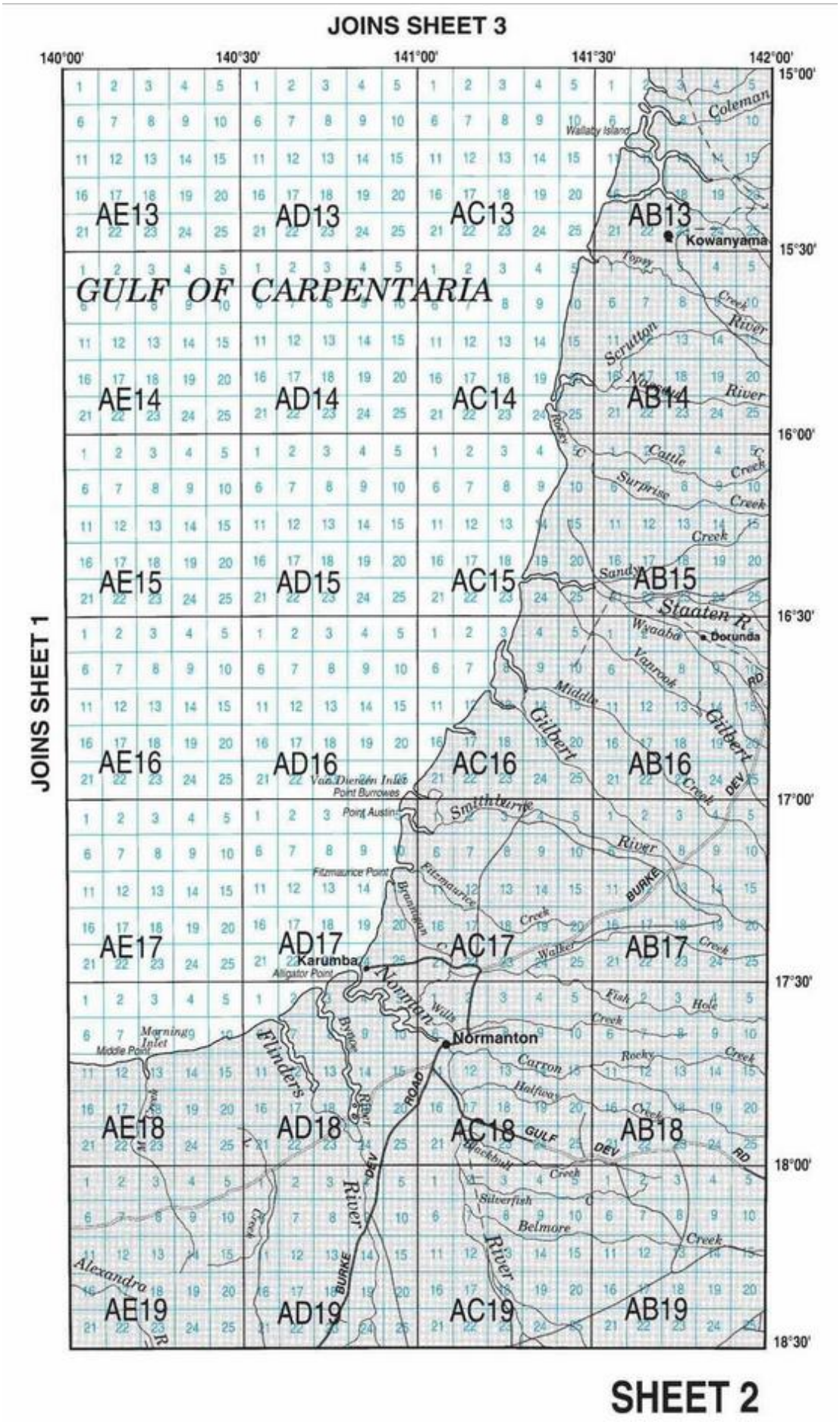
18°30'
AI13
AH13
AG13
AF13
GULF OF CARPENTARIA
AI14
AH14
AG14
AF14
AI15
AH15
AG15
AF15
AI16
AH16
AG16
AF16
AI17
AH17
AG17
AF17
AI18
AH18
AG18
AF18
AI19
AH19
AG19
AF19
JOINS SHEET 2
Manowar Island
Rocky Island
Birri Lodge
Mornington Island
ABORIGINAL LAND
LEASE NO 2
Gununa
WELLESLEY IS
Bountiful Is
FORSYTH ISLANDS
Forsyth Island
Bentinck Island
Sweers Island
SOUTH WELLESLEY ISLANDS
Tully Inlet
Massacre Inlet
Settlement Creek
Buchanan Creek
Eight Mile Creek
Passmore Creek
Moonlight Creek
Hell's Gate Roadhouse
Lily Creek
Escott
Burketown
Nicholson River
Albert River
Doomadgee
Elizabeth
Archie Creek
Twelve Mile Creek
Kangaroo Point

SHEET 1


JOINS SHEET 3
JOINS SHEET 1
SHEET 2
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140°30'
141°00'
141°30'
142°00'
15°00'
15°30'
16°00'
16°30'
17°00'
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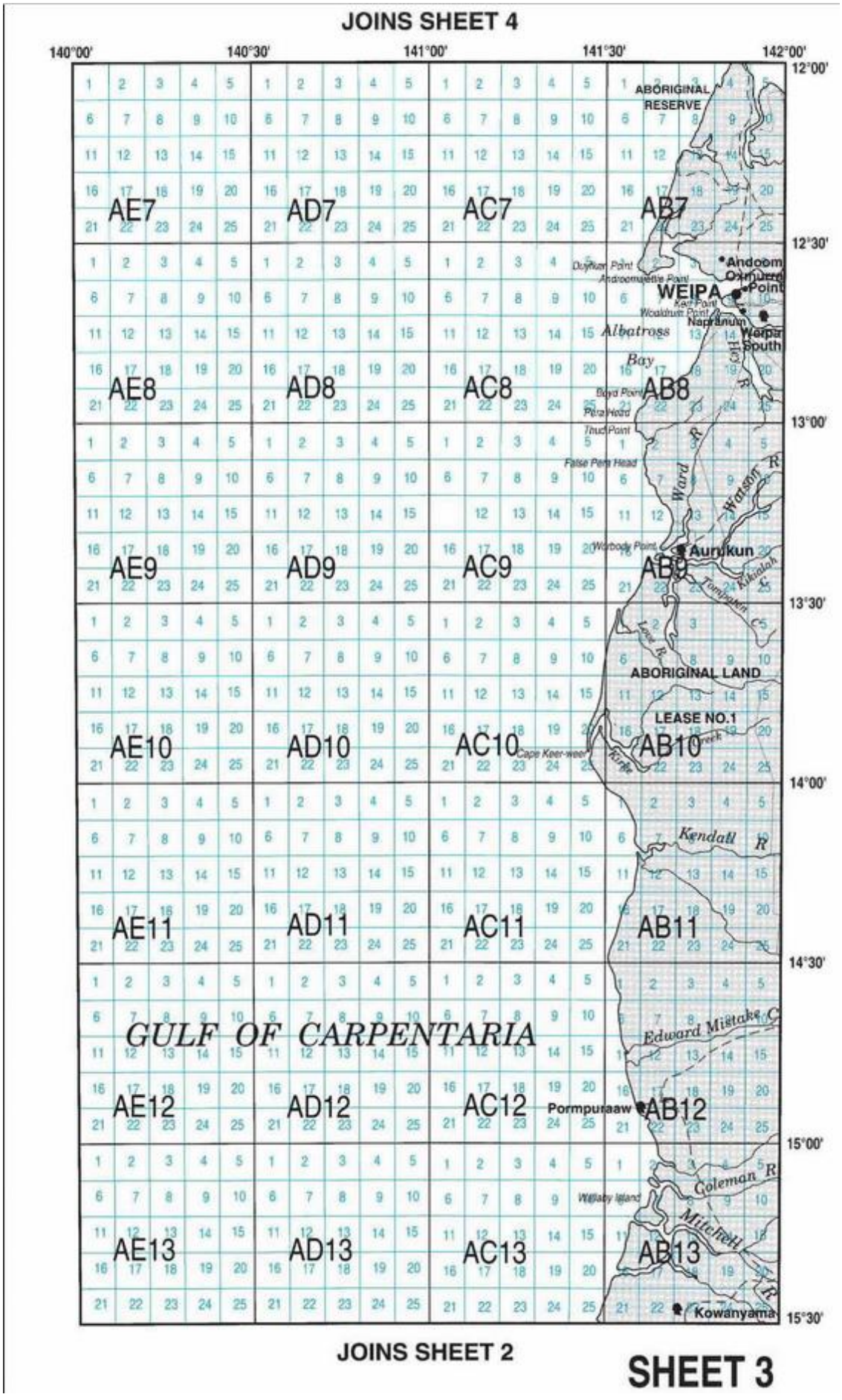
18°00'
18°30'
AE13
AD13
AC13
AB13
AE14
AD14
AC14
AB14
AE15
AD15
AC15
AB15
AE16
AD16
AC16
AB16
AE17
AD17
AC17
AB17
AE18
AD18
AC18
AB18
AE19
AD19
AC19
AB19
GULF OF CARPENTARIA
Kowanyama
Coleman
Wallaby Island
Topsy Creek
Scrutton River
Nassau River
Rocky C.
Cattle Creek
Surprise Creek
Sandy Creek
Staaten R.
Dorunda
Wyaaba
Yanrook
Middle
Gilbert
Gilbert
RD
DEV
Van Diemen Inlet
Point Burnowes
Point Austin
Smithburne
River
Fitzmaurice Point
Fitzmaurice
Brantigan C.
Creek
BURKE
Karumba
Alligator Point
Norman
Wills
Creek
Normanton
Fish Hole
Morning Inlet
Middle Point
Byrce
Flinders
River
ROAD
Carron
Rocky
Creek
Halfway
Creek
GULF
DEV
RD
Blackbutt
Creek
Silverfish
Creek
Belmore
Creek
River
Alexandra
R.
BURKE
DEV
River


JOINS SHEET 4
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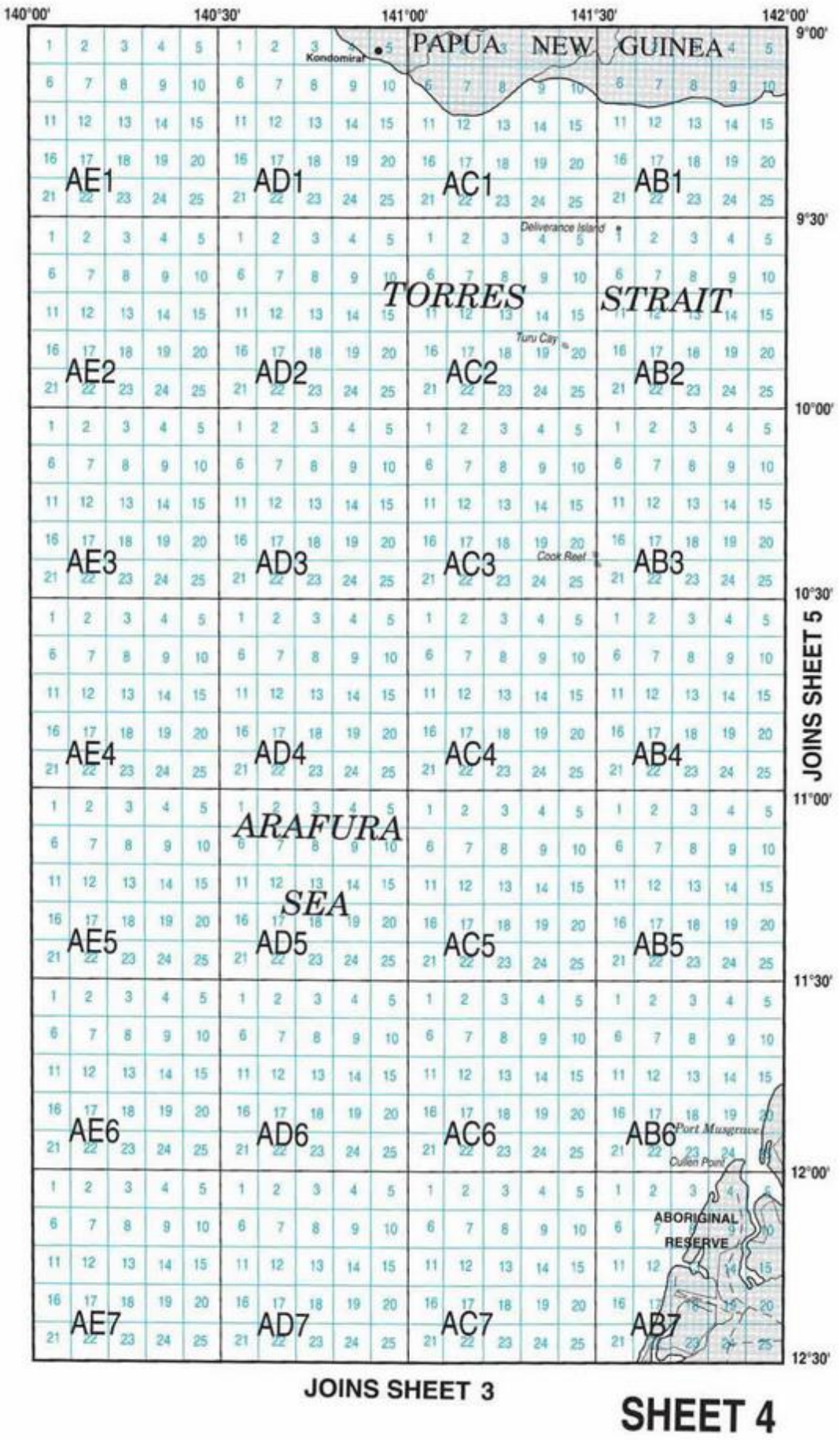
15°30'
ABORIGINAL RESERVE
AE7
AD7
AC7
AB7
AE8
AD8
AC8
AB8
AE9
AD9
AC9
AB9
AE10
AD10
AC10
AB10
AE11
AD11
AC11
AB11
AE12
AD12
AC12
AB12
AE13
AD13
AC13
AB13
Andoom
Oxnurra
Point
WEIPA
Napranum
Weipa South
Albatross Bay
Hey R
Ward R
Watson R
Aurukun
Kendall R
ABORIGINAL LAND
LEASE NO.1
GULF OF CARPENTARIA
Edward
Mistake C
Pormpuraaw
Coleman R
Mitchell R
Kowanyama
JOINS SHEET 2
SHEET 3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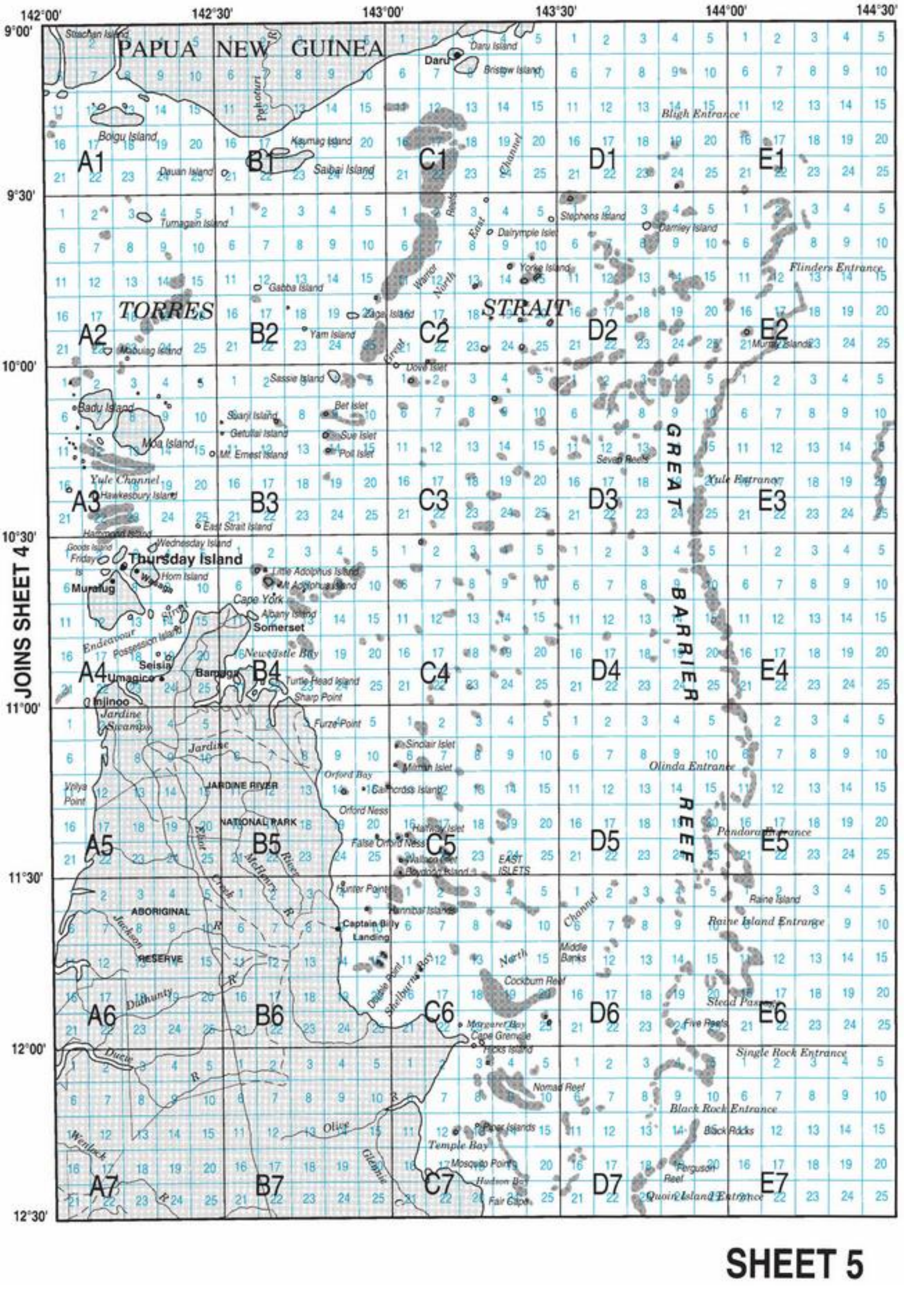
142°00'
9°00'
9°30'
10°00'
10°30'
11°00'
11°30'
12°00'
12°30'
PAPUA NEW GUINEA
Kondomirat
Deliverance Island
TORRES STRAIT
Turu Cay
Cook Reef
ARAFURA SEA
Port Musgrave
Cullen Point
ABORIGINAL RESERVE
AE1
AD1
AC1
AB1
AE2
AD2
AC2
AB2
AE3
AD3
AC3
AB3
AE4
AD4
AC4
AB4
AE5
AD5
AC5
AB5
AE6
AD6
AC6
AB6
AE7
AD7
AC7
AB7
JOINS SHEET 5
JOINS SHEET 3
SHEET 4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12°30'
JOINS SHEET 4
PAPUA NEW GUINEA
TORRES
STRAIT
GREAT
BARRIER
REEF
Daru
Daru Island
Bristow Island
Boigu Island
Dauan Island
Saibai Island
Kaumag Island
Bligh Entrance
Turnagain Island
Stephens Island
Darnley Island
Dalrymple Islet
Yorke Island
Flinders Entrance
Gabba Island
Yam Island
Mabuiag Island
Murray Islands
Sassie Island
Badu Island
Moa Island
Seven Reefs
Yule Channel
Hawkesbury Island
Yule Entrance
East Strait Island
Wednesday Island
Thursday Island
Horn Island
Muralug
Cape York
Albany Island
Somerset
Endeavour
Possession Island
Seisia
Umagico
Bamaga
Newcastle Bay
Turtle Head Island
Sharp Point
Injinoo
Jardine Swamps
Furze Point
Sinclair Islet
Olinda Entrance
Orford Bay
JARDINE RIVER
Orford Ness
NATIONAL PARK
Halfway Islet
False Orford Ness
EAST ISLETS
Pandora Entrance
Hunter Point
Hannibal Islands
Raine Island
Raine Island Entrance
ABORIGINAL
RESERVE
Captain Billy Landing
Middle Banks
Cockburn Reef
Steed Passage
Margaret Bay
Cape Grenville
Five Reefs
Single Rock Entrance
Nomad Reef
Black Rock Entrance
Black Rocks
Temple Bay
Mosquito Point
Ferguson Reef
Hudson Bay
Fair Cape
Quoin Island Entrance
A1
B1
C1
D1
E1
A2
B2
C2
D2
E2
A3
B3
C3
D3
E3
A4
B4
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D4
E4
A5
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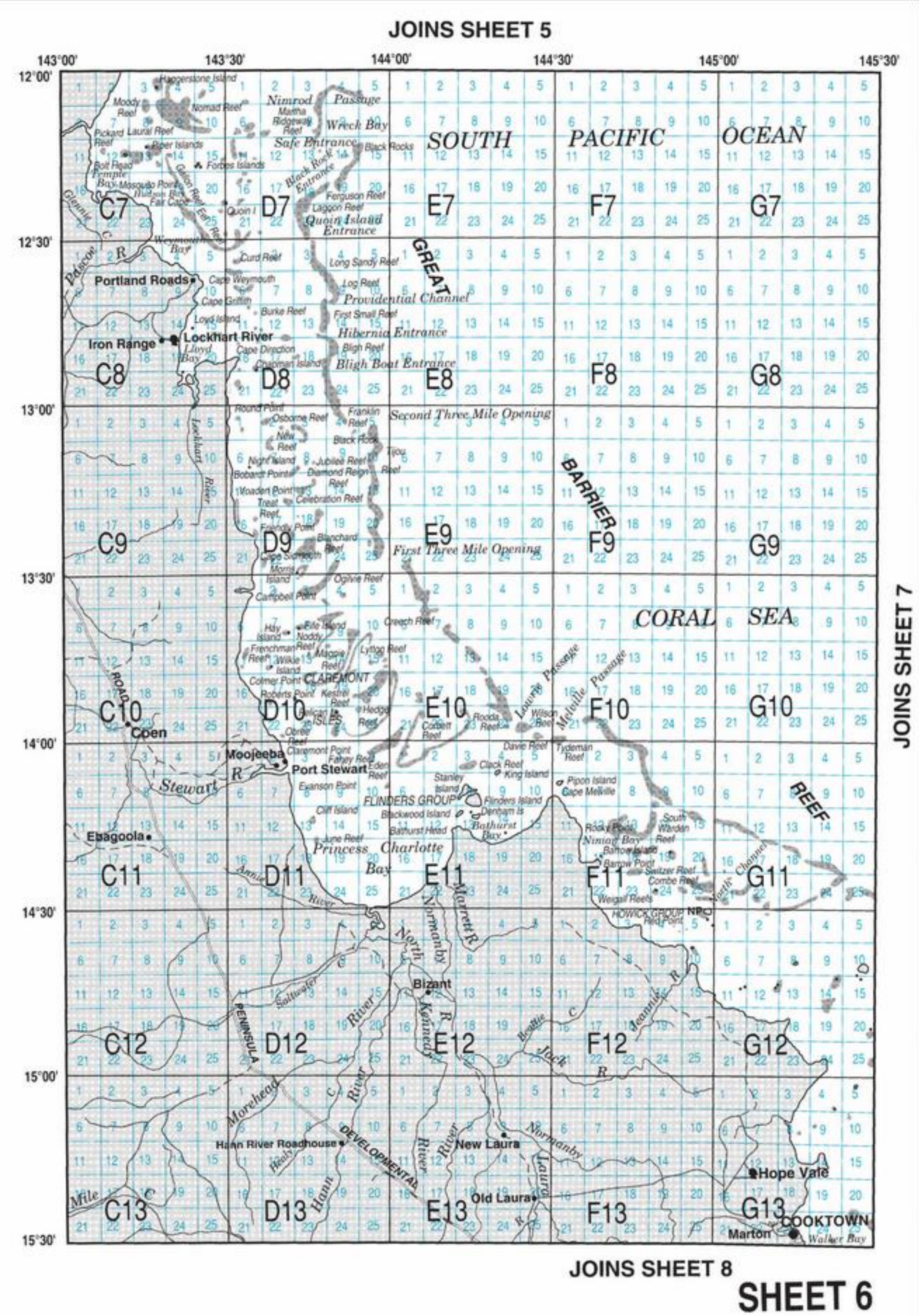
C7
D7
E7

SHEET 5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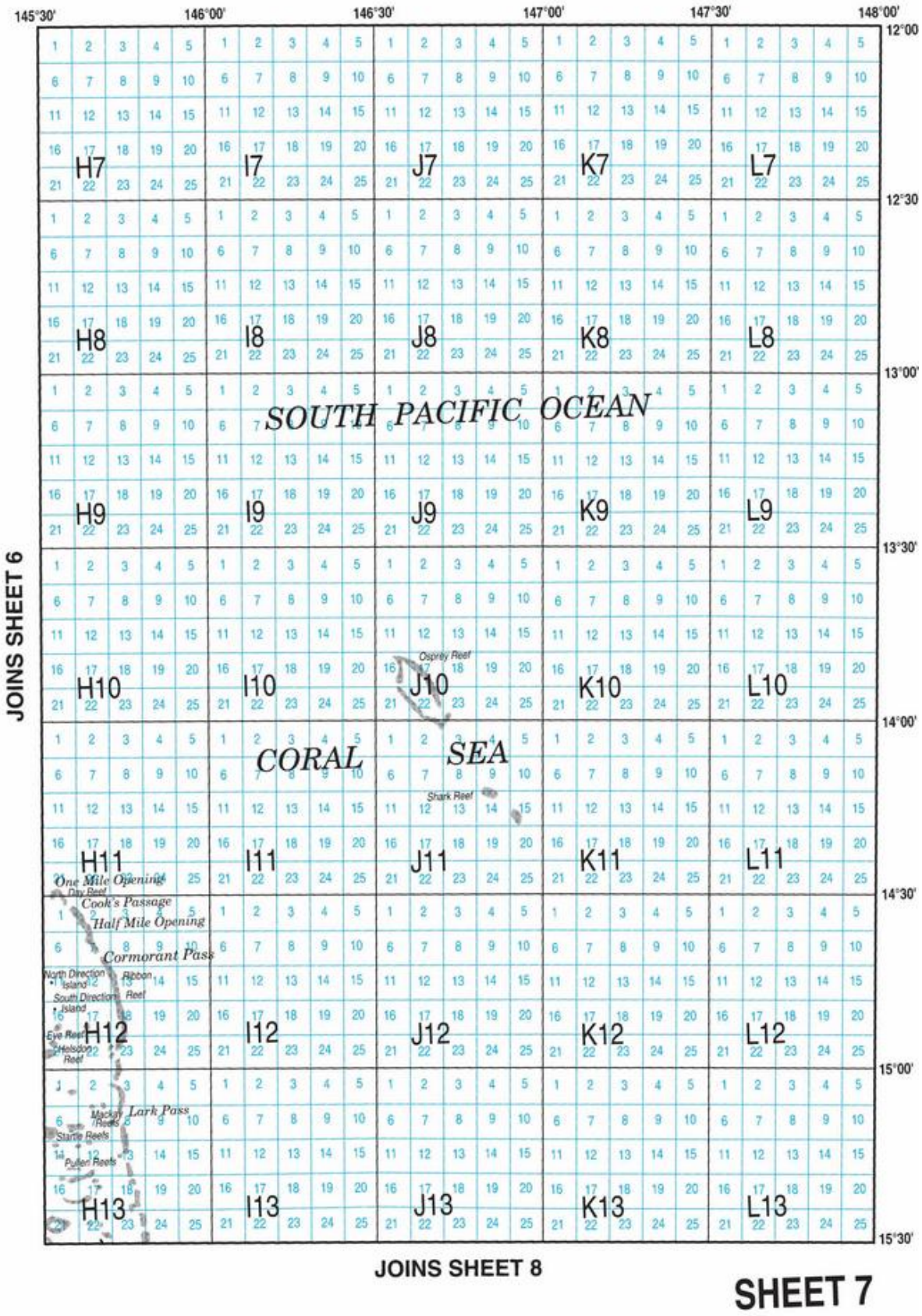
SOUTH PACIFIC OCEAN
GREAT BARRIER REEF
CORAL SEA
C7
D7
E7
F7
G7
C8
D8
E8
F8
G8
C9
D9
E9
F9
G9
C10
D10
E10
F10
G10
C11
D11
E11
F11
G11
C12
D12
E12
F12
G12
C13
D13
E13
F13
G13
Nimrod Passage
Wreck Bay
Safe Entrance
Quoin Island Entrance
Providential Channel
Hibernia Entrance
Bligh Boat Entrance
Second Three Mile Opening
First Three Mile Opening
Portland Roads
Lockhart River
Iron Range
Coen
Moojeeba
Port Stewart
Stewart R
Ebagoola
FLINDERS GROUP
Princess Charlotte Bay
Bizant
PENINSULA DEVELOPMENTAL ROAD
Hann River Roadhouse
New Laura
Old Laura
Hope Vale
COOKTOWN
Marton
Walker Bay
JOINS SHEET 7
JOINS SHEET 8
SHEET 6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L11
H12
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K12
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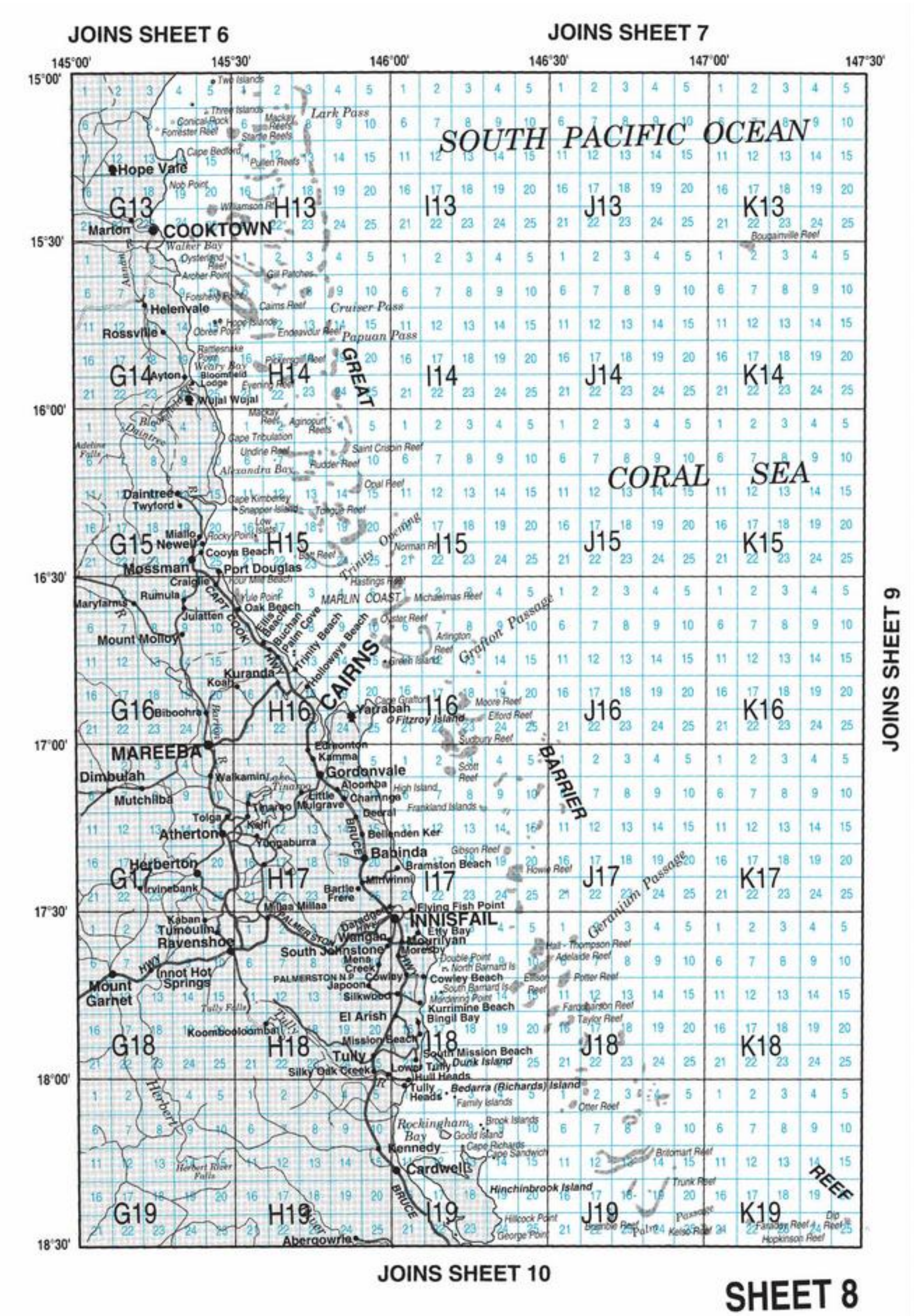
H13
I13
J13
K13
L13
SOUTH PACIFIC OCEAN
CORAL SEA
Osprey Reef
Shark Reef
One Mile Opening
Day Reef
Cook's Passage
Half Mile Opening
Cormorant Pass
North Direction Island
South Direction Island
Ribbon Reef
Eye Reef
Helsdon Reef
Mackay Reefs
Lark Pass
Startle Reefs
Pullen Reefs
JOINS SHEET 6
JOINS SHEET 8
SHEET 7



JOINS SHEET 6
JOINS SHEET 7
JOINS SHEET 9
JOINS SHEET 10
SHEET 8
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CORAL SEA
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BARRIER
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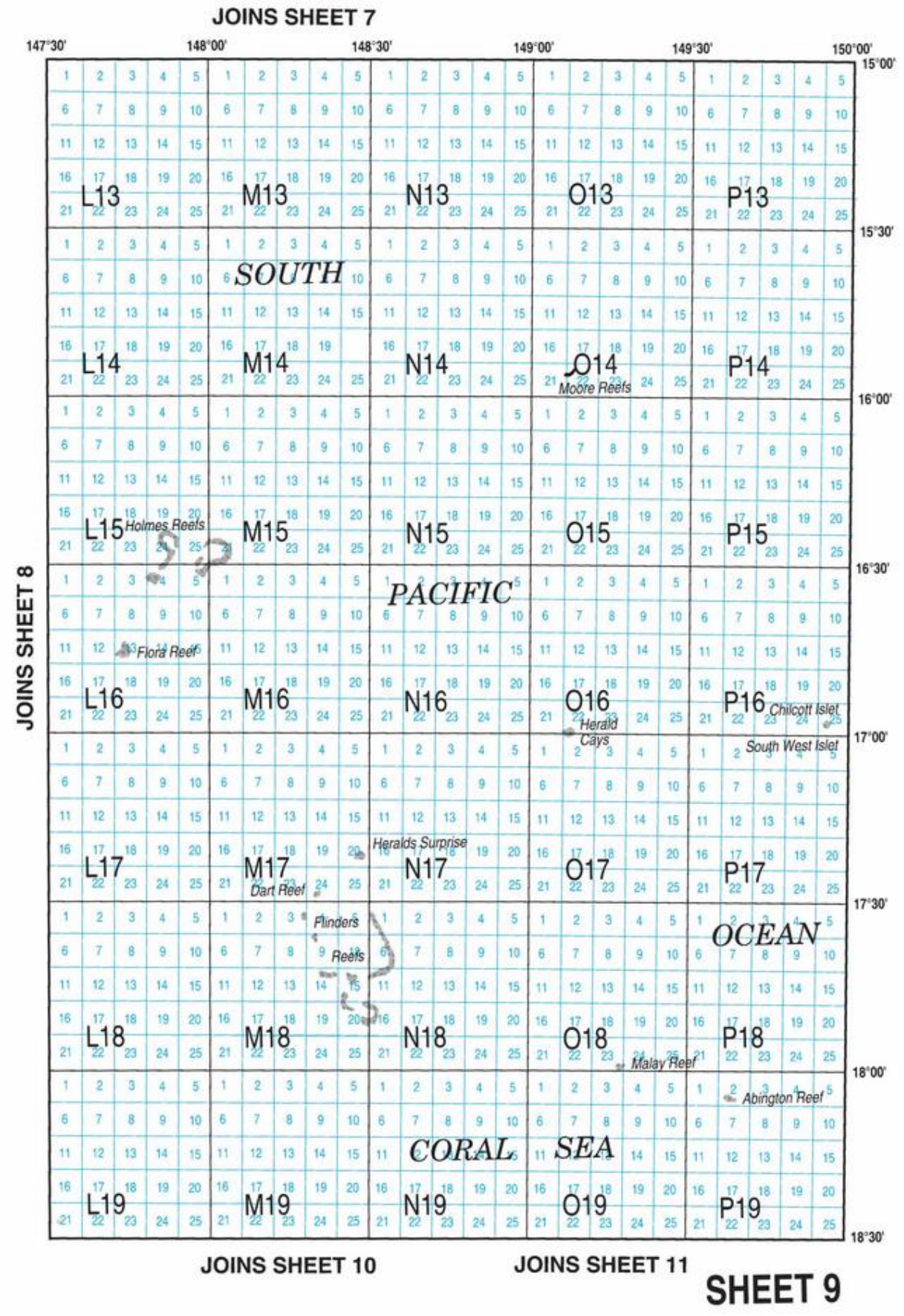
G19
H19
I19
J19
K19
Hope Vale
Marton
COOKTOWN
Helenvale
Rossville
Ayton
Wujal Wujal
Daintree
Twyford
Miallo
Newell
Cooya Beach
Mossman
Port Douglas
Craiglie
Rumula
Julatten
Oak Beach
Mount Molloy
Kuranda
Koah
CAIRNS
Yarrabah
Fitzroy Island
Biboohra
MAREEBA
Edmonton
Kamma
Gordonvale
Aloomba
Chaminga
Deeral
Walkamin
Dimbulah
Mutchilba
Tolga
Atherton
Yungaburra
Bellenden Ker
Babinda
Bramston Beach
Mirriwinni
Herberton
Irvinebank
Bartle Frere
Millaa Millaa
Flying Fish Point
INNISFAIL
Etty Bay
Mourilyan
Wangan
Moresby
Kaban
Tumoulin
Ravenshoe
South Johnstone
Innot Hot Springs
Mount Garnet
Mena Creek
Cowley Beach
Japoon
Silkwood
Kurrimine Beach
El Arish
Bingil Bay
Mission Beach
South Mission Beach
Dunk Island
Koombooloomba
Tully
Silky Oak Creek
Lower Tully
Hull Heads
Tully Heads
Bedarra (Richards) Island
Family Islands
Rockingham Bay
Kennedy
Cardwell
Hinchinbrook Island
Abergowrie
Lark Pass
Cruiser Pass
Papuan Pass
Trinity Opening
Grafton Passage
Geranium Passage
MARLIN COAST
CAPT COOK HWY
BRUCE HWY
Walker Bay
Weary Bay
Alexandra Bay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P13
SOUTH
L14
M14
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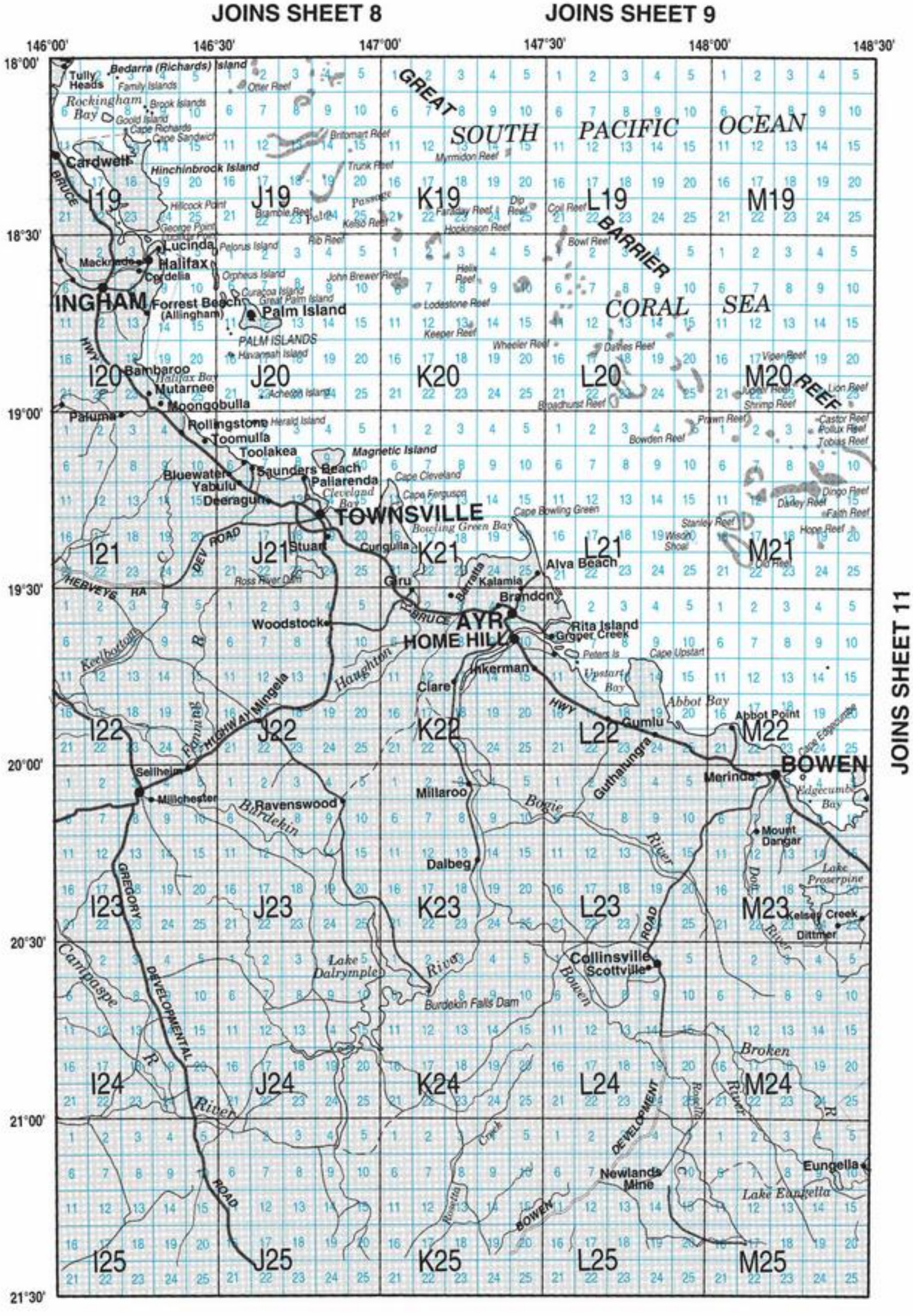
O14
P14
Moore Reefs
L15
Holmes Reefs
M15
N15
O15
P15
PACIFIC
Flora Reef
L16
M16
N16
O16
P16
Chilcott Islet
Herald Cays
South West Islet
L17
M17
N17
O17
P17
Herald's Surprise
Dart Reef
Flinders Reefs
OCEAN
L18
M18
N18
O18
P18
Malay Reef
Abington Reef
L19
M19
N19
O19
P19
CORAL SEA
JOINS SHEET 8
JOINS SHEET 10
JOINS SHEET 11
SHEET 9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JOINS SHEET 11
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PACIFIC
OCEAN
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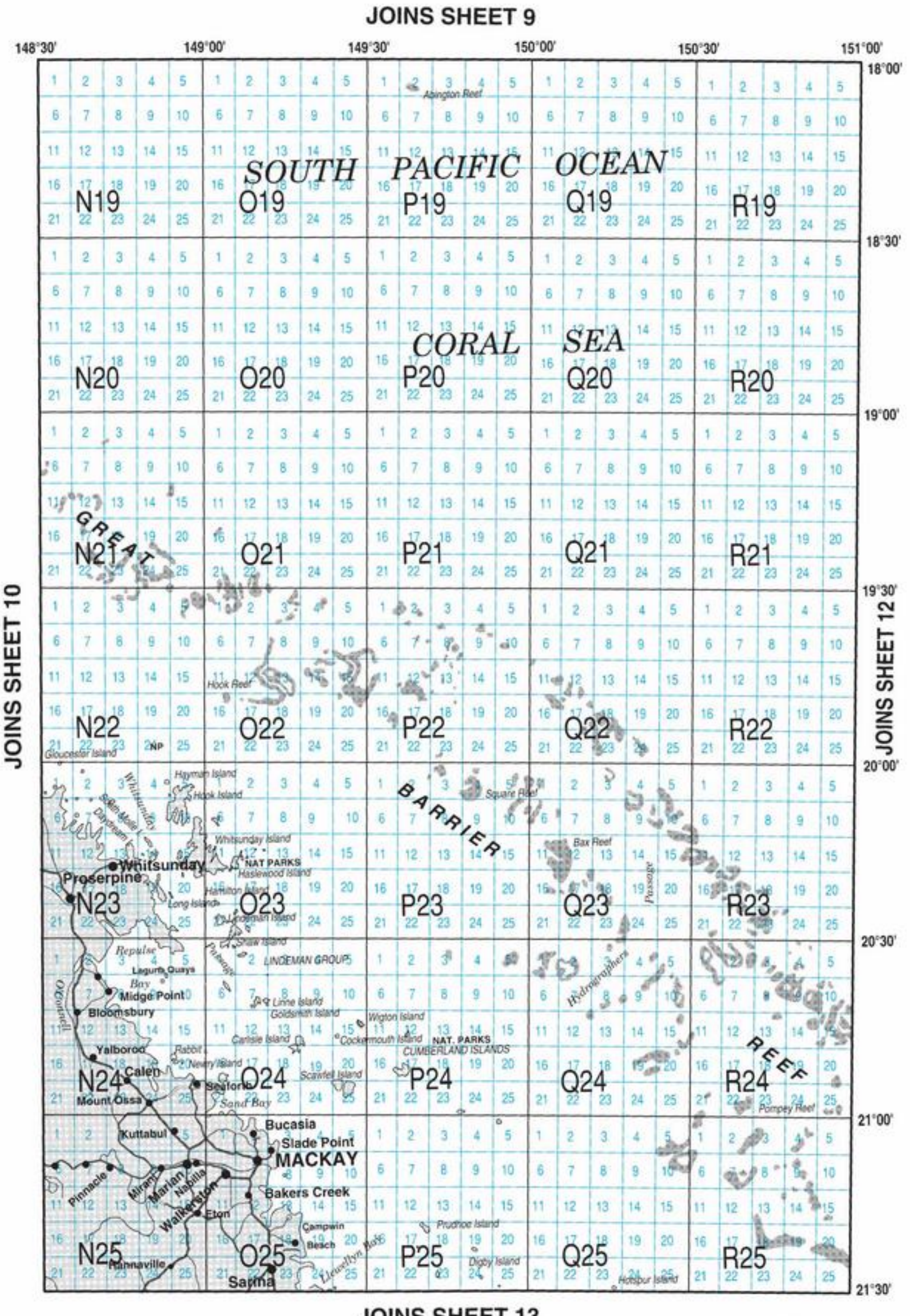
J24
K24
L24
M24
I25
J25
K25
L25
M25
Tully Heads
Rockingham Bay
Cardwell
Hinchinbrook Island
Lucinda
Halifax
Macknade
Cordelia
INGHAM
Forrest Beach (Allingham)
Palm Island
PALM ISLANDS
Bambaroo
Mutarnee
Moongobulla
Paluma
Rollingstone
Toomulla
Toolakea
Magnetic Island
Saunders Beach
Pallarenda
Bluewater
Yabulu
Deeragun
TOWNSVILLE
Cape Cleveland
Cape Ferguson
Bowling Green Bay
Cape Bowling Green
Stuart
Cungulla
Alva Beach
Giru
Kalamia
Brandon
Woodstock
AYR
HOME HILL
Rita Island
Groper Creek
Cape Upstart
Upstart Bay
Inkerman
Clare
Abbot Bay
Abbot Point
Gumlu
BOWEN
Merinda
Edgecumbe Bay
Mount Dangar
Sellheim
Millchester
Ravenswood
Millaroo
Dalbeg
Lake Proserpine
Kelsey Creek
Dittmer
Collinsville
Scottville
Lake Dalrymple
Burdekin Falls Dam
Eungella
Newlands Mine
Lake Eungella
HERVEYS RA
DEV ROAD
BRUCE HWY
GREGORY DEVELOPMENTAL ROAD
Burdekin
Bogie
Bowen
Broken
River

SHEET 10



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JOINS SHEET 10
JOINS SHEET 12
JOINS SHEET 13
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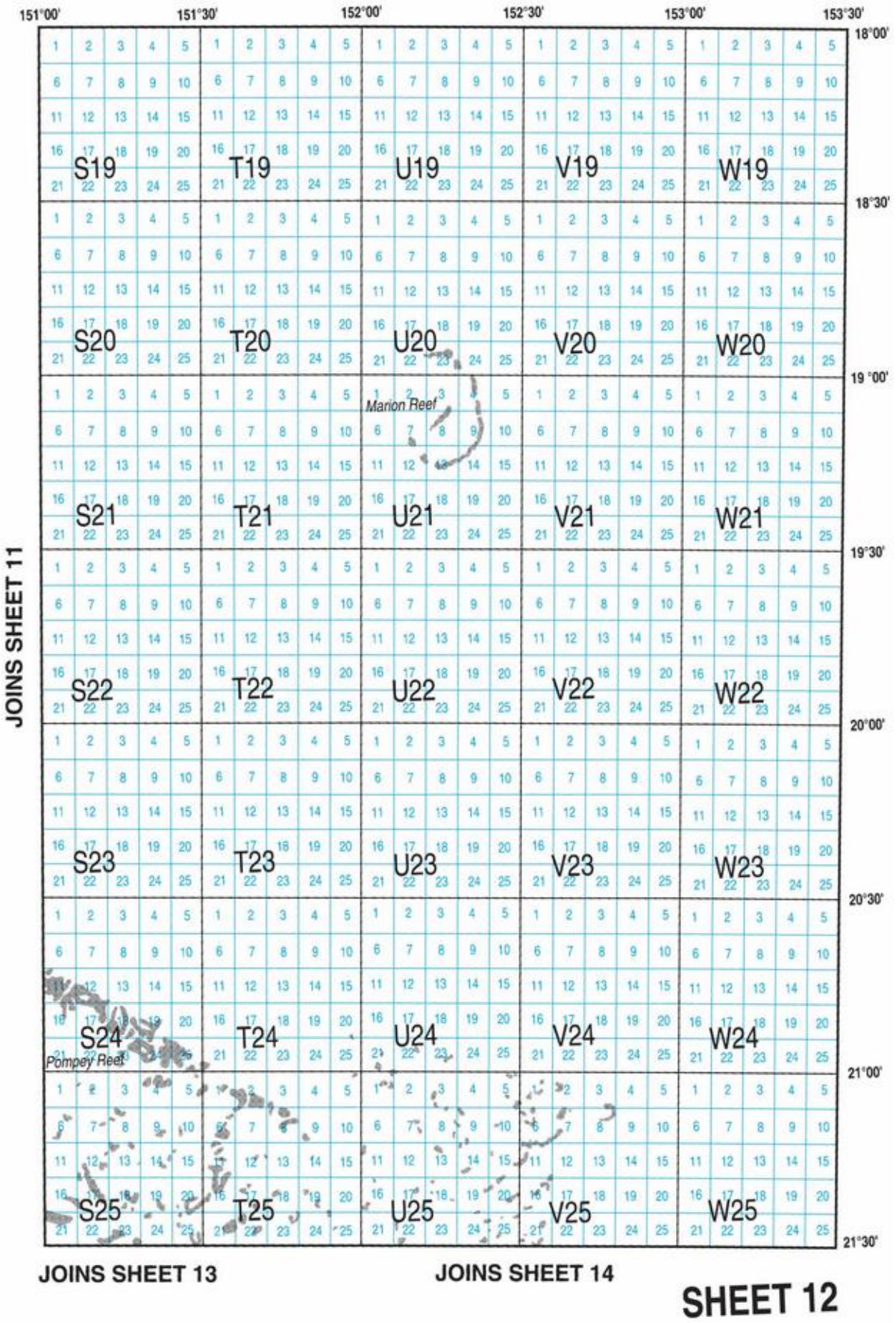
18°30'
19°00'
19°30'
20°00'
20°30'
21°00'
21°30'
SOUTH PACIFIC OCEAN
CORAL SEA
GREAT BARRIER REEF
N19
O19
P19
Q19
R19
N20
O20
P20
Q20
R20
N21
O21
P21
Q21
R21
N22
O22
P22
Q22
R22
N23
O23
P23
Q23
R23
N24
O24
P24
Q24
R24
N25
O25
P25
Q25
R25
Abington Reef
Hook Reef
Gloucester Island
Hayman Island
Hook Island
Whitsunday Island
NAT PARKS
Haslewood Island
Hamilton Island
Long Island
Whitsunday
Proserpine
Square Reef
Bax Reef
Passage
Hydrographers
Repulse Bay
Laguna Quays
Midge Point
Bloomsbury
O'Connell
Yalboroo
Calen
Mount Ossa
Seaforth
Sand Bay
Newry Island
Rabbit
LINDEMAN GROUP
Linne Island
Goldsmith Island
Carlisle Island
Scawfell Island
Wigton Island
Cockermouth Island
NAT. PARKS
CUMBERLAND ISLANDS
Pompey Reef
Kuttabul
Bucasia
Slade Point
MACKAY
Bakers Creek
Pinnacle
Mirani
Marian
Walkerston
Eton
Campwin Beach
Llewellyn Bay
Prudhoe Island
Digby Island
Hotspur Island
Sarina

SHEET 11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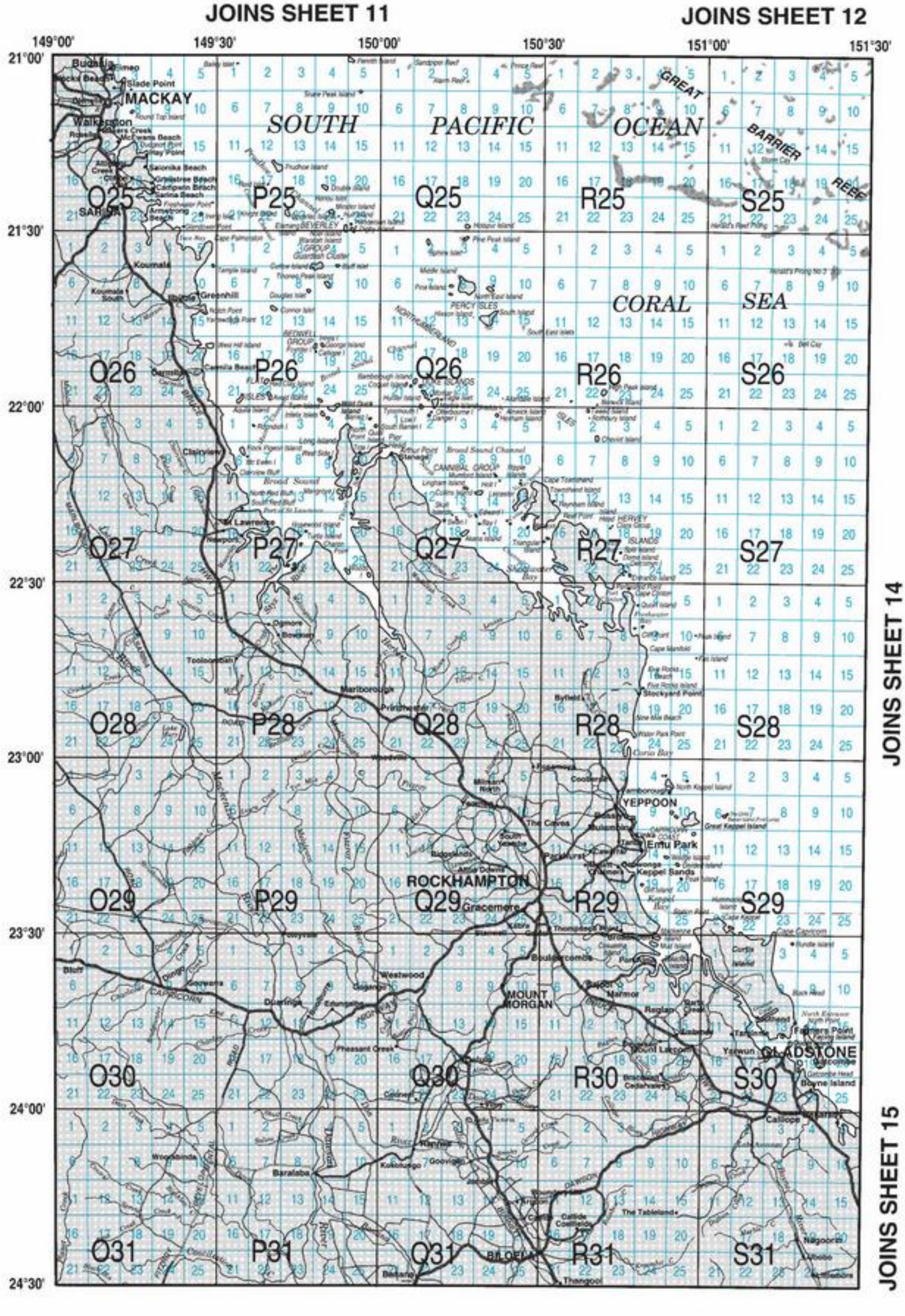
Marion Reef
Pompey Reef
JOINS SHEET 11
JOINS SHEET 13
JOINS SHEET 14
SHEET 12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SOUTH
PACIFIC
OCEAN
CORAL
SEA
MACKAY
ROCKHAMPTON
YEPPOON
GLADSTONE
MOUNT MORGAN
BILOELA
Q25
P25
Q25
R25
S25
Q26
P26
Q26
R26
S26
Q27
P27
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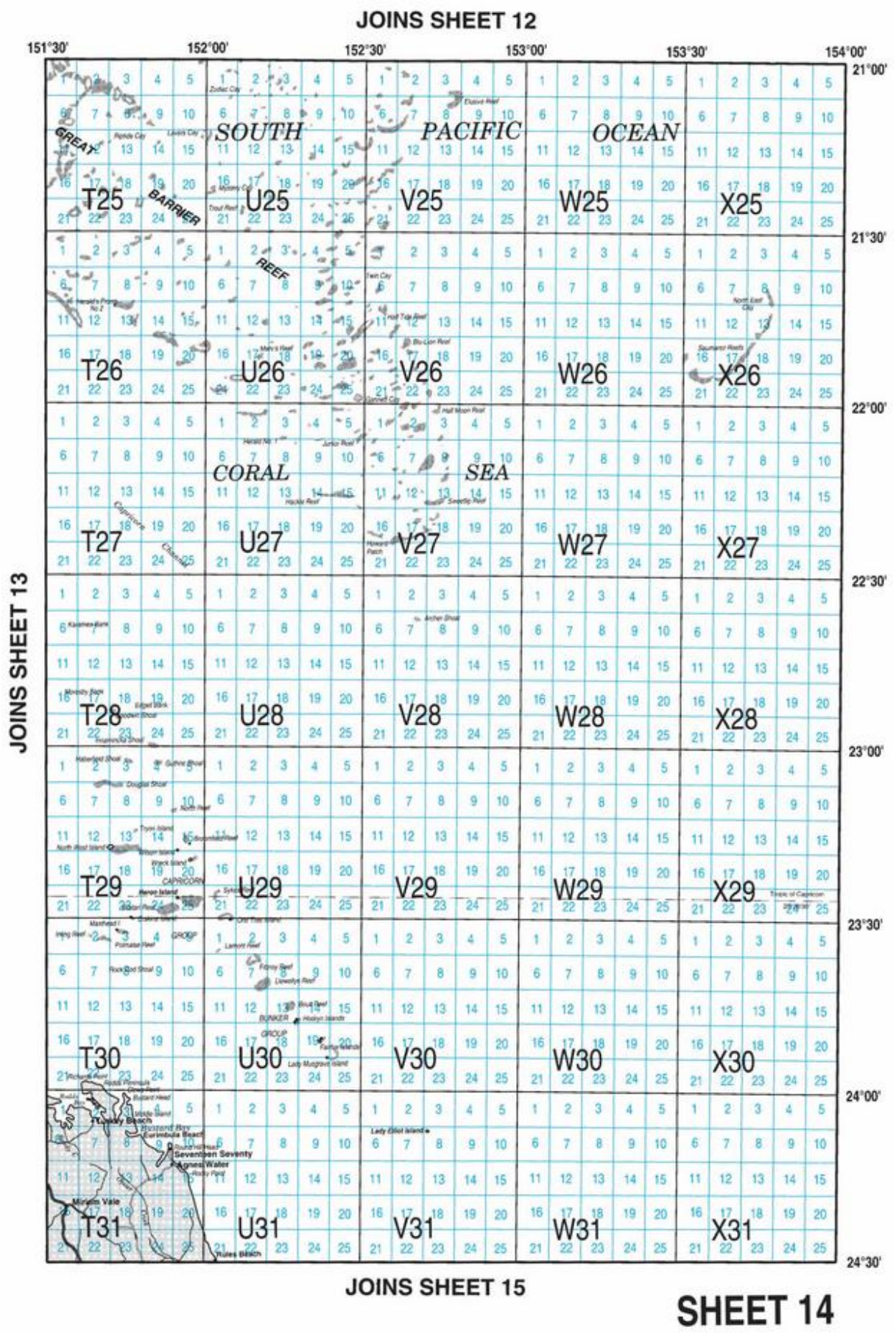
SHEET 13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24°30'
JOINS SHEET 13
JOINS SHEET 15
SHEET 14
SOUTH PACIFIC OCEAN
CORAL SEA
GREAT BARRIER REEF
CAPRICORN GROUP
BUNKER GROUP
T25
U25
V25
W25
X25
T26
U26
V26
W26
X26
T27
U27
V27
W27
X27
T28
U28
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X28
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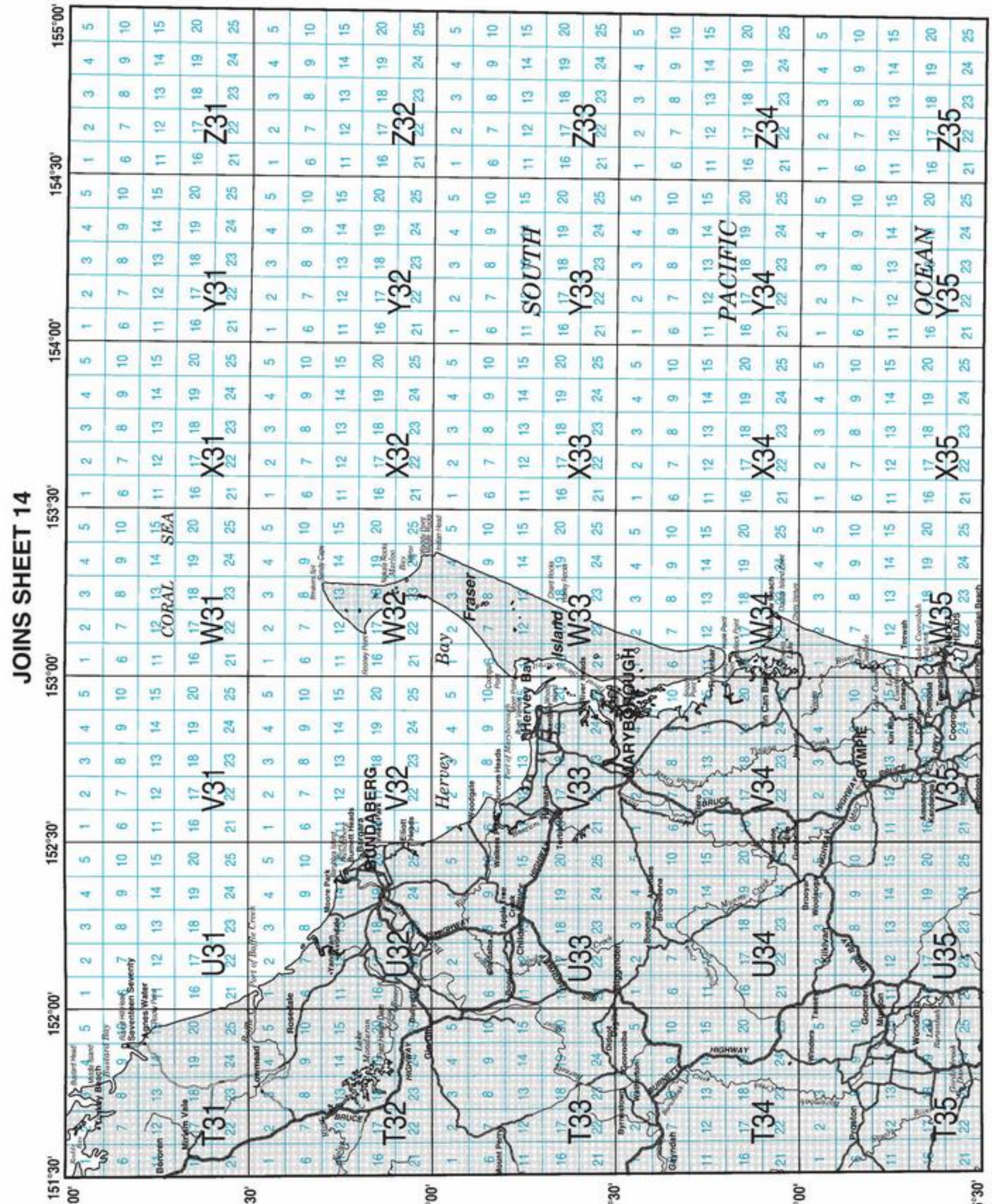
JOINS SHEET 14
CORAL SEA
SOUTH PACIFIC OCEAN
Hervey Bay
Fraser Island
BUNDABERG
MARYBOROUGH
GYMPIE
Hervey Bay
T31
U31
V31
W31
X31
Y31
Z31
T32
U32
V32
W32
X32
Y32
Z32
T33
U33
V33
W33
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Z35
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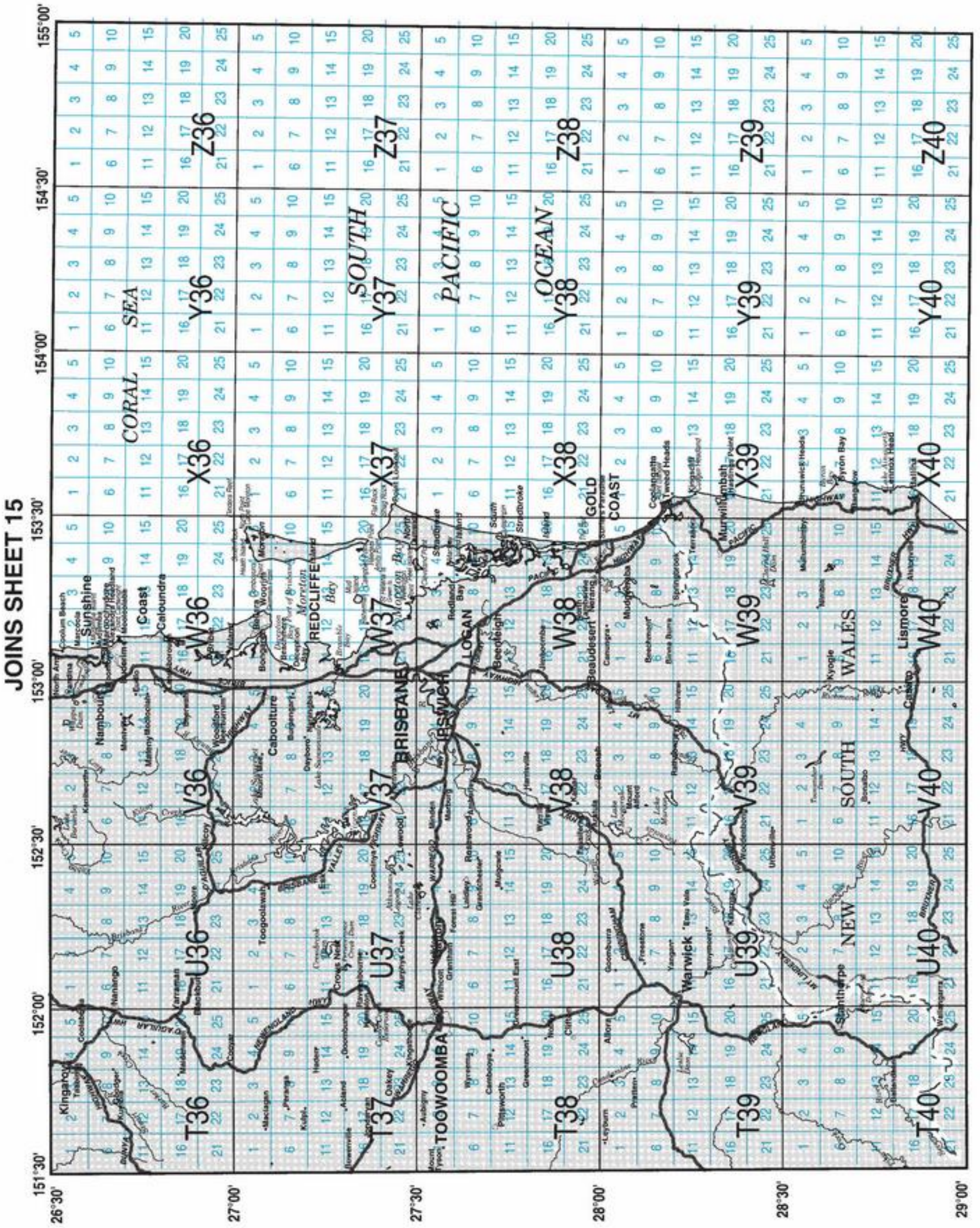
SHEET 15



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28°00'
28°30'
29°00'
CORAL SEA
SOUTH PACIFIC OCEAN
Moreton Bay
BRISBANE
IPSWICH
TOOWOOMBA
REDCLIFFE
LOGAN
GOLD COAST
Sunshine Coast
Caloundra
Nambour
Caboolture
Beaudesert
Warwick
Stanthorpe
Lismore
Casino
Murwillumbah
Coolangatta
Kyogle
NEW SOUTH WALES
T36 U36 V36 W36 X36 Y36 Z36
T37 U37 V37 W37 X37 Y37 Z37
T38 U38 V38 W38 X38 Y38 Z38
T39 U39 V39 W39 X39 Y39 Z39
T40 U40 V40 W40 X40 Y40 Z40

SHEET 16