

Chapter 2 Basin Plan Environmental Outcomes Monitoring for Fish (2014/15 – 2019/20): Barwon-Darling Watercourse Water Resource Planning Area



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Chapter cover image credit: NSW DPI FER Staff; Fish images credit: Gunther Schmida

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Introduction

This report spans the first series of the Basin Plan Environmental Outcome Monitoring – Fish (BPEOM-F) program, starting in 2014/15 as a pilot and running annually until 2019/2020. This report focusses on the Barwon-Darling Watercourse Water Resource Planning Area (WRPA) shown in [Figure 2.1](#).

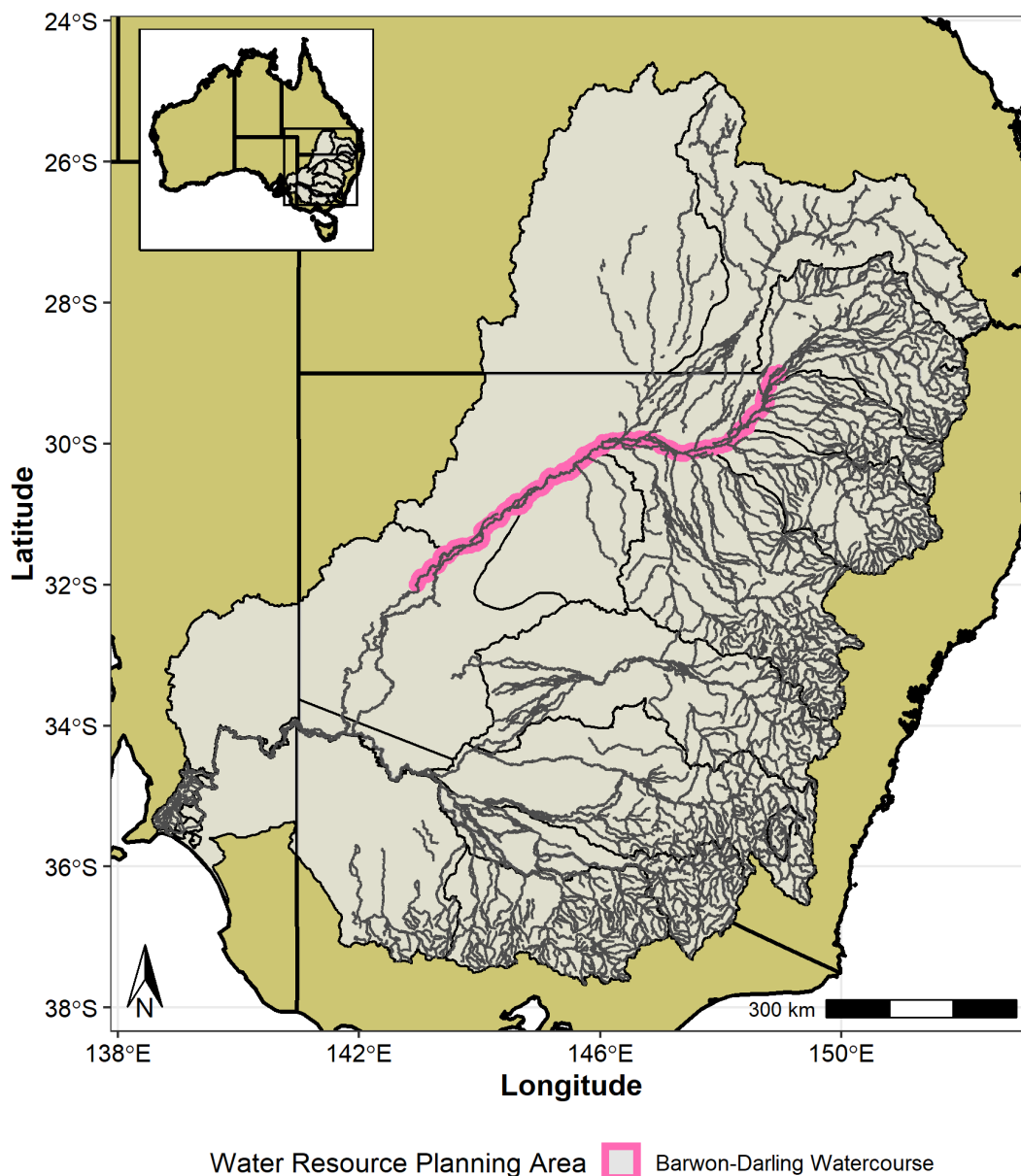


Figure 2.1: Murray-Darling Basin with the key region of this report highlighted. Inset map shows the whole of Australia with a box around the MDB. Note the Barwon-Darling Watercourse includes only the main channel of the river.

What This Report Includes

This report starts with an overview of the BPEOM-F program including sampling details and statistics. An overview of the hydrological and climatic conditions during the reporting period is also provided as context for interpreting the fish population status data.

Following the introductory sections, we present a summary of *fish diversity* across the Barwon-Darling Watercourse WRPA. Separate plots for native and alien species show the total number of unique species observed at each site.

The main body of the report provides detailed information on the *population structure, relative abundance, health, and distribution* of six key fish species:

- Murray cod
- Golden perch
- Freshwater catfish
- Bony herring
- Australian smelt
- Common carp

Population structure information includes length frequency plots of observed fish and the proportion of fish classified as Young of the Year (YOY). This information can be used to infer the size structure of populations and the level of recruitment each year. For additional context, we provide a summary table showing any stocking which occurred for the species in each year (if relevant).

Relative abundance (a unit-less measure representing the number of fish in an area) information is presented based on the modelled outputs from a more in-depth publication ([Crook et al. 2023](#)) which considers all available electrofishing data within the NSW Murray-Darling Basin (MDB). The analysis uses Bayesian generalised additive mixed models to generate time series of relative abundance for each WRPA since the early 1990s. In this report we present the modelled time series of relative abundance showing the predicted number of fish observed per 90 second shot of electrofishing. The abundance trend for the Gwydir WRPA is contrasted with the overall NSW MDB dataset. It should be noted that these are modelled estimates of relative abundance, not absolute abundance as absolute abundance estimates require calibration surveys.

Health information is provided as a summary of any visible health conditions recorded for the key species. The number of health conditions observed in a fish population is generally reflective of water quality, competition, and many other factors. Fewer observations of health conditions indicate healthier populations. Healthier fish tend to have increased fecundity and reproductive success. The health conditions detailed are any that were observed as part of the biological measurements taken. We provide a comparison of the prevalence of health conditions in the Barwon-Darling Watercourse WRPA and greater MDB (excluding the Barwon-Darling Watercourse WRPA).

Distribution maps are provided for each species to show the observed distribution of each species from the BPEOM-F program (other sampling programs not reported in this report). The distribution maps also show the relative abundance (number of fish observed per 90 seconds of electrofishing) at each site to give an indication of how the population is spread over the landscape.

Finally, the distributions and numbers of *Threatened species* are reported. The report includes threatened species that were recorded by the BPEOM-F program in the Barwon-Darling Watercourse WRPA during the study period.

For each section of the report, we provide a *Summary Statement*. This statement provides a very brief overview of the key messages for each section.

Sampling Methods

Three main methods were used during the BPEOM-F program: boat electrofishing, backpack electrofishing and bait traps. This report mainly includes the electrofishing data with the bait traps informing the distribution of small bodied threatened species. The electrofishing was conducted using the standard methodology implemented in the Sustainable Rivers Audit (SRA). This usually includes 12 shots of 90 seconds “power on” during each sampling event. Sites included in this round of the BPEOM-F program were chosen using a stratified random approach.

Various amounts of sampling effort (number of sites) were conducted for each year of the reporting period. It should be noted that there was very little sampling conducted in 2014/15 and 2015/16 in the Barwon-Darling Watercourse (Table 2.1). At each site, sampling gear was applied as suited to the local conditions with either boat, backpack, or a hybrid of the two in addition to the 10 unbaited bait traps that are set in areas of the sampling reach that are not electrofished. Most sampling occurred between the months of September and May.

Table 2.1: Sampling effort (Number of sites sampled) each sampling season. The number of sites which were planned to be sampled but were dry are shown in brackets and excluded from the sampled count.

Sampling Season	Number of Sites Sampled (Dry Sites)
2014/2015	4 (0)
2015/2016	7 (1)
2016/2017	11 (0)
2017/2018	13 (2)
2018/2019	25 (0)
2019/2020	23 (1)

The sites sampled during the reporting period are shown in Figure 2.2. A breakdown of sites sampled each sampling season is shown in the Appendix (Figure 2.30).

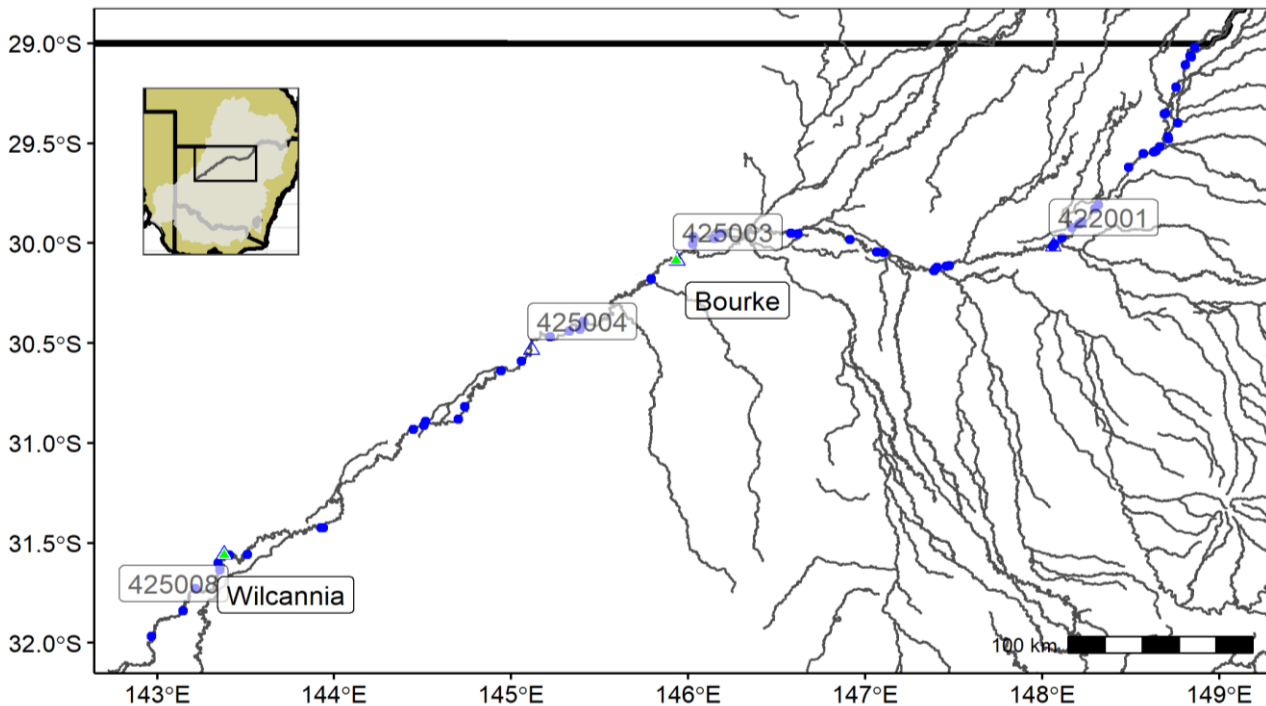


Figure 2.2: Sites (dots) sampled during the BPEOM-F program. Triangles show key flow gauges along with their gauge ID number. Dry sites are not shown.

Each sampling method has a different effectiveness at sampling each species. [Table 2.2](#) shows the total amount of each species caught by each method.

Table 2.2: Number of each key species caught by sample method over the whole program. Further data on total catch is provided in the Appendix.

Common name	Boat Electrofishing	Backpack Electrofishing	Bait Trap
Murray cod	48	1	0
Golden perch	474	28	5
Freshwater catfish	0	0	0
Bony herring	10,094	74	36
Australian smelt	54	0	1
Common carp	1,302	34	10

A subset of sampled fish had biological measurements taken during the surveys, including but not limited to length and weight measurements and visual health assessments. [Table 2.3](#) shows the number of fish biological measurements taken each year for the six species.

Table 2.3: Number of biological measurements taken for the key species each sampling season.

	Murray cod	Golden perch	Bony herring	Australian smelt	Common carp
2014/2015	8	34	208	2	42
2015/2016	4	14	330	3	55
2016/2017	4	60	602	0	394
2017/2018	13	73	992	1	214
2018/2019	11	178	1579	1	254
2019/2020	9	147	771	48	219

Reference:

Crook D. A., Schilling H. T., Gilligan D. M., Asmus M., Boys C. A., Butler G. L., Cameron L. M., Hohnberg D., Michie L. E., Miles N. G., Rayner T. S., Robinson W. A., Rourke M. L., Stocks J. R., Thiem J. D., Townsend A., van der Meulen D. E., Wooden I., Cheshire K. J. M. (2023) Multi-decadal trends in large-bodied fish populations in the New South Wales Murray–Darling Basin, Australia. *Marine and Freshwater Research* <https://doi.org/10.1071/MF23046>

Climate Overview

The following is a summary of the climatic conditions during the BPEOM-F program in terms of how the observed conditions compare to long term records. These are direct extracts from the [Australian Bureau of Meteorology climate summaries archive](#) and are written in the given year. To interpret, 2014 states it was the warmest year on record, meaning 2014 was the warmest year on record up to and including 2014 but not the more recent years.

2014

New South Wales experienced its warmest year on record in 2014, with several heatwaves and persistently warm conditions across the State. Rainfall was well below average in the northeast, and close to average elsewhere.

2015

New South Wales recorded well above average temperatures in 2015. Nights were particularly warm, the sixth-warmest on record for the State. Rainfall was close to average for the state as a whole.

2016

2016 was a generally wet, warm year for NSW as a whole, with substantial variability throughout the year and across the state. Following a record-warm start to the year, May to September was the wettest such period on record for NSW, with cooler weather in much of the west of the state. Minimum temperatures were the warmest on record for the State as a whole, with record-warm daytime temperatures on parts of the east coast.

2017

The year 2017 was the warmest on record for New South Wales for both mean and daytime temperatures. It was also the State's driest year since 2006. Following the warmest summer on record for the State, heavy rain in March across the east then made way for a very dry winter and start to spring. Winter overnight temperatures were the lowest since 1997, but daytime temperatures remained above average for most of the year, and were the warmest on record overall.

2018

2018 was the warmest on record for New South Wales for both mean temperature and mean maximum temperature, whilst the mean minimum temperature was fourth-warmest on record. The year was dominated by very dry conditions, with the third-driest January to September on record. October to December saw some relief from the dry, with above average rainfall across parts of the State. Despite this, New South Wales experienced its sixth-lowest annual rainfall on record; its driest year since 2002.

2019

2019 was the driest and warmest year on record for New South Wales. Despite some rain in some months, most of the State received much less rainfall than usual, with the northeast and far west particularly dry. Heatwaves in January brought very high temperatures, and large fires from September onward caused extensive damage and persistent smoke.

2020

2020 saw above average temperature and rainfall in New South Wales. Temperatures were above average across the state in most months except during autumn. There was widespread rain during autumn and spring and in December, but early winter and November rain was below average.

Flow Data

Below shows a summary of flow data from a variety of flow gauges in the Barwon-Darling Watercourse WRPA (Figure 2.3).

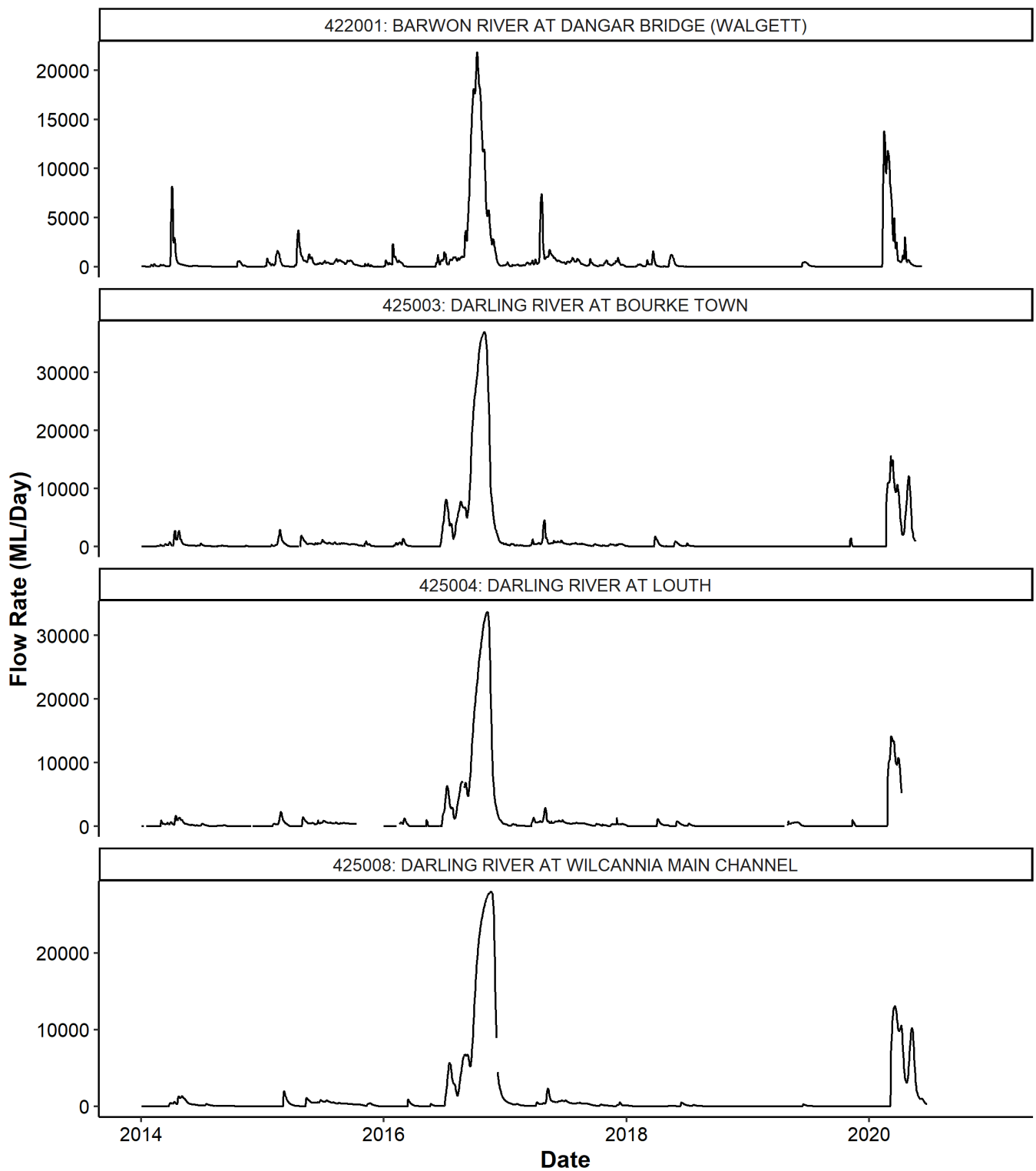


Figure 2.3: Flow data from various gauges in the Barwon-Darling Watercourse WRPA over the reporting period. Gauge locations can be seen on Figure 2.2. Note the differing scales on the y-axis.

Water temperature data, where available, are also shown in [Figure 2.4](#).

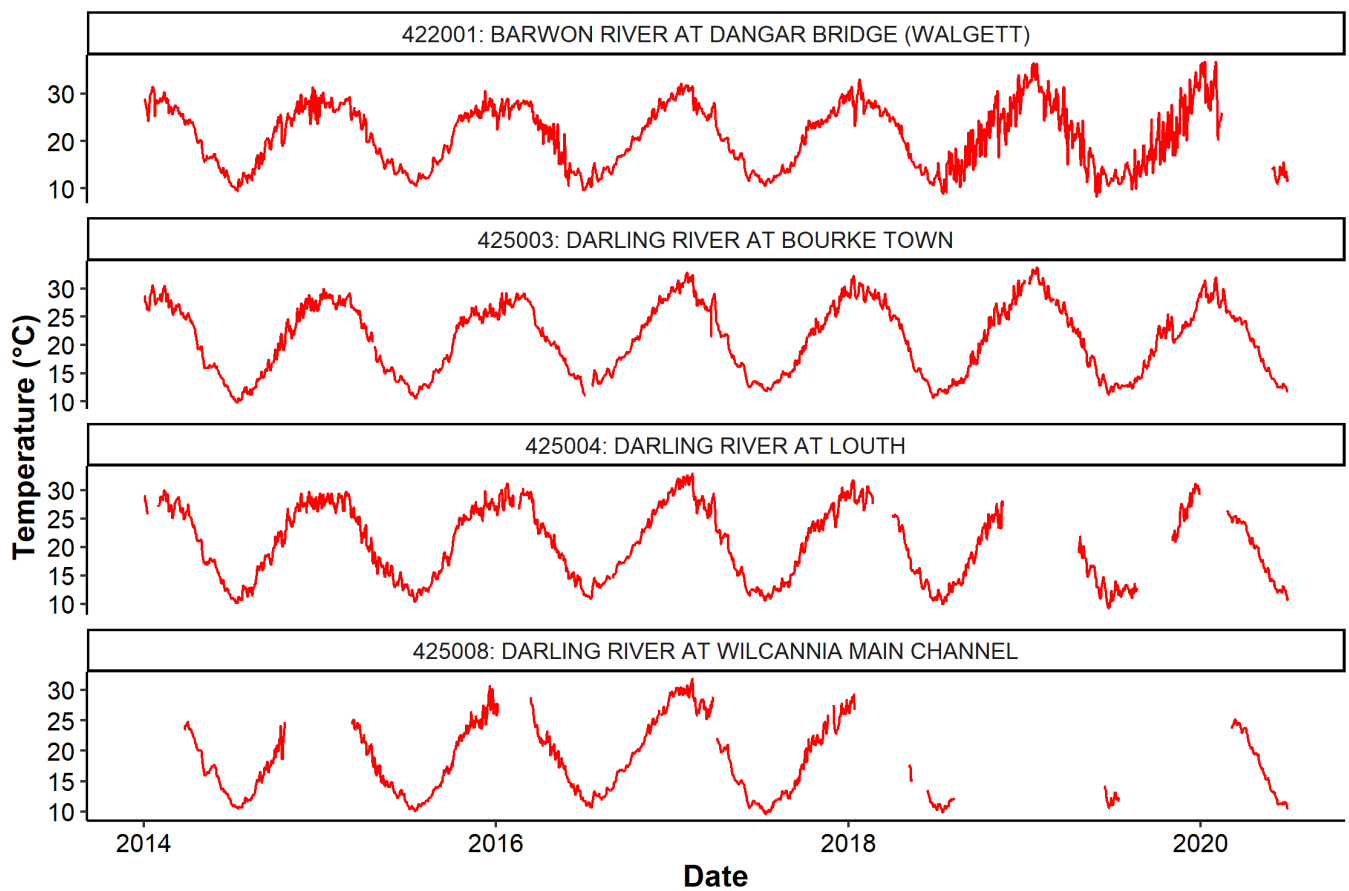


Figure 2.4: Water temperature data from various gauges in the Barwon-Darling Watercourse WRPA over the reporting period. Gauge locations can be seen on [Figure 2.2](#). Note the differing scales on the y-axis.

Species Diversity

A total of 11 species were observed across the Barwon-Darling Watercourse WRPA including three alien species. [Figure 2.5](#) shows the number of native and alien species found at each site. The full list of species caught and observed is in [Table 2.7](#).

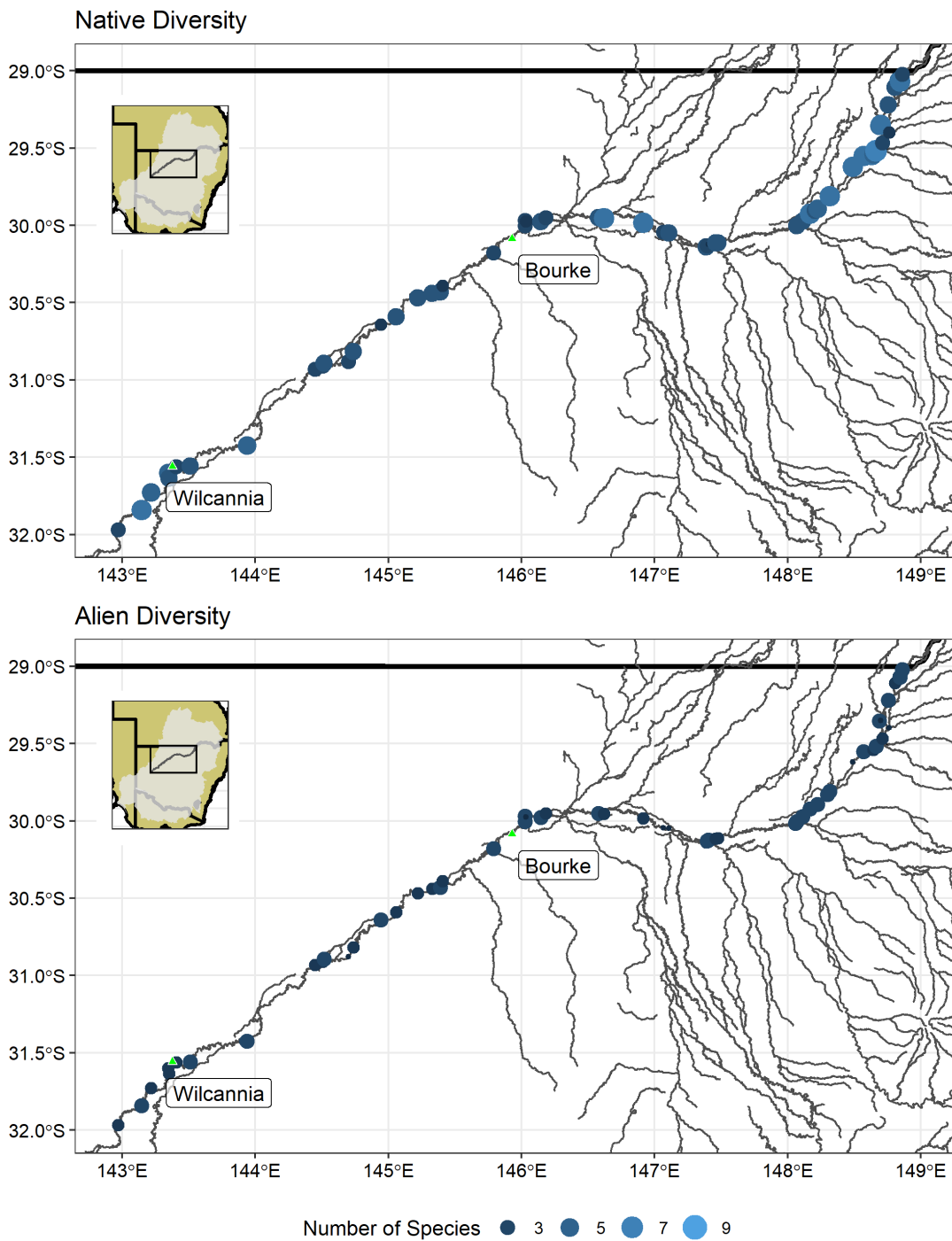


Figure 2.5: Diversity across all sampling sites. Bubble size represents the number of unique species observed at each site across all sampling methods and events. X represents a site that was sampled with water but with no species caught. Dry sites are excluded. Green triangles show major towns.

Summary Statement:

Native and alien diversity was generally consistent across the region the Barwon-Darling Watercourse WRPA.

Murray cod



Population Structure

Figure 2.6 shows the observed length frequency plot for Murray cod across all the sampling seasons. The observed numbers of Young of the Year (YOY) ranged from 0 to 2, and 0% to 18% of measured fish within a season.

Overall, during the BPEOM-F program, across all the MDB water resource planning areas, the percentage YOY for Murray cod was 13% (500 out of 3,801).

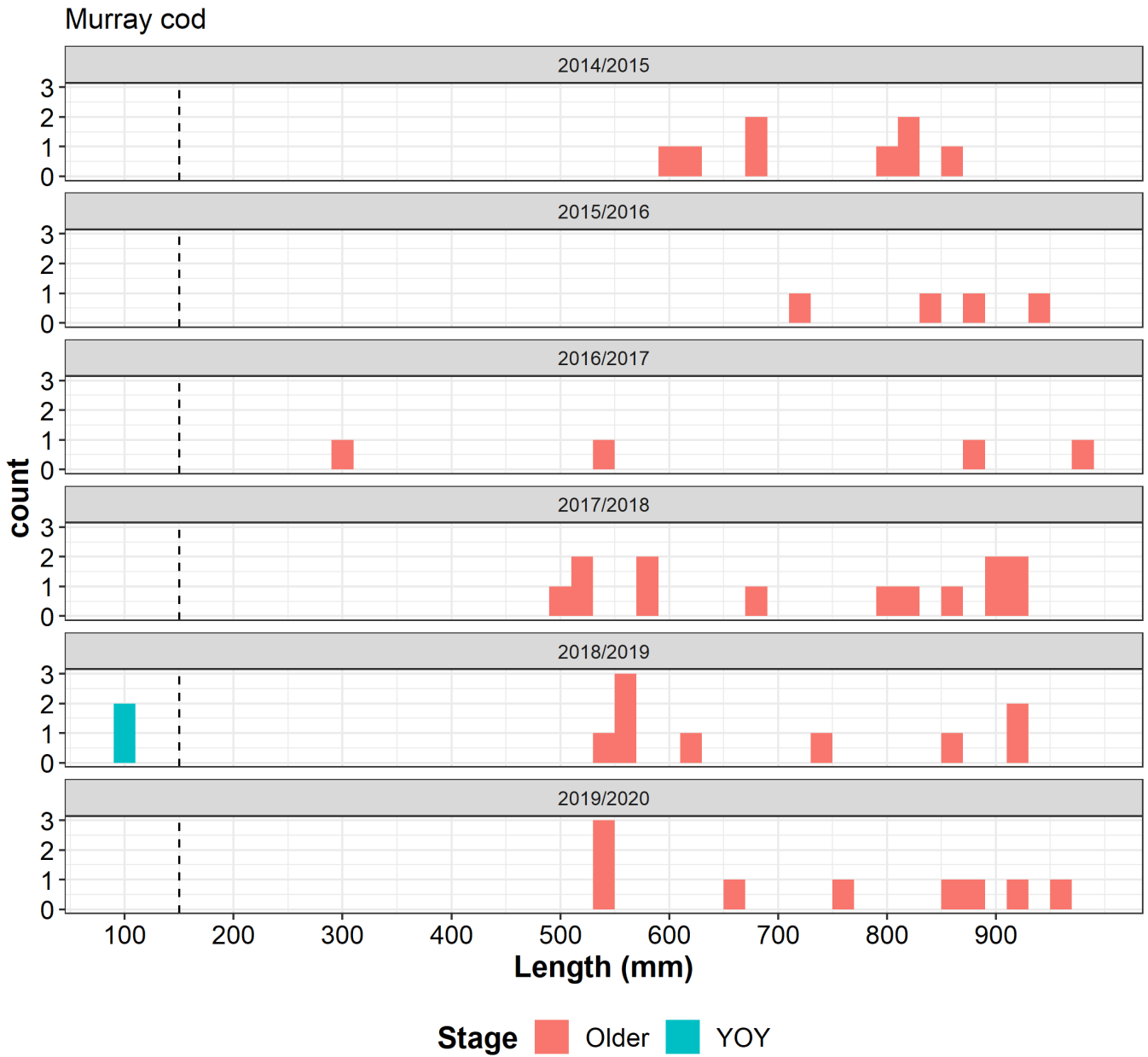


Figure 2.6: Length frequency plots for Murray cod by sampling season. YOY = Young of the Year fish.

Summary Statement:

Limited recruitment and low numbers of Murray cod suggesting limited recruitment over successive years.

Stocking

A total of 109,956 Murray cod were stocked into the waterways of the Barwon-Darling Watercourse WRPA during the reporting period. Of these fish, 0 (0%) were stocked into impoundments while 109,956 (100%) were stocked into rivers or creeks. [Table 2.4](#) shows the detailed breakdown of stocking by season, location and life stage while [Figure 2.7](#) shows the locations of stocking.

Table 2.4: Number and life stage of stocked Murray cod each sampling season.

Sampling Season	River/Creek or Impoundment	Life Stage	Number Stocked
2014/2015	River/Creek	Fingerling	3,334
2014/2015	River/Creek	Fry	17,676
2014/2015	River/Creek	Sub Adult	2,500
2015/2016	River/Creek	Fingerling	5,000
2015/2016	River/Creek	Fry	20,218
2016/2017	River/Creek	Fingerling	26,228
2016/2017	River/Creek	Fry	20,000
2018/2019	River/Creek	Fry	15,000

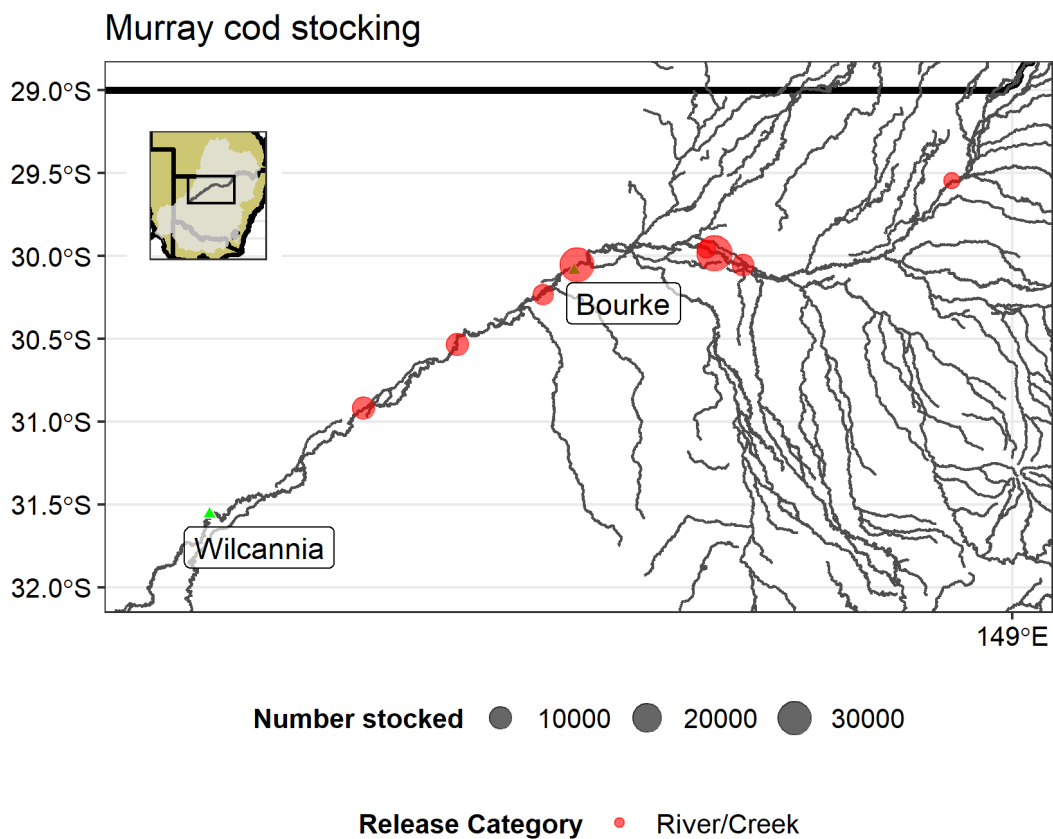


Figure 2.7: Locations of Murray cod stocking. Colours show whether a site was a river/creek site or an impoundment while the size of the point reflects the total number of fish stocked over the reporting period. Green triangles show major towns

Temporal Trends in Abundance

We have modelled the relative abundance of Murray cod since 1994 based on all suitable boat electrofishing data. The left-hand panel of [Figure 2.8](#) shows the abundance trend for the Barwon-Darling Watercourse WRPA and the right-hand panel shows the overall trend across the NSW MDB.

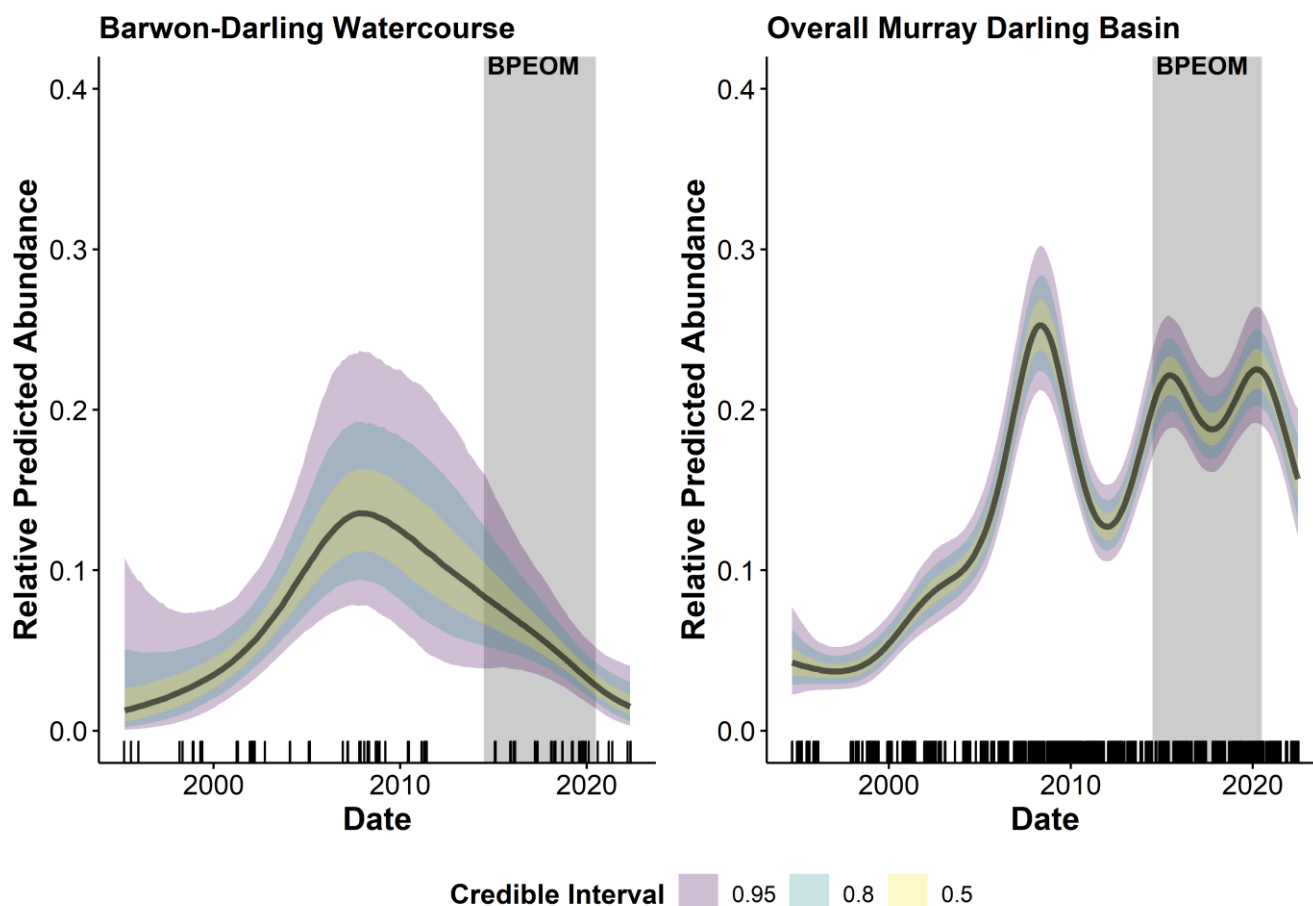


Figure 2.8: Relative abundance of Murray cod in both the Barwon-Darling Watercourse WRPA and the overall NSW MDB. These are model estimates based upon all boat electrofishing data within the NSW DPI Freshwater ecosystem database and the output of Bayesian generalised additive mixed models. The grey shaded region represents the period during which the BPEOM-F program was run. The black lines on the x-axis represent data coverage while the colours on the figure show various levels of confidence. Note when overlapping, the colours look slightly different due to the transparency and the y-axes vary between chapters of this report.

Summary Statement:

A slight increasing trend in abundance up until ~2010, followed by a recent decline back to 1990s levels. In the most recent years, relative abundance is much lower than the overall abundance across the NSW MDB.

Health

The prevalence of any health issues ranged from 25% of sampled fish in 2016/2017 to 88% of sampled fish to 2014/2015 (Figure 2.9). The most common health issue for Murray cod in the Barwon-Darling Watercourse WRPAs was *Lernea*, which was observed in a total of 24 fish, corresponding to 49% of all Murray cod measured.

Across the other NSW MDB WRPA, 16% of Murray cod (620 out of 3,801 Murray cod) showed a health condition (excludes the Barwon-Darling Watercourse WRPAs).

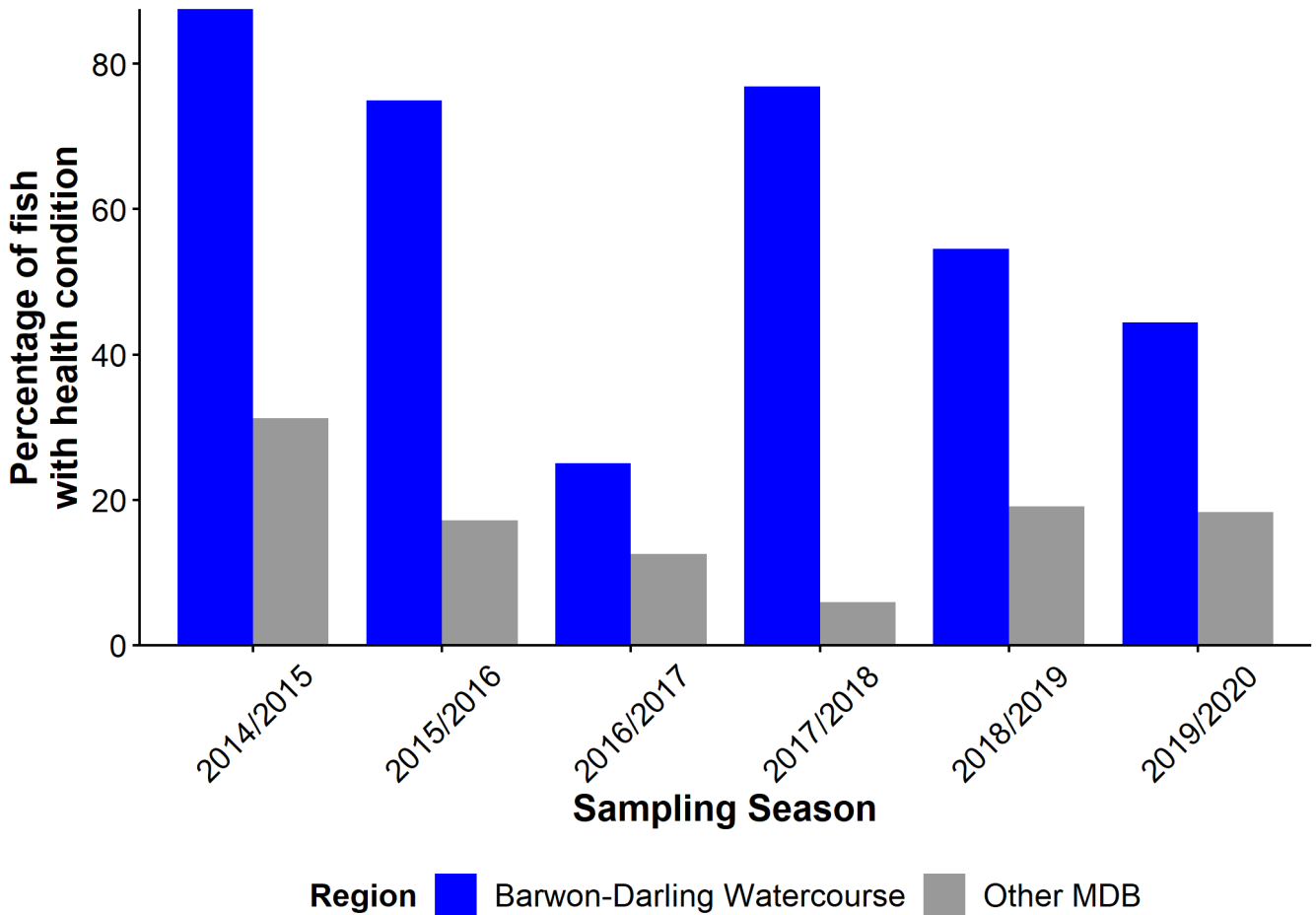


Figure 2.9: Timeseries showing the prevalence of health conditions in Murray cod. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPA.

Summary Statement:

Presence of observable health conditions was variable across years but consistently higher than the NSW MDB.

Distribution

Murray cod were recorded at 20 out of 58 sites in the Barwon-Darling Watercourse WRPA. The maximum observed relative abundance at a site was 0.27 fish caught per 90 seconds of electrofishing. [Figure 2.10](#) shows the distribution and relative abundance of Murray cod across the Barwon-Darling Watercourse WRPA.

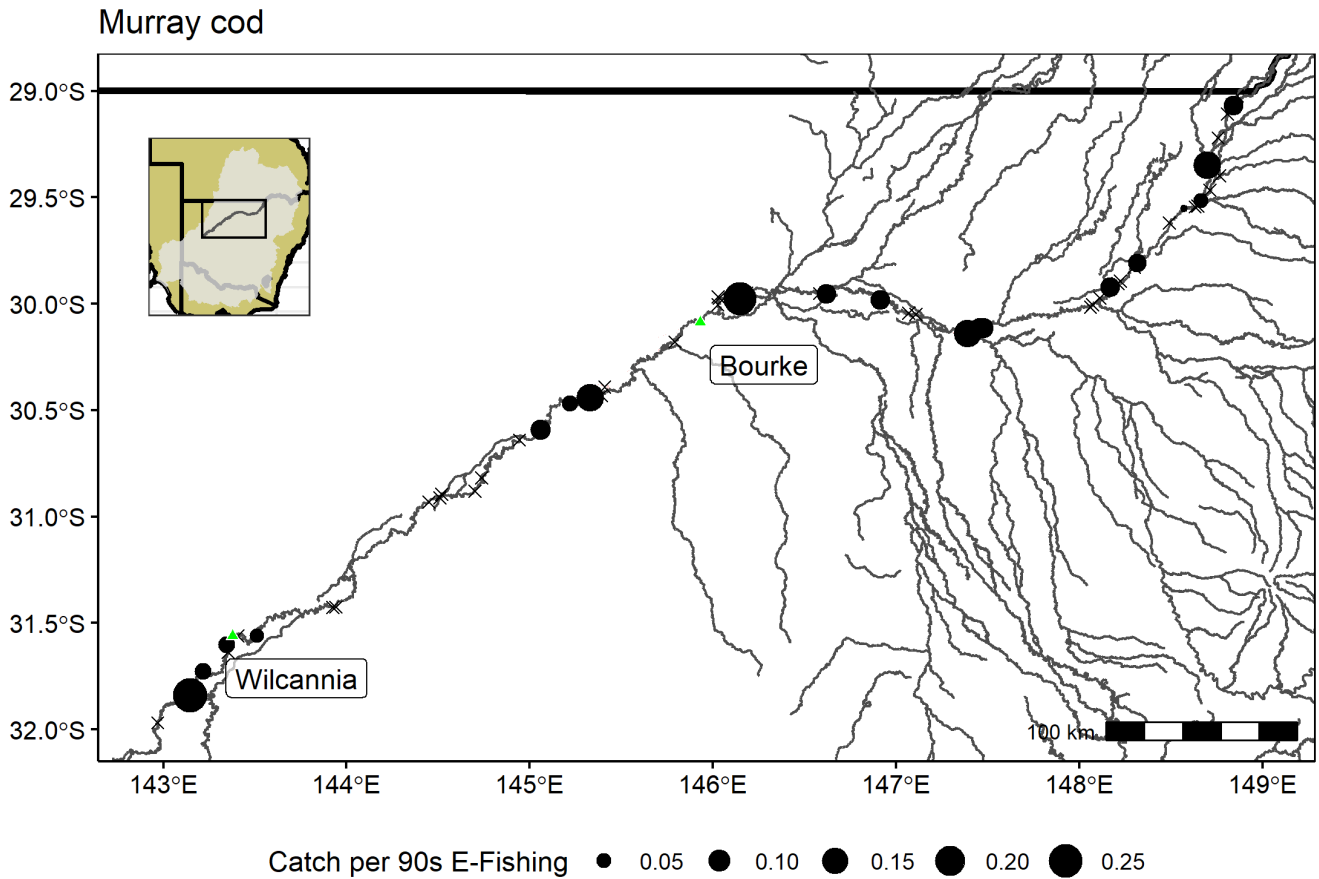


Figure 2.10: Distribution of Murray cod. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X. Green triangles show major towns.

Summary Statement:

Murray cod were recorded across the Barwon-Darling Watercourse WRPA but were less abundant or absent in southwestern sites and upstream of Bourke.

Golden perch



Population Structure

Figure 2.11 shows the observed length frequency plot for Golden perch across all the sampling seasons. The observed numbers of Young of the Year (YOY) ranged from 0 to 24, and 0% to 14% of measured fish within a season.

Overall, during the BPEOM-F program, across all the MDB water resource planning areas, the percentage YOY for Golden perch was 12 % (217 out of 1,814).

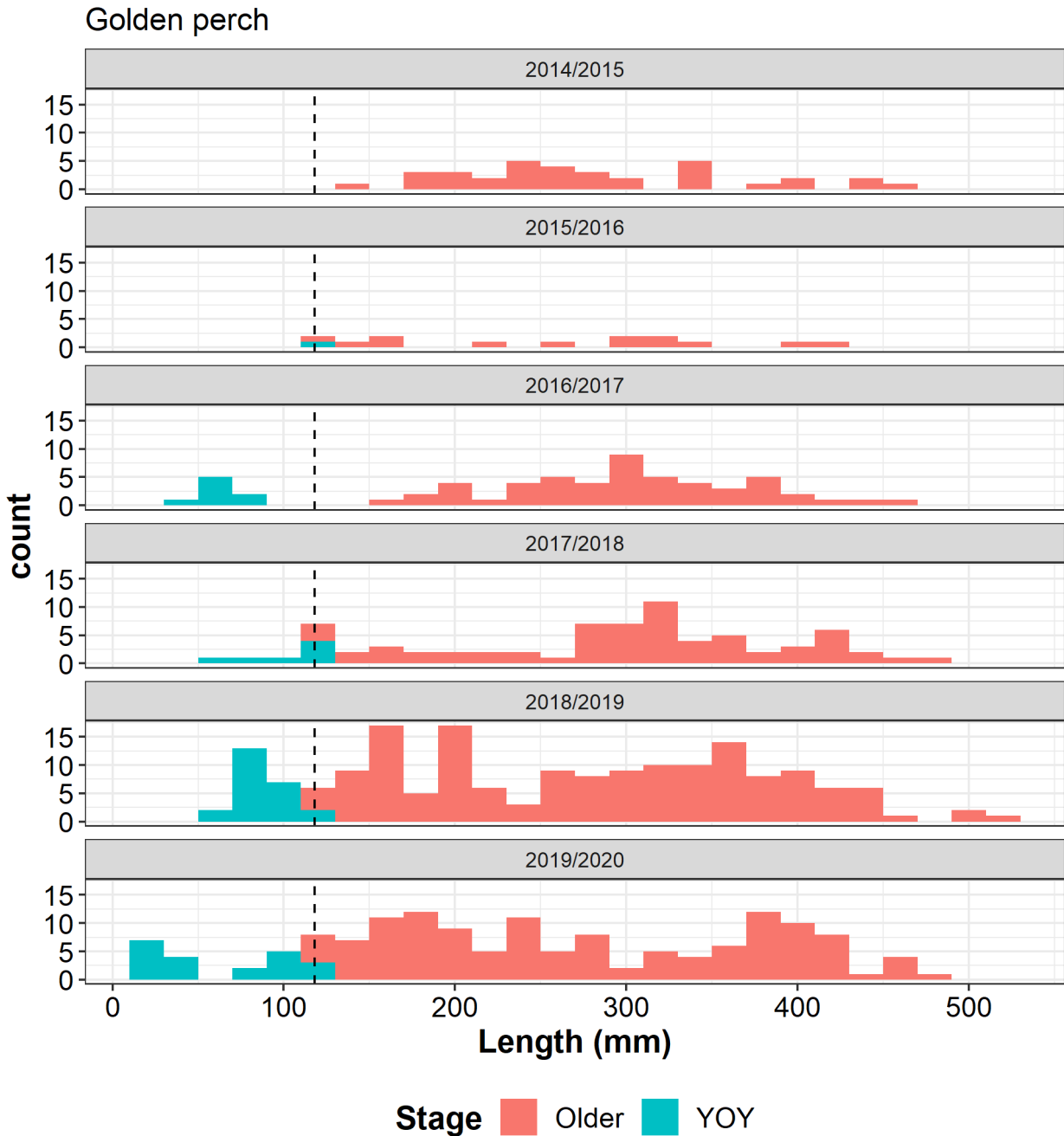


Figure 2.11: Length frequency plots for Golden perch by sampling season. YOY = Young of the Year fish.

Summary Statement:

Sporadic recruitment with low or no recruitment in 2014/15 & 2015/16. A good range of size classes in most years.

Stocking

A total of 71,530 Golden perch were stocked into the waterways of the Barwon-Darling Watercourse WRPA during the reporting period. Of these fish, 0 (0%) were stocked into impoundments while 71,530 (100%) were stocked into rivers or creeks. Table 2.5 shows the detailed breakdown of stocking by season, location and life stage while Figure 2.12 shows the locations of stocking.

Table 2.5: Number and life stage of stocked Golden perch each sampling season.

Sampling Season	River/Creek or Impoundment	Life Stage	Number Stocked
2014/2015	River/Creek	Fry	11,363
2015/2016	River/Creek	Fry	40,303
2016/2017	River/Creek	Fingerling	14,864
2017/2018	River/Creek	Fry	5,000

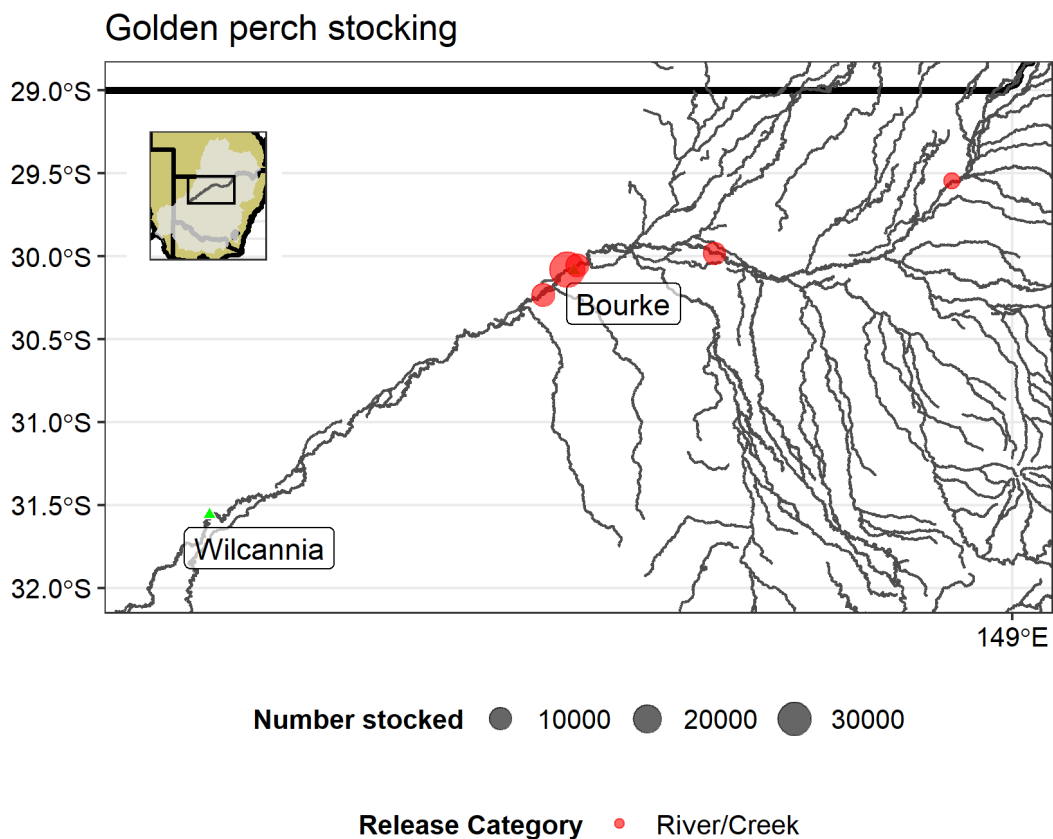


Figure 2.12: Locations of Golden perch stocking. Colours show whether a site was a river/creek site or an impoundment while the size of the point reflects the total number of fish stocked over the reporting period. Green triangles show major towns.

Temporal Trends in Abundance

We have modelled the relative abundance of Golden perch since 1994 based on all suitable boat electrofishing data. The left-hand panel of [Figure 2.13](#) shows the abundance trend for the Barwon-Darling Watercourse WRPA and the right-hand panel shows the overall trend across the NSW MDB.

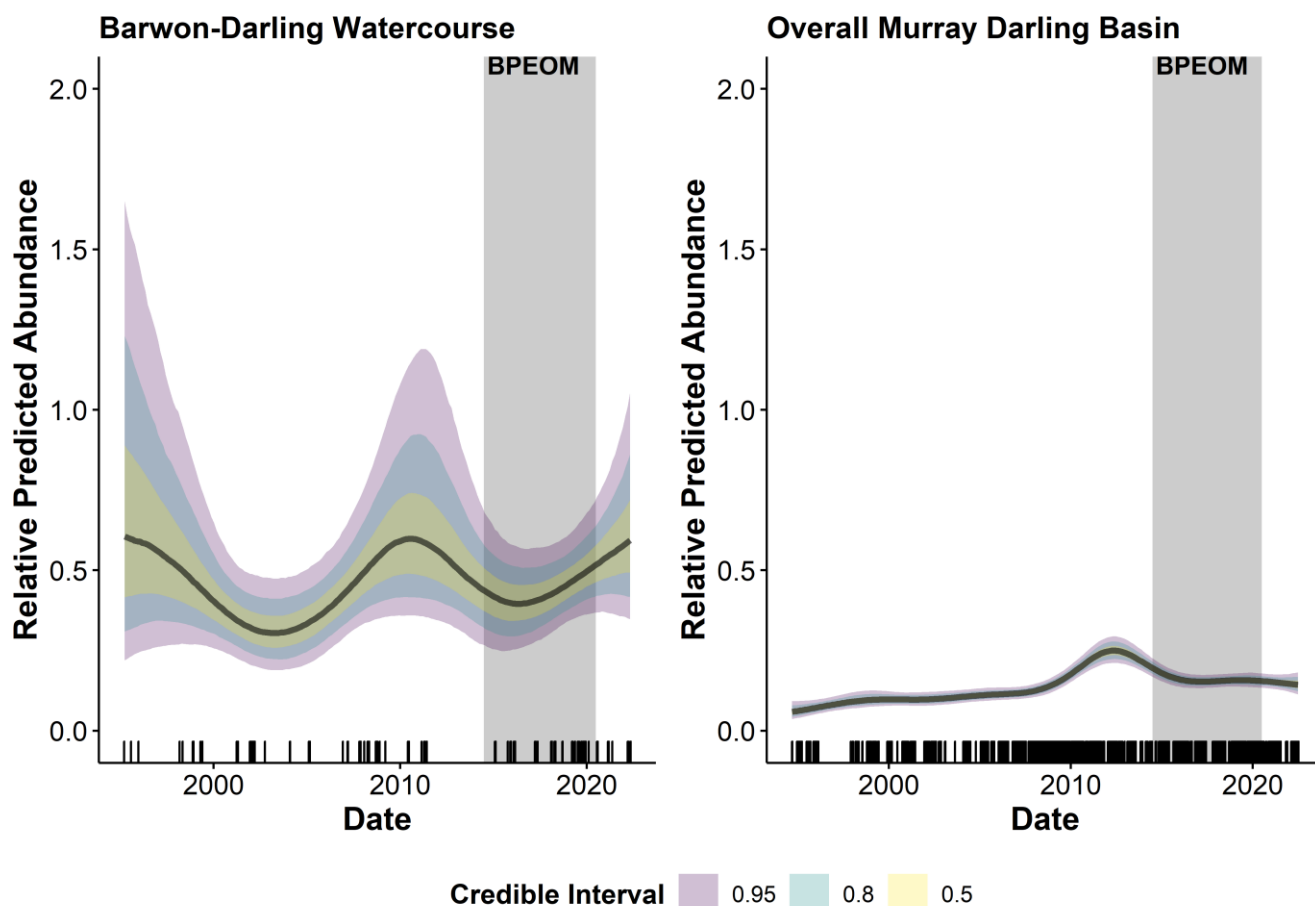


Figure 2.13: Relative abundance of Golden perch in both this valley and the overall Murray-Darling Basin. These are model estimates based upon all boat electrofishing data within the NSW DPI Freshwater ecosystem database and the output of Bayesian generalised additive mixed models. The grey shaded region represents the period during which the BPEOM-F program was run. The black lines on the x-axis represent data coverage while the colours on the figure show various levels of confidence. Note when overlapping, the colours look slightly different due to the transparency and the y-axes vary between chapters of this report.

Summary Statement:

Relatively stable abundance since the 1990's with minor fluctuations across the time series and a slight increasing trend in recent years. Relative abundance of Golden perch is substantially higher than the overall abundance across the NSW MDB.

Health

The prevalence of any health issues ranged from 36% of sampled fish in 2019/2020 to 85% of sampled fish to 2014/2015 (Figure 2.14). The most common health issue for Golden perch in the Barwon-Darling Watercourse water resource planning area was *Lernea*, which was observed in a total of 131 fish, corresponding to 26% of all Golden perch measured.

Across the other WRPAs, 30% of Golden perch (542 out of 1,814 Golden perch) showed a health condition (excludes Barwon-Darling Watercourse).

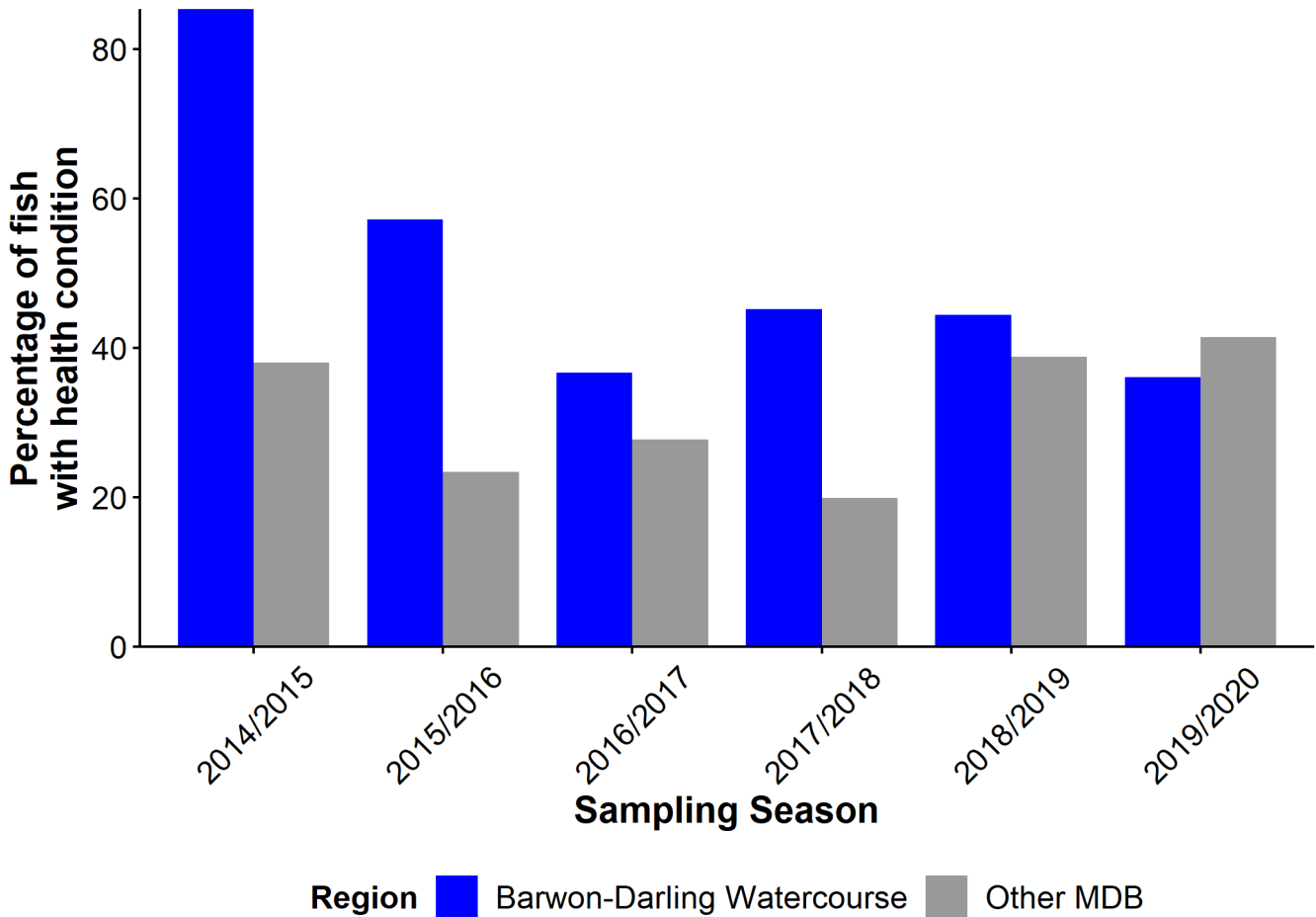


Figure 2.14: Timeseries showing the prevalence of health conditions in Golden perch. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPAs.

Summary Statement:

The presence of observable health conditions for Golden perch in the Barwon-Darling Watercourse was generally higher than the rest of the NSW MDB.

Distribution

Golden perch were recorded at 51 out of 58 sites in the Barwon-Darling Watercourse WRPA. The maximum observed relative abundance at a site was 2.1 fish caught per 90 seconds of electrofishing. [Figure 2.15](#) shows the distribution and relative abundance of Golden perch across the Barwon-Darling Watercourse WRPA.

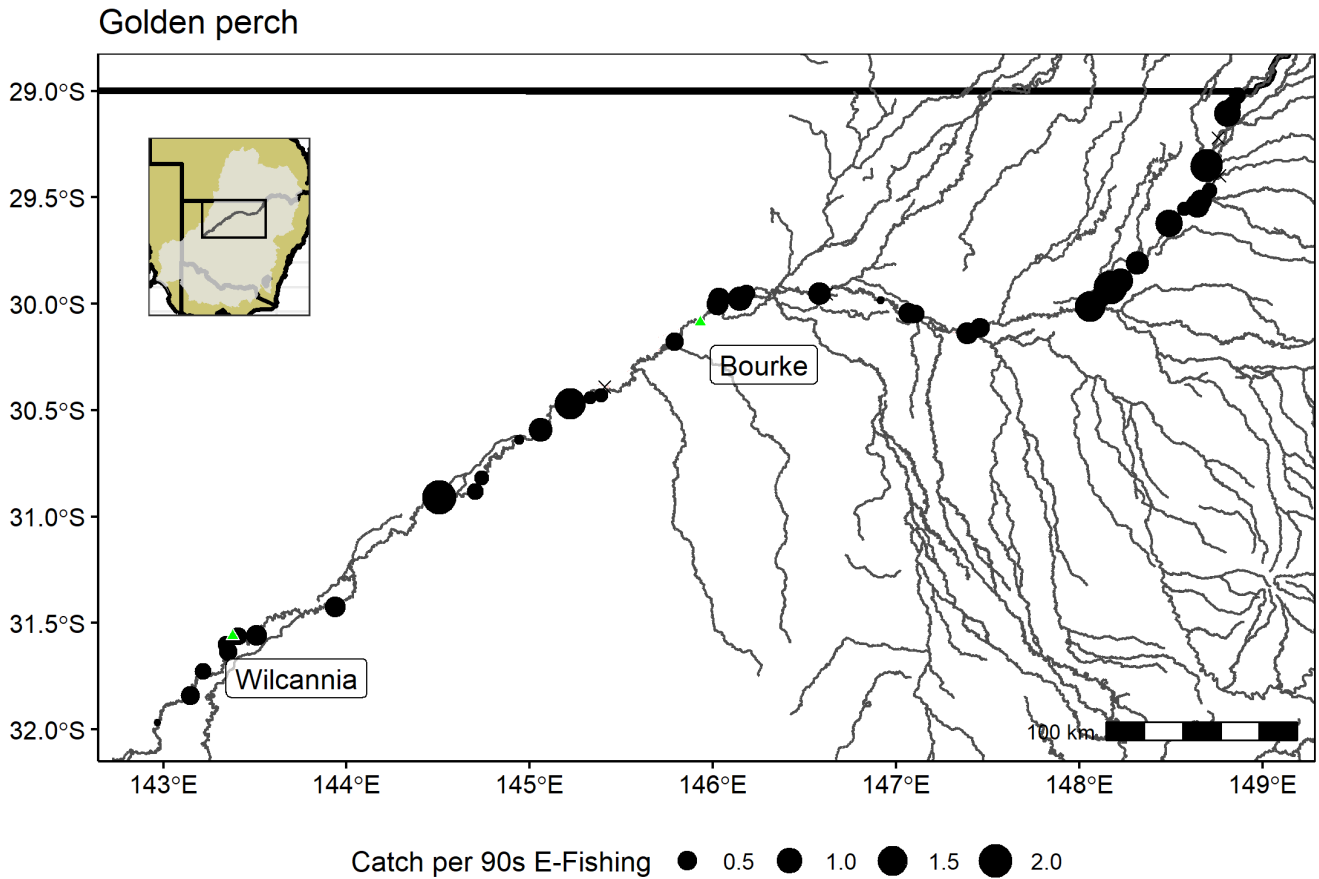


Figure 2.15: Distribution of Golden perch. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X. Green triangles show major towns.

Summary Statement:

Golden perch were widely distributed across the Barwon-Darling Watercourse region.

Freshwater catfish



No Freshwater catfish were observed or collected in the Barwon-Darling Watercourse WRPA as part of the BPEOM-F sampling program or any other program during the reporting period.

Summary Statement:

Freshwater catfish were not recorded in surveys of the Barwon-Darling Watercourse across the survey period. This suggests they are currently in very low abundance or absent from this region, even though the habitat is expected to be suitable in the WRPA.

Bony herring



Population Structure

Figure 2.16 shows the observed length frequency plot for Bony herring across all the sampling seasons. The observed numbers of Young of the Year (YOY) ranged from 97 to 845, and 11% to 55% of measured fish within a season.

Overall, during the BPEOM-F program, across all the MDB water resource planning areas, the percentage YOY for Bony herring was 29 % (3,473 out of 12,084). Bony herring are not a stocked species.

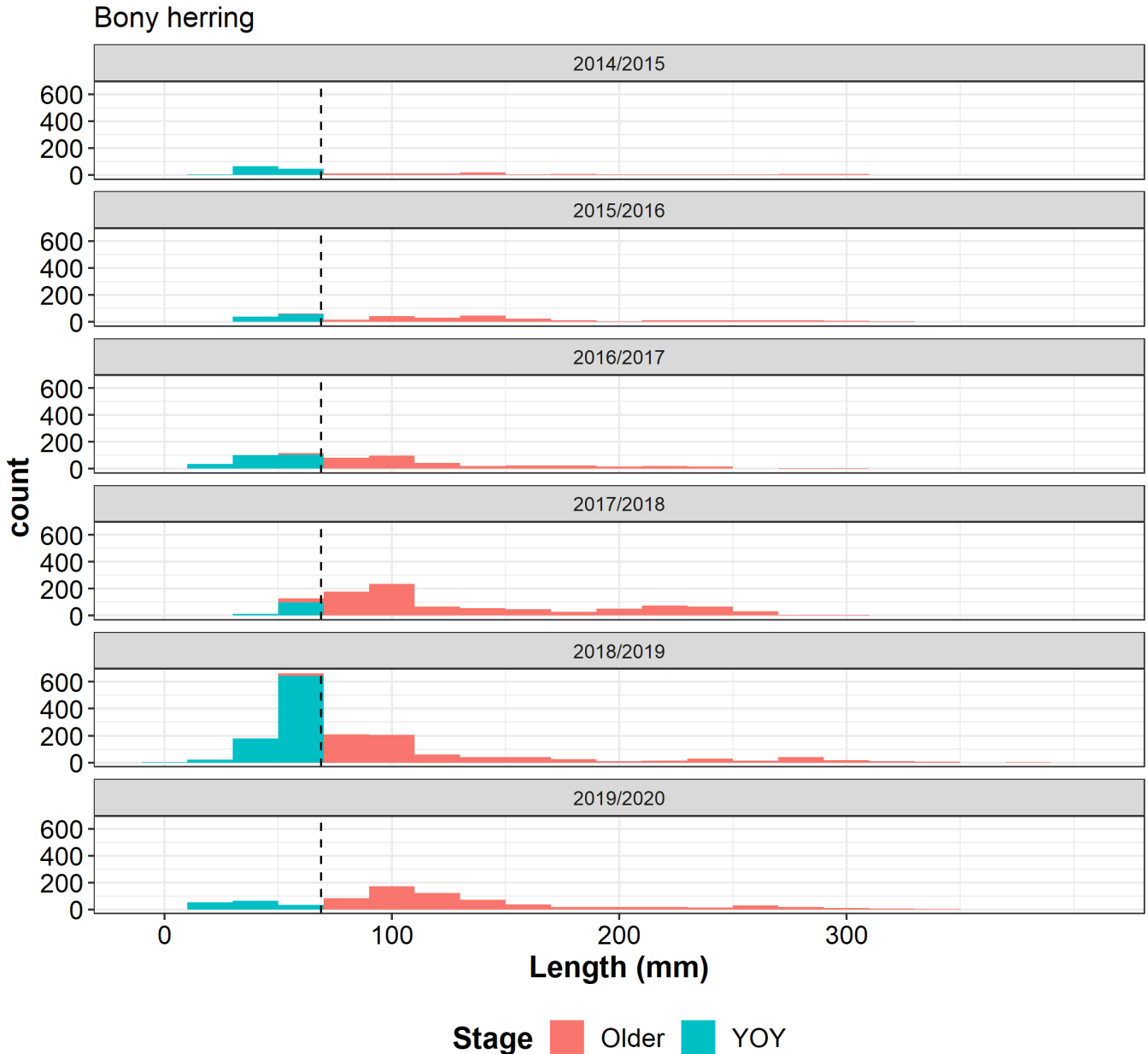


Figure 2.16: Length frequency plots for Bony herring by sampling season. YOY represents Young of the Year fish.

Summary Statement:

Regular recruitment but variable numbers of young-of-year and a good range of size classes in most years.

Temporal Trends in Abundance

We have modelled the relative abundance of Bony herring since 1994 based on all suitable boat electrofishing data. The left-hand panel of [Figure 2.17](#) shows the abundance trend for the Barwon-Darling Watercourse WRPA and the right-hand panel shows the overall trend across the NSW MDB.

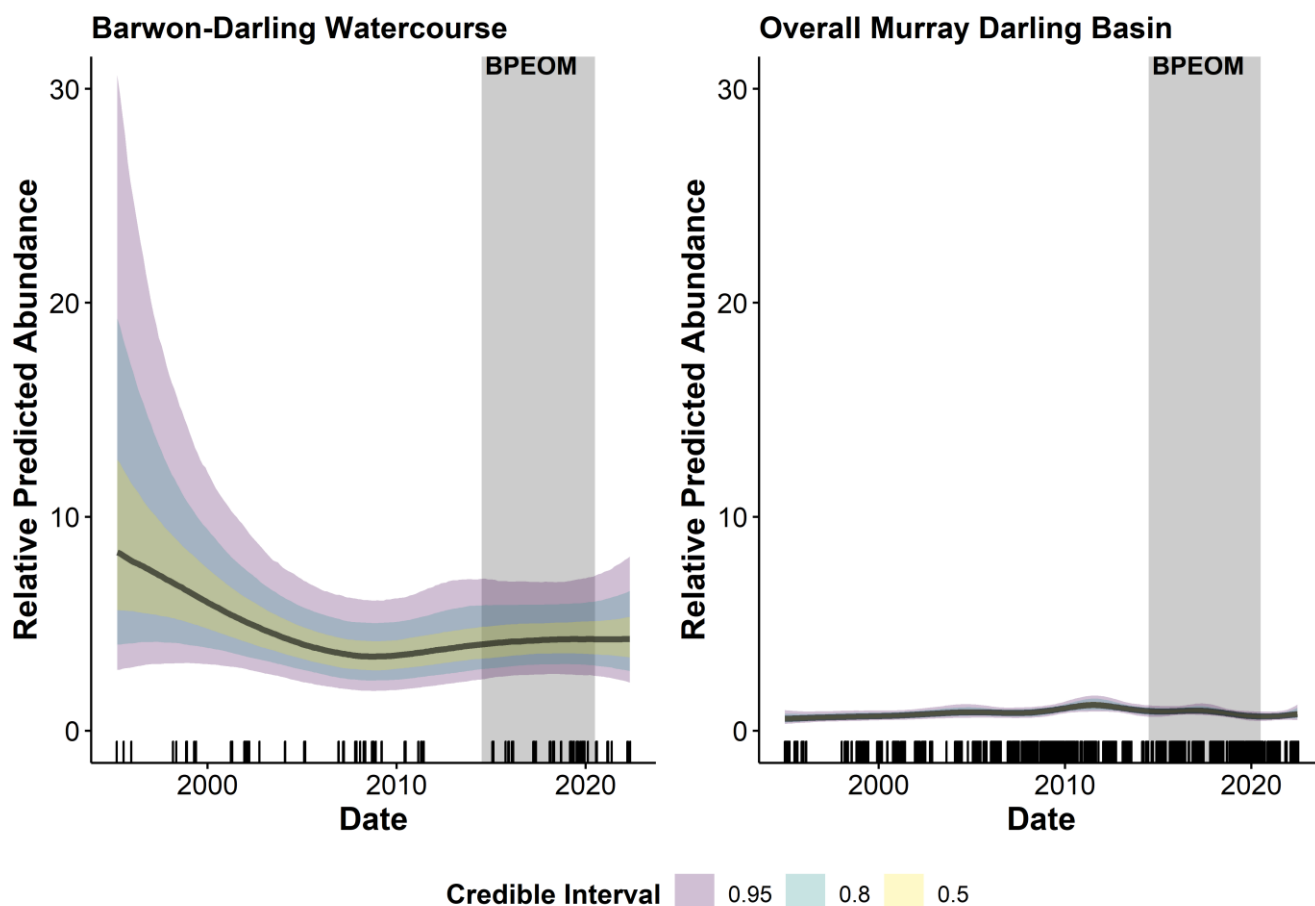


Figure 2.17: Relative abundance of Bony herring in both the Barwon-Darling Watercourse WRPA and the overall NSW MDB. These are model estimates based upon all boat electrofishing data within the NSW DPI Freshwater ecosystem database and the output of Bayesian generalised additive mixed models. The grey shaded region represents the period during which the BPEOM-F program was run. The black lines on the x-axis represent data coverage while the colours on the figure show various levels of confidence. Note when overlapping, the colours look slightly different due to the transparency and the y-axes vary between chapters of this report.

Summary Statement:

Relatively stable abundance since the 1990s. Relative abundance substantially higher than the overall abundance across the NSW MDB.

Health

The prevalence of any health issues ranged from <1% of sampled fish in 2015/2016 to 3% of sampled fish to 2017/2018 (Figure 2.18). The most common health issue for Bony herring in the Barwon-Darling Watercourse WRPAs was Lesions, which was observed in a total of 31 fish, corresponding to 1% of all Bony herring measured.

Across the other NSW MDB WRPA, 1 % of Bony herring (136 out of 12,084 Bony herring) showed a health condition (excludes the Barwon-Darling Watercourse WRPAs).

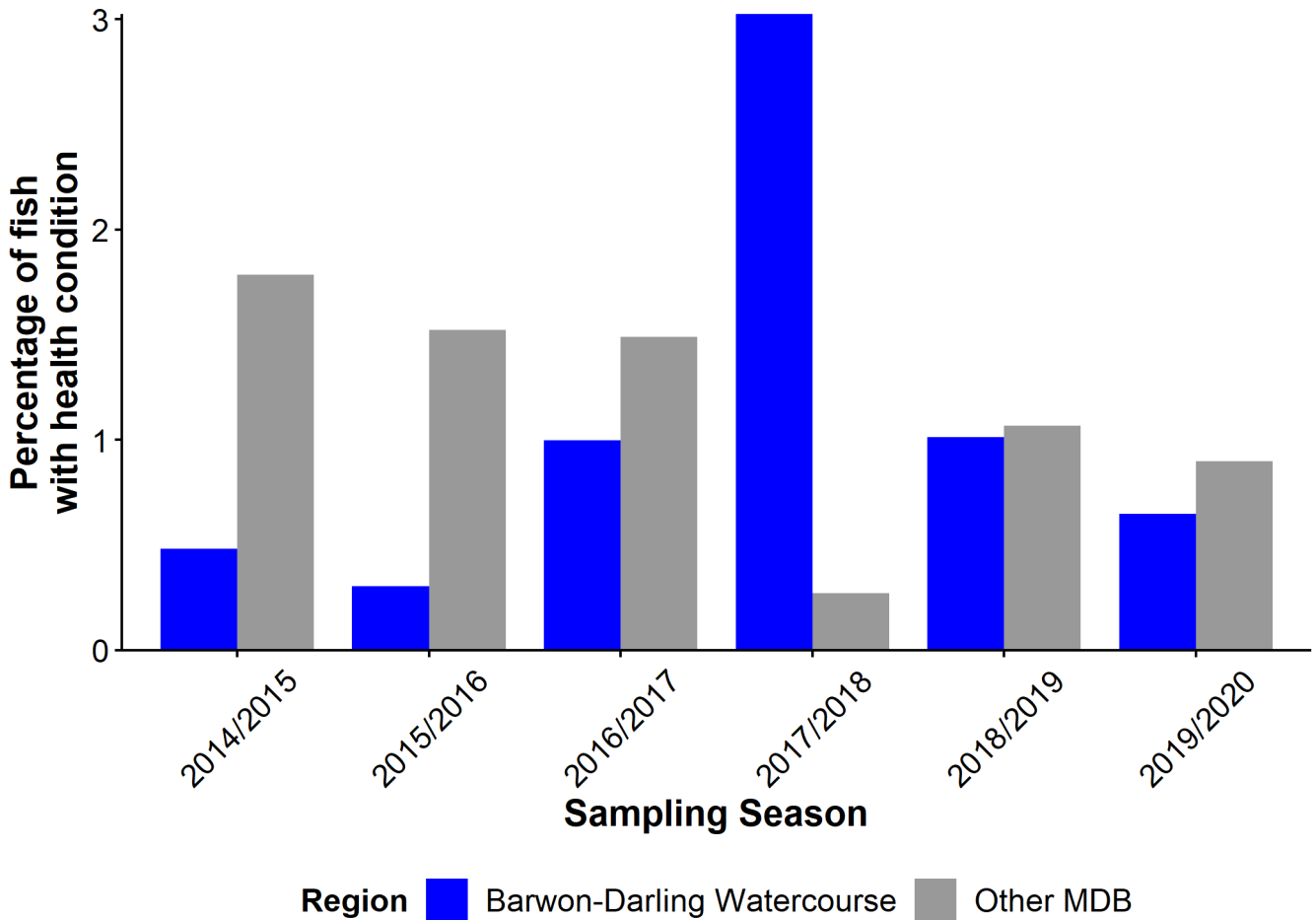


Figure 2.18: Timeseries showing the prevalence of health conditions in Bony herring. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPA.

Summary Statement:

Presence of observable health conditions was overall low but variable across years and generally comparable to the rest of the NSW MDB.

Distribution

Bony herring were recorded at 54 out of 58 sites in the Barwon-Darling Watercourse WRPA. The maximum observed relative abundance at a site was 101 fish caught per 90 seconds of electrofishing. [Figure 2.19](#) shows the distribution and relative abundance of Bony herring across the Barwon-Darling Watercourse WRPA.

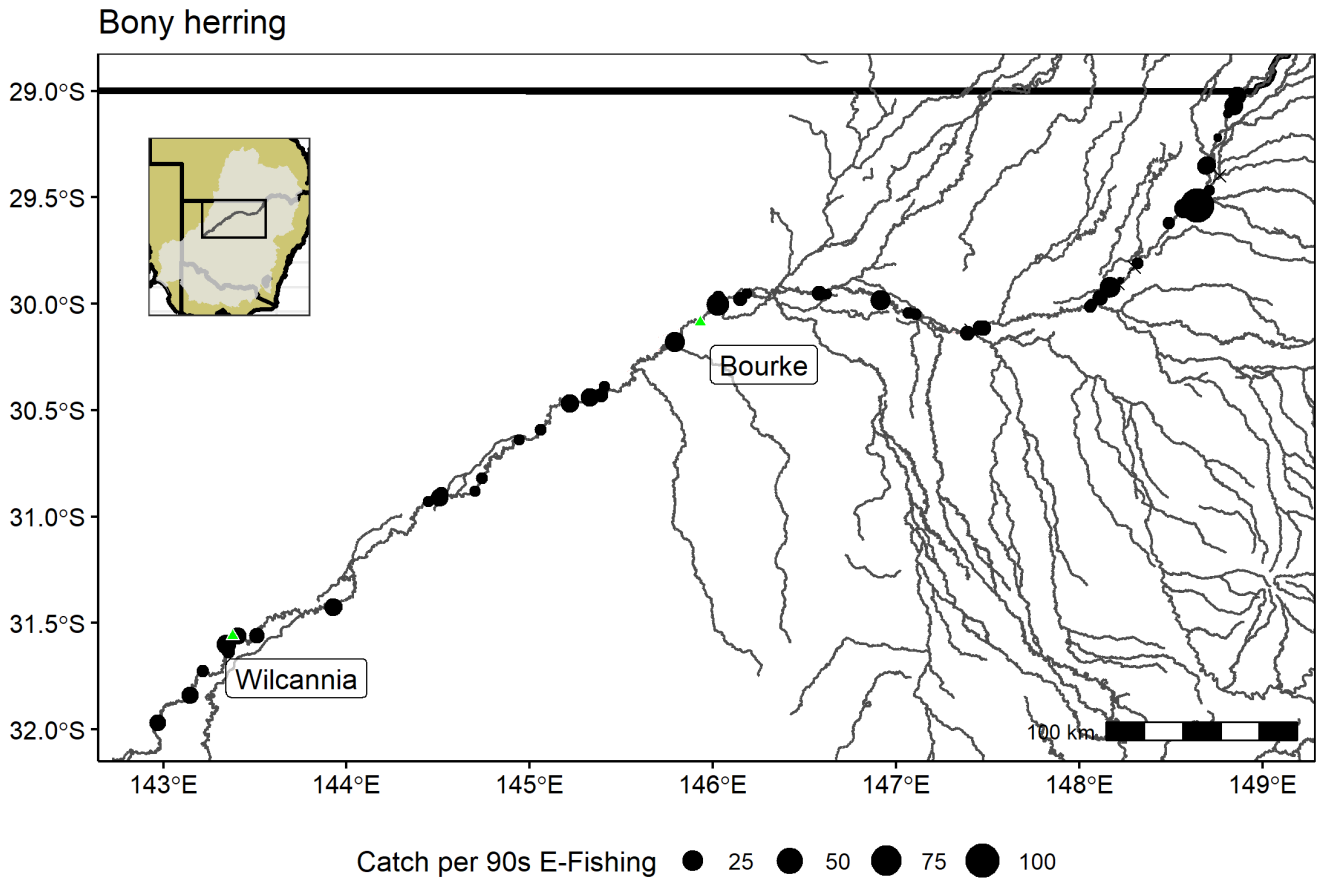


Figure 2.19: Distribution of Bony herring. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X. Green triangles show major towns.

Summary Statement:

Bony herring were present in relatively high abundance across the Barwon-Darling Watercourse WRPA.

Australian smelt



Population Structure

Figure 2.20 shows the observed length frequency plot for Australian smelt across all the sampling seasons. The observed numbers of Young of the Year (YOY) ranged from 0 to 43, and 0% to 100% of measured fish within a season.

Overall, during the BPEOM-F program, across all the MDB water resource planning areas, the percentage YOY for Australian smelt was 42% (3,498 out of 8,352). Australian smelt are not a stocked species.

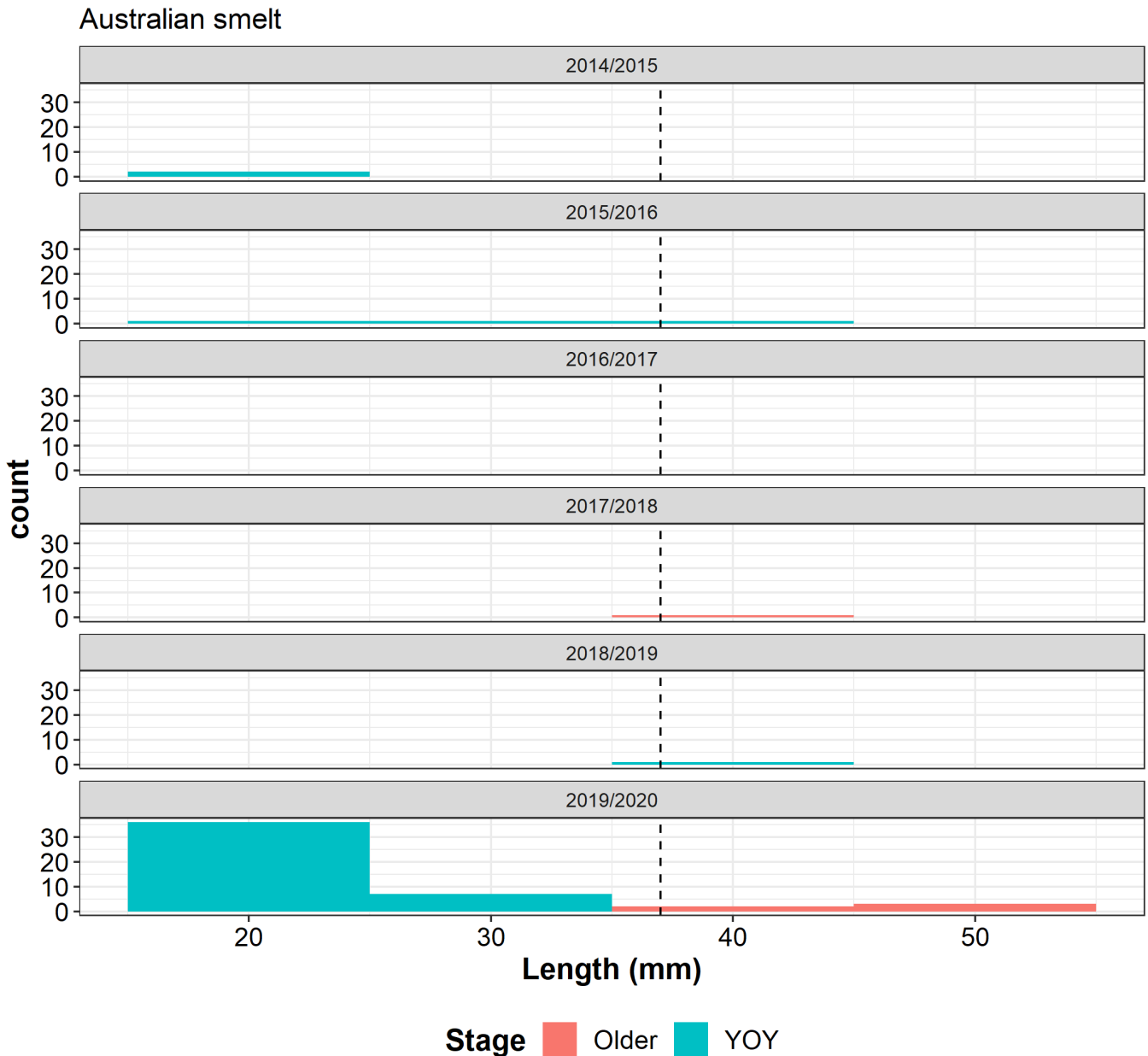


Figure 2.20: Length frequency plots for Australian smelt by sampling season. YOY represents Young of the Year fish.

Summary Statement:

No Australia smelt were detected in 2016/17. Some evidence of sporadic recruitment with size ranges varying among years.

Temporal Trends in Abundance

We have modelled the relative abundance of Australian smelt since 1994 based on all suitable boat electrofishing data. The left-hand panel of [Figure 2.21](#) shows the abundance trend for the Barwon-Darling Watercourse WRPA and the right-hand panel shows the overall trend across the NSW MDB.

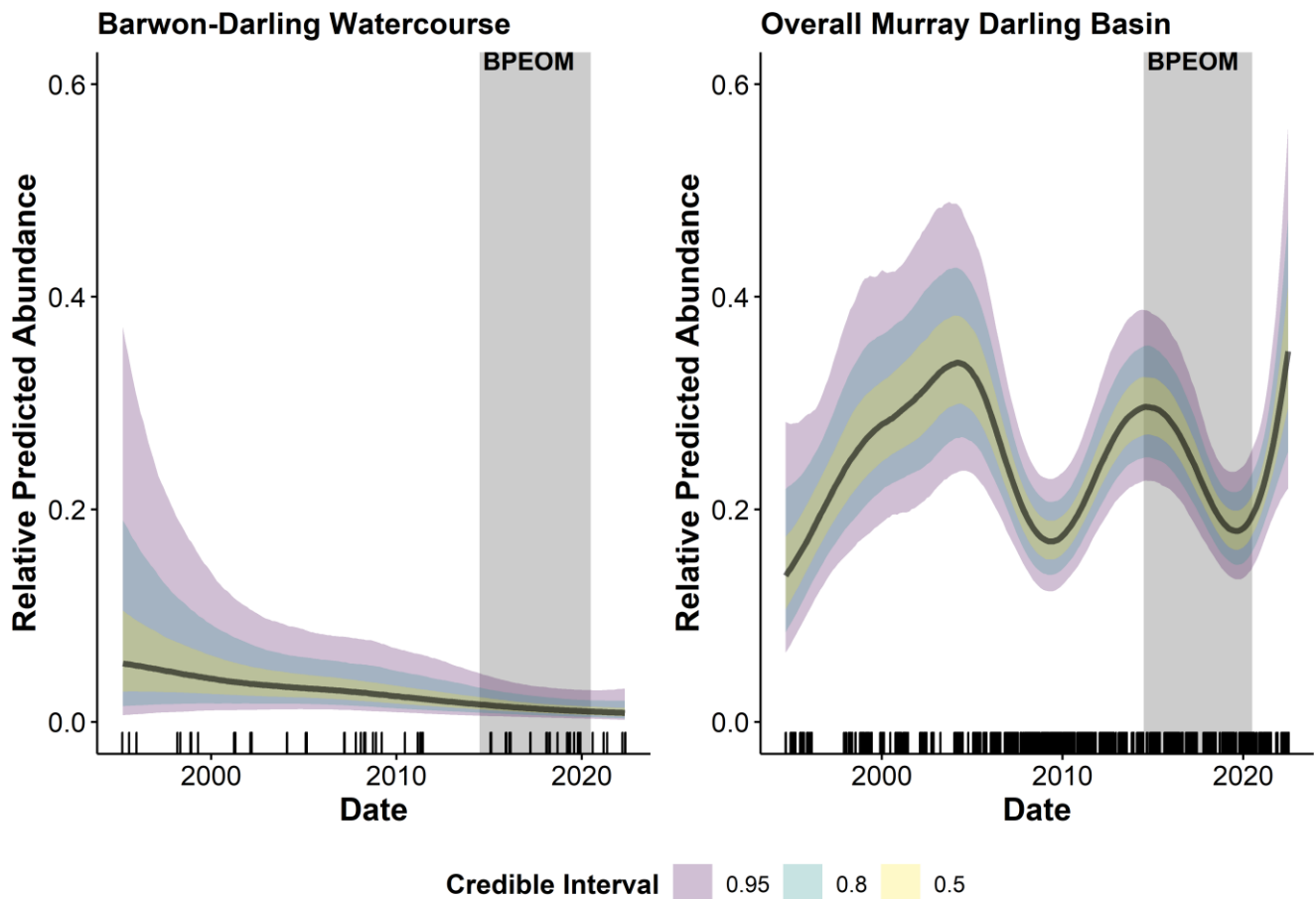


Figure 2.21: Relative abundance of Australian smelt in both the Barwon-Darling Watercourse WRPA and the overall NSW MDB. These are model estimates based upon all boat electrofishing data within the NSW DPI Freshwater ecosystem database and the output of Bayesian generalised additive mixed models. The grey shaded region represents the period during which the BPEOM-F program was run. The black lines on the x-axis represent data coverage while the colours on the figure show various levels of confidence. Note when overlapping, the colours look slightly different due to the transparency and the y-axes vary between chapters of this report.

Summary Statement:

Relative abundance substantially lower than overall abundance across the NSW MDB. Trends in abundance should be treated cautiously due to the paucity of data over the survey period.

Health

No health issues were detected in Australian smelt in the Barwon-Darling Watercourse (Figure 2.22). Across the other NSW MDB WRPA, <1% of Australian smelt (53 out of 8,447 Australian smelt) showed a health condition (excludes the Barwon-Darling Watercourse WRPA).

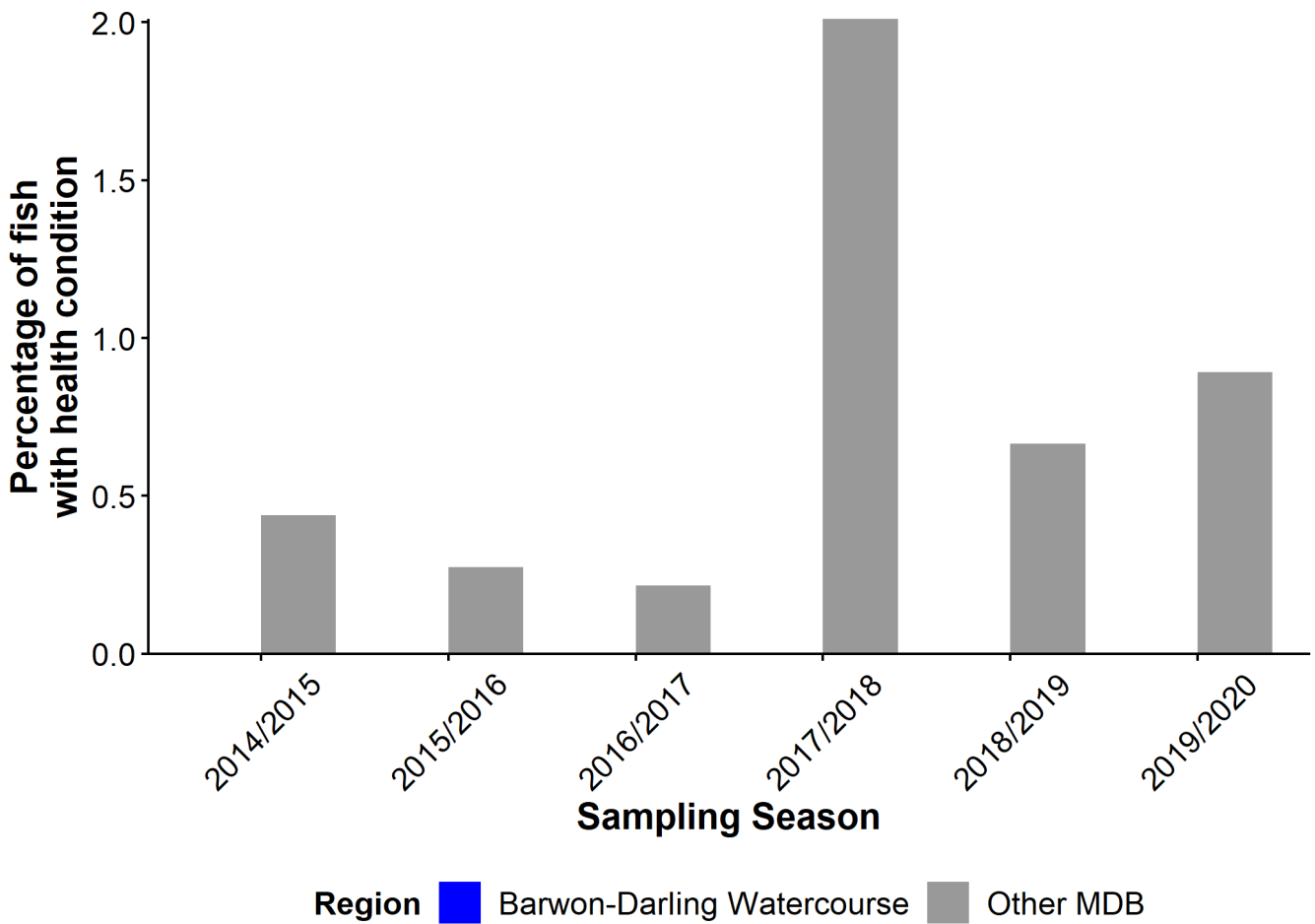


Figure 2.22: Timeseries showing the prevalence of health conditions in Australian smelt. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPA.

Summary Statement:

No health issues were detected in Australian smelt in the Barwon-Darling Watercourse.

Distribution

Australian smelt were recorded at 8 out of 58 sites in the Barwon-Darling Watercourse WRP. The maximum observed relative abundance at a site was 2.7 fish caught per 90 seconds of electrofishing. [Figure 2.23](#) shows the distribution and relative abundance of Australian smelt across the Barwon-Darling Watercourse WRP.

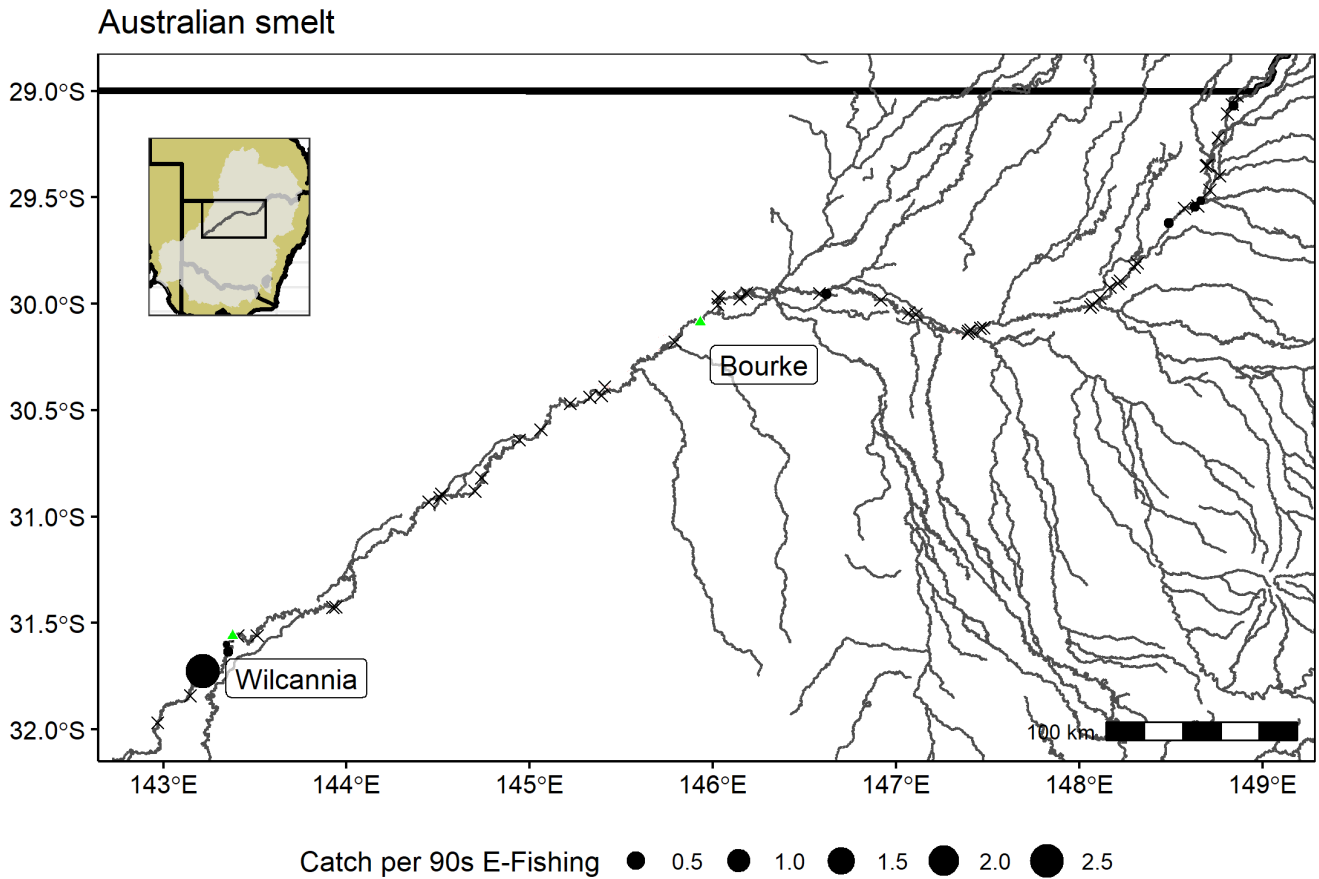


Figure 2.23: Distribution of Australian smelt. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X. Green triangles show major towns.

Summary Statement:

Australian smelt were recorded in the southwest and northeast sites of the Barwon-Darling Watercourse and were absent across the central region. This fragmented pattern of distribution is unusual for this normally ubiquitous and widely distributed species.

Common carp



Population Structure

Figure 2.24 shows the observed length frequency plot for Common carp across all the sampling seasons. The observed numbers of Young of the Year (YOY) ranged from 1 to 298, and 2% to 76% of measured fish within a season.

Overall, during the BPEOM-F program, across all the MDB water resource planning areas, the percentage YOY for Common carp was 58% (11,710 out of 20,084). Common carp are not a stocked species.

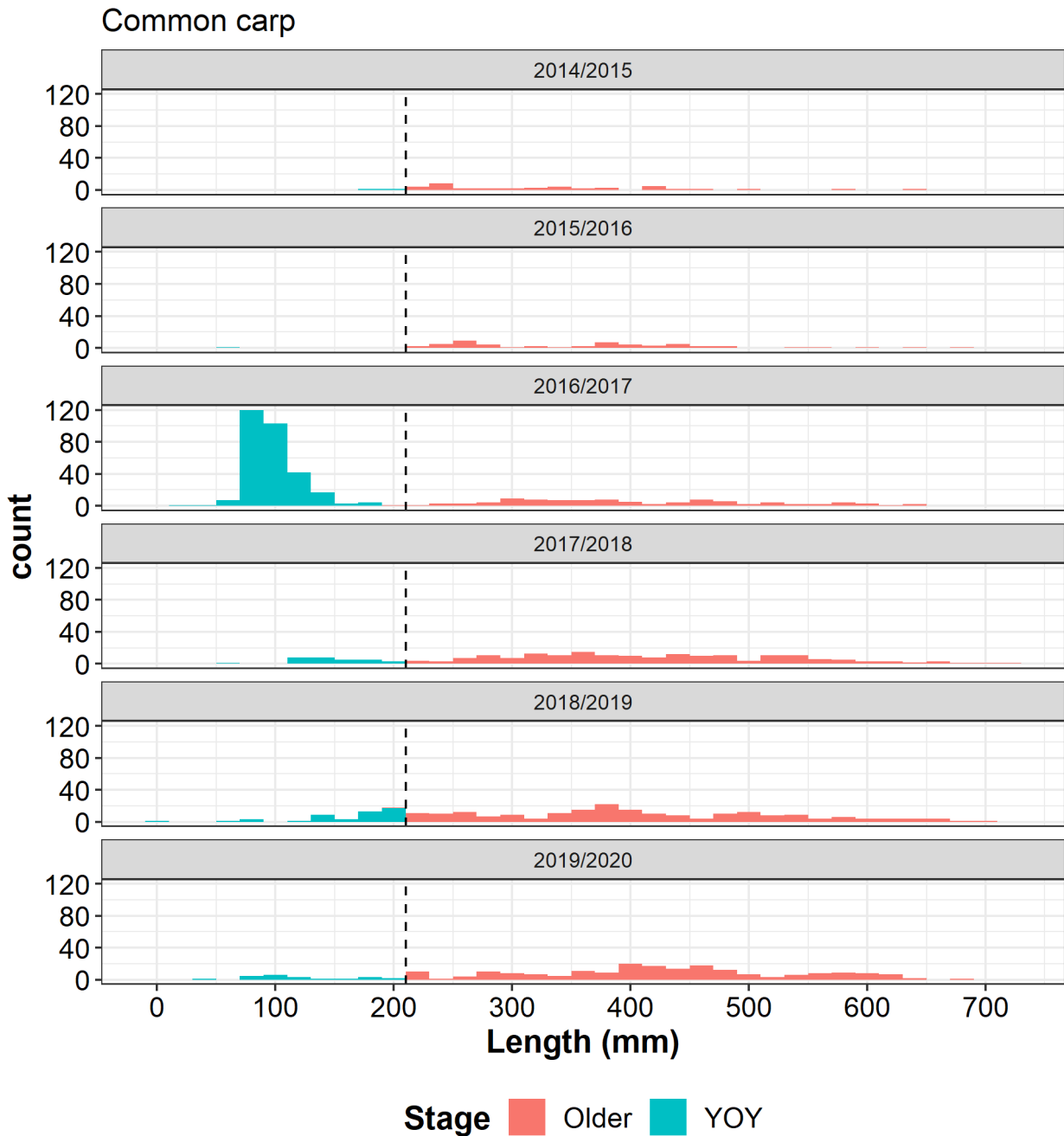


Figure 2.24: Length frequency plots for common carp by sampling season. YOY represents Young of the Year fish.

Summary Statement:

Semi-regular recruitment observed with a clear peak in 2016/17 and little recruitment observed in 2014/15 and 2015/16. A wide range of size classes.

Temporal Trends in Abundance

We have modelled the relative abundance of Common carp since 1994 based on all suitable boat and backpack electrofishing data. The left-hand panel of [Figure 2.25](#) shows the abundance trend for the Barwon-Darling Watercourse WRPA and the right-hand panel shows the overall trend across the NSW MDB.

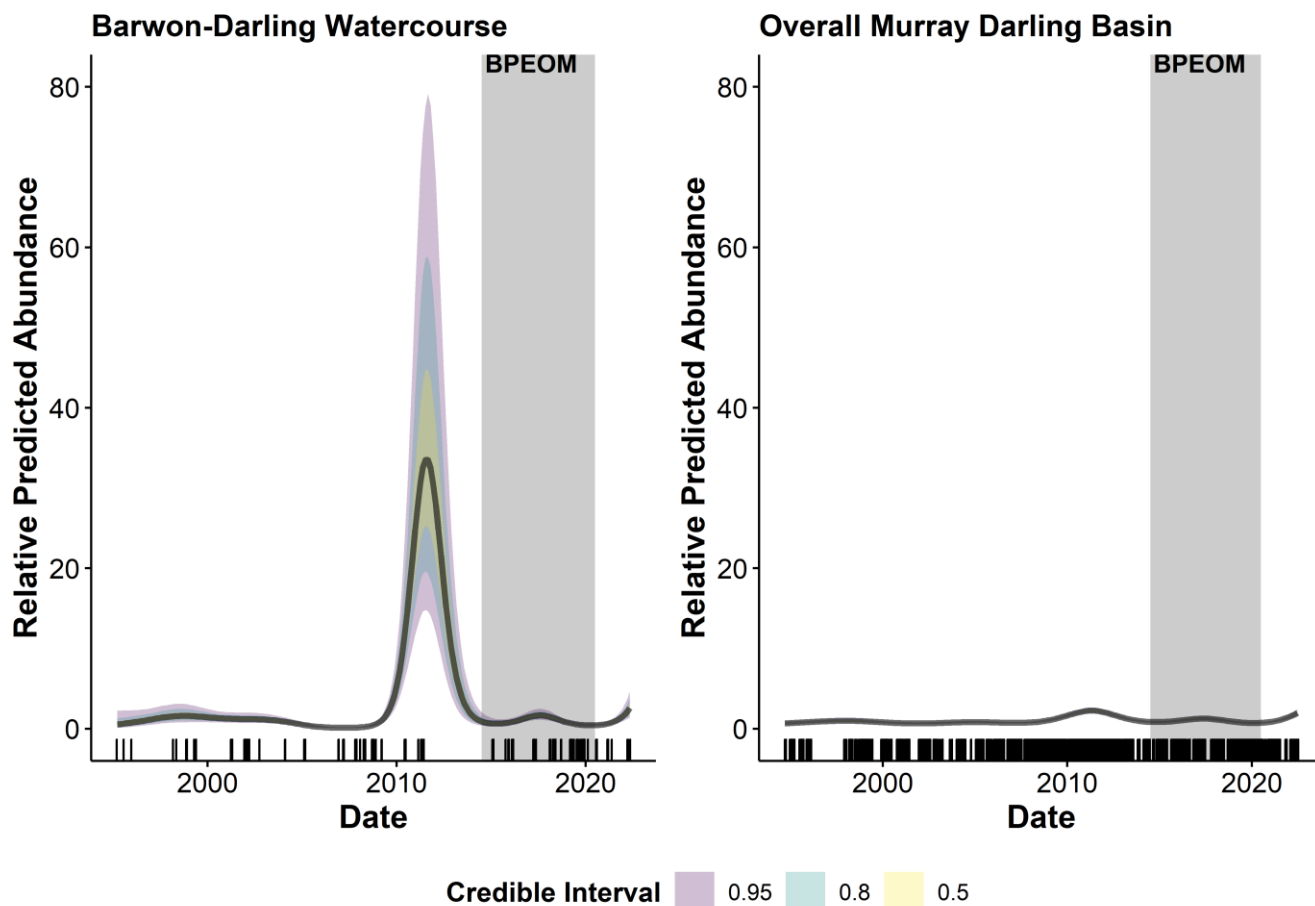


Figure 2.25: Relative abundance of Common carp in both this valley and the overall NSW MDB. These are model estimates based upon all electrofishing data within the NSW DPI Freshwater ecosystem database and the output of Bayesian generalised additive mixed models. The grey shaded region represents the period during which the BPEOM-F program was run. The black lines on the x-axis represent data coverage while the colours on the figure show various levels of confidence. Note when overlapping, the colours look slightly different due to the transparency and the y-axes vary between chapters of this report.

Summary Statement:

A major increase in abundance around 2011/12 before return to approximate 1990s levels. Evidence of an increase in abundance in recent years. Relative abundance is slightly higher than the overall abundance across the NSW MDB.

Health

The prevalence of any health issues ranged from 2% of sampled fish in 2015/2016 to 9% of sampled fish to 2018/2019 (Figure 2.26). The most common health issue for Common carp in the Barwon-Darling Watercourse water resource planning area was *Lernaeae*, which was observed in a total of 43 fish, corresponding to 4% of all Common carp measured.

Across the other WRPAs, 5% of Common carp (1,089 out of 20,085 Common carp) showed a health condition (excludes Barwon-Darling Watercourse).

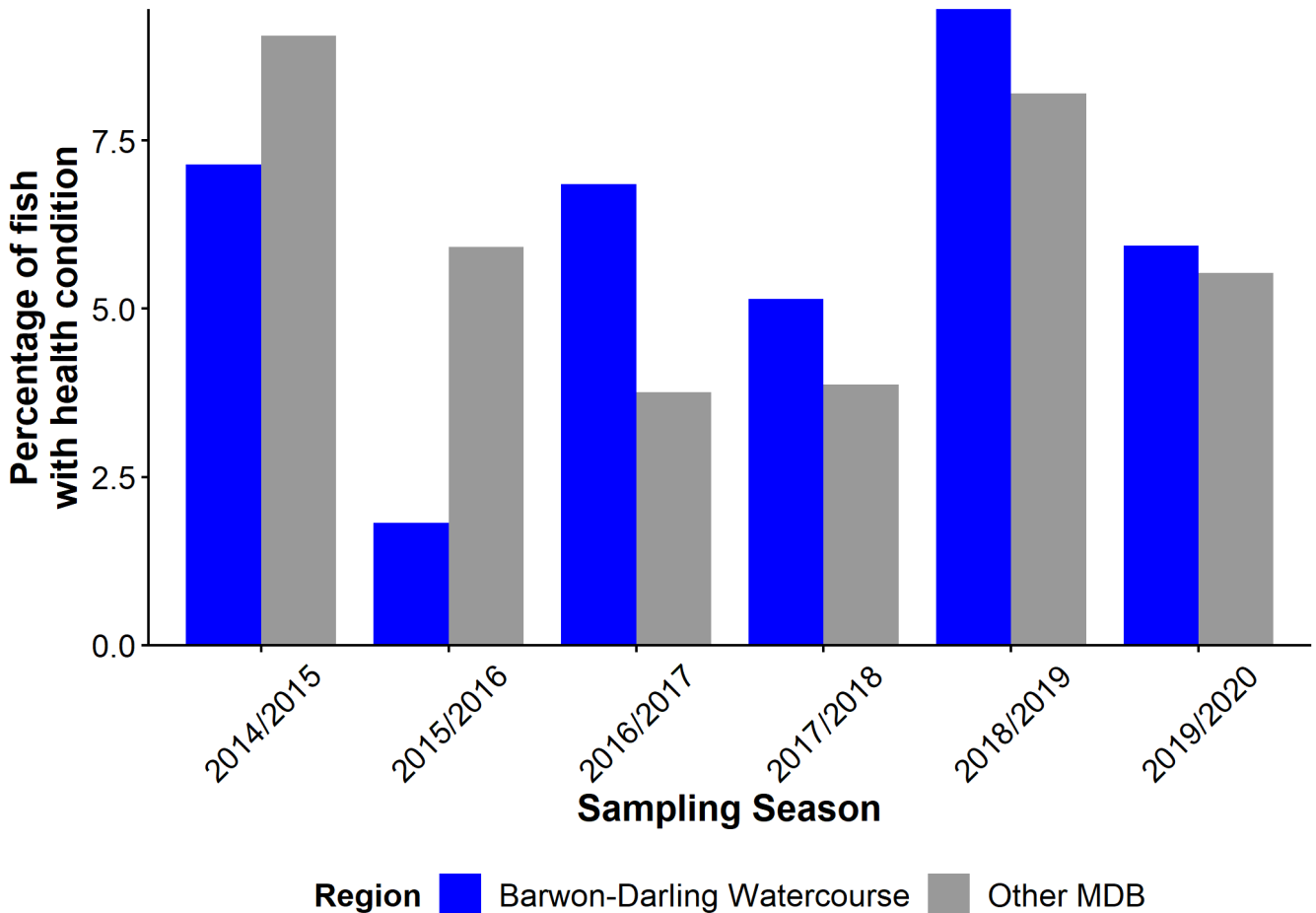


Figure 2.26: Timeseries showing the prevalence of health conditions in Common carp. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPAs.

Summary Statement:

The presence of observable health conditions for Common carp in the Barwon-Darling Watercourse was moderate and generally similar to the wider NSW MDB.

Distribution

Common carp were recorded at 55 out of 58 sites in the Barwon-Darling Watercourse WRPA. The maximum observed relative abundance at a site was 17 fish caught per 90 seconds of electrofishing. [Figure 2.27](#) shows the distribution and relative abundance of Common carp across the Barwon-Darling Watercourse WRPA.

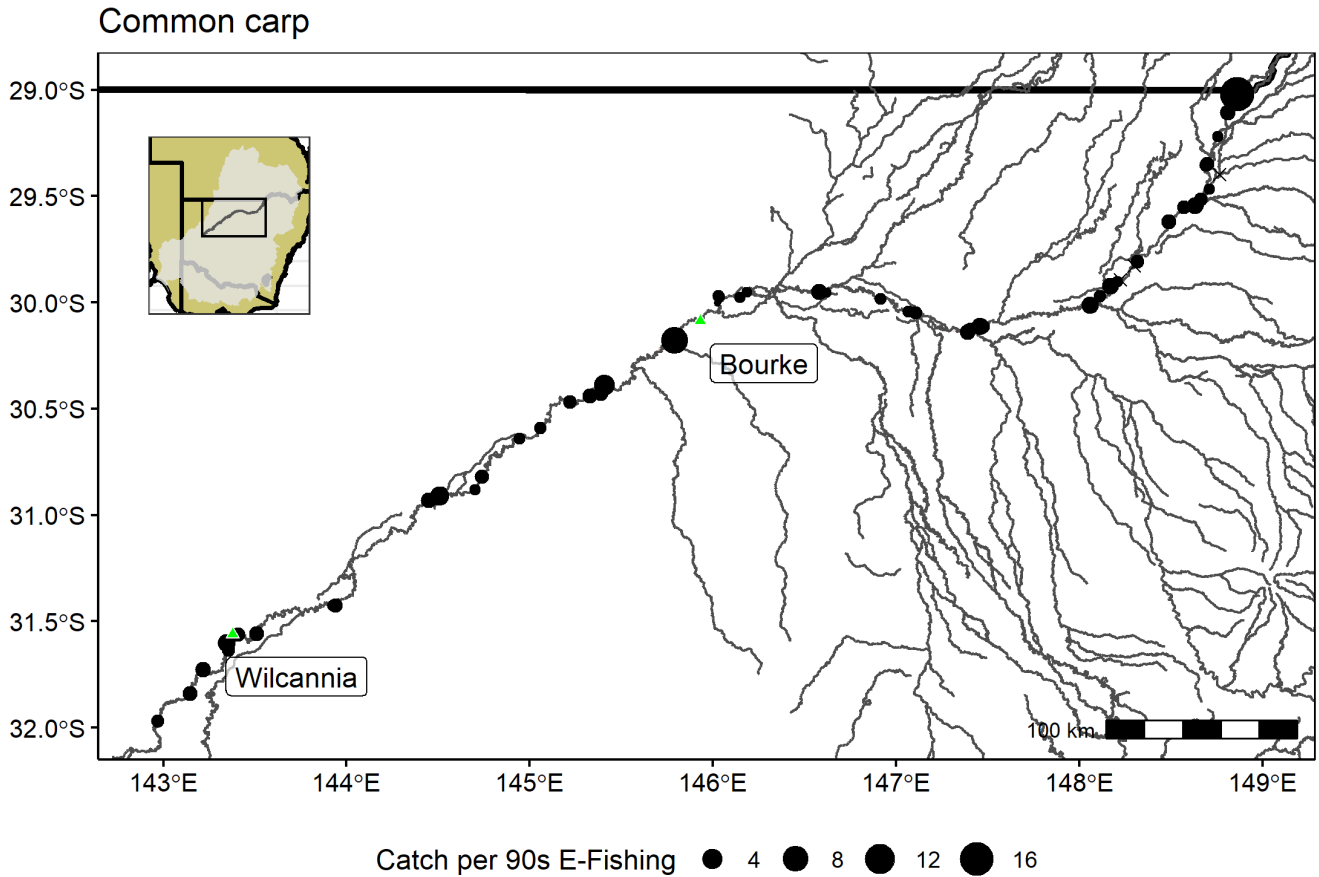


Figure 2.27: Distribution of Common carp. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X. Green triangles show major towns.

Summary Statement:

Common carp were found in relatively high abundance across the Barwon-Darling Watercourse region.

Threatened Species

The following table ([Table 2.6](#)) shows the fish species listed under either the *NSW Fisheries Management Act 1994* (FMA) or the *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999* (EPBC) which were observed in the Barwon-Darling Watercourse Water Resource Planning Area during the BPEOM-F program. A list of all threatened fish species observed by NSW DPI Fisheries (as part of any sampling program in any area) is provided in [Table 2.9](#).

Table 2.6: Listed species which were observed in this region during the BPEOM-F program. (* = FMA, # = EPBC)

Species	Common name	Total caught (observed)
<i>Bidyanus bidyanus</i>	Silver perch*#	1 (0)
<i>Maccullochella peelii</i>	Murray cod#	49 (24)

The following pages provide more information on where each species was observed.

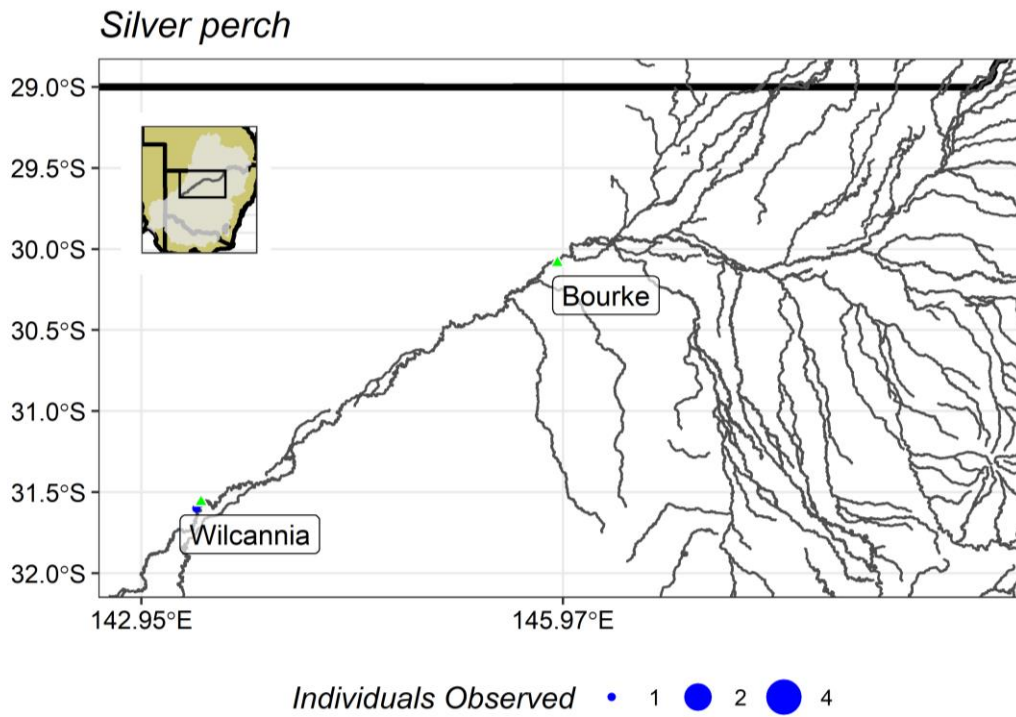


Figure 2.28: Distribution of the observed threatened species. Filled circles show sites where the species was present, and the size of the circle represents number of observed individuals abundance. Green triangles show major towns.

Summary Statement:

A single Silver perch of 134 mm Fork Length was recorded in the Darling-Baaka River near Wilcannia, in October 2018.

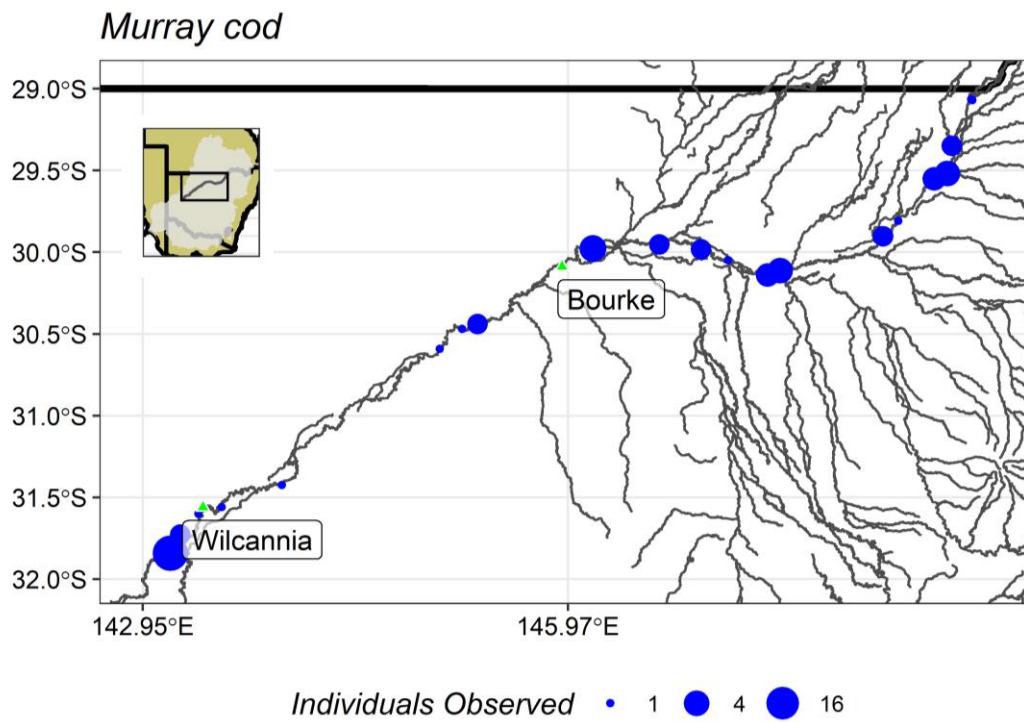


Figure 2.29: Distribution of the observed threatened species. Filled circles show sites where the species was present, and the size of the circle represents number of observed individuals abundance. Green triangles show major towns.

Summary Statement:

A total of 73 Murray cod were caught or observed across 24 sites in the Barwon-Darling Watercourse region. The sites were distributed across the whole region.

Appendix

Figure 2.30 shows the locations of sites sampled in each sampling season.

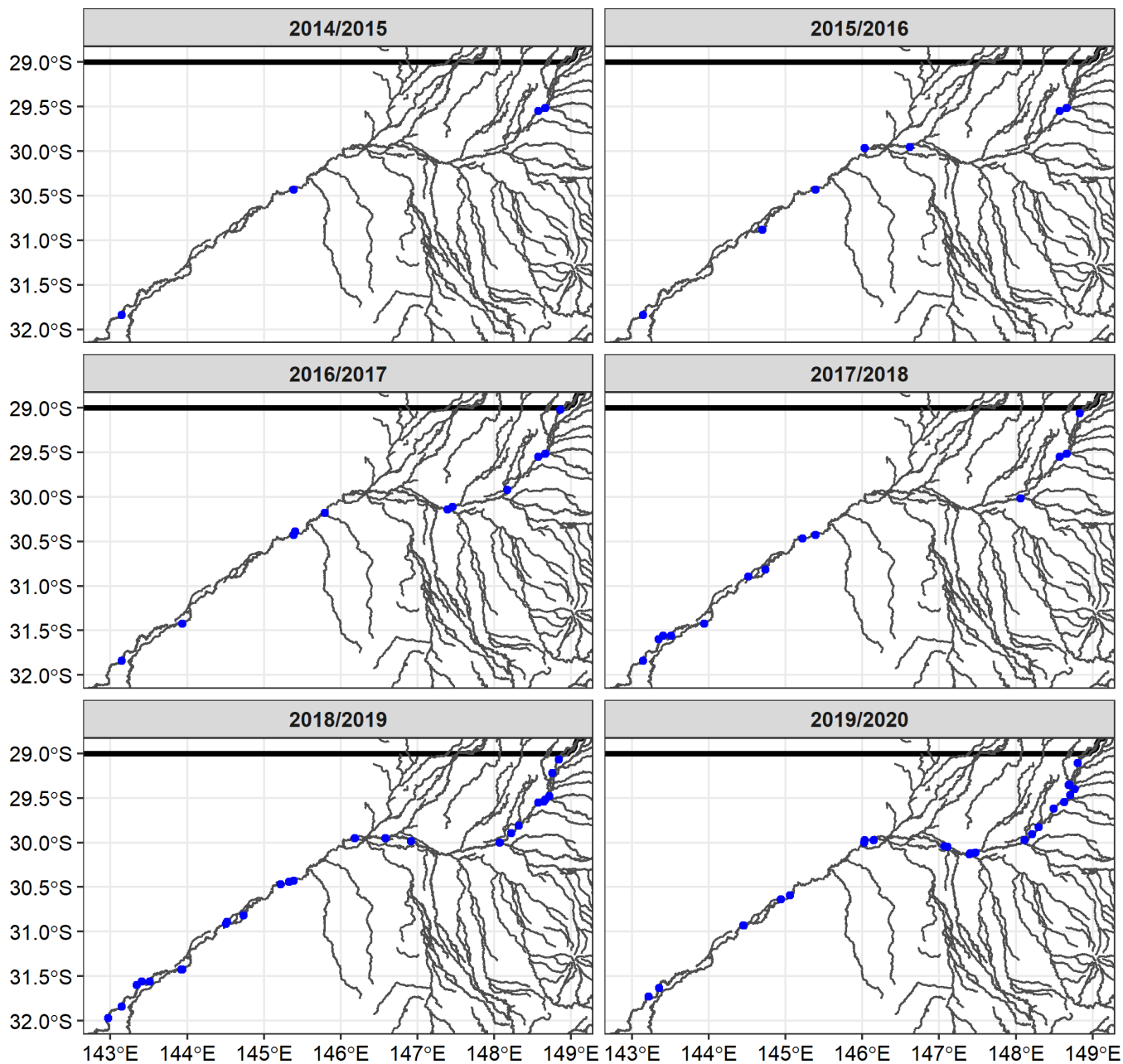


Figure 2.30: Sites sampled during the BPEOM-F program by Sampling Season. Dry sites are not shown.

Table 2.7 shows all fish species detected during this survey period. Note there are variations in effort between sampling seasons so this information should be considered in conjunction with Table 2.1. The Expected from modelling column identifies species which are possible to occur based upon MaxENT habitat modelling (likelihood threshold > 0.33; NA represents no modelling was undertaken). Species that were possible from the modelling but not observed during BPEOM sampling in the Barwon-Darling Watercourse WSPA were: Olive perchlet, Unspecked hardyhead, Southern purple-spotted gudgeon, Hyrtl's catfish and Freshwater catfish. It should be noted that the MaxENT modelling actually models habitat availability and is not always a reliable index of abundance, it merely indicates possible distribution based upon habitat. A full list of species observed during this period across all programs is in Table 2.10.

Table 2.7: Total number caught of each species by sampling season.

Common name	Expected from modelling	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Australian smelt	YES	2	3	0	1	1	48
Bony herring	YES	451	591	1,650	2,328	3,744	1,440
Carp-gudgeon species complex	YES	657	31	23	113	6,153	2,412
Common carp	NA	42	55	561	214	254	220
Eastern gambusia	NA	18	13	29	39	256	149
Golden perch	YES	34	14	60	73	178	148
Goldfish	NA	2	4	175	31	94	60
Murray-Darling rainbowfish	YES	9	18	12	36	144	41
Murray cod	YES	8	4	4	13	11	9
Silver perch	YES	0	0	0	1	0	0
Spangled perch	YES	1	1	117	7	219	12

The following table summarises the sampling methods by which each fish species was caught (Table 2.8).

Table 2.8: Summary of total catch of each species by sampling method.

Common name	Backpack Electrofishing	Bait Trap	Boat Electrofishing
Australian smelt	0	1	54
Bony herring	74	36	10,094
Carp-gudgeon species complex	245	8,405	739
Common carp	34	10	1,302
Eastern gambusia	162	115	227
Golden perch	28	5	474
Goldfish	95	2	269
Murray-Darling rainbowfish	23	12	225
Murray cod	1	0	48
Silver perch	0	0	1
Spangled perch	88	45	224

Table 2.9: Listed threatened species recorded in the MDB (from the NSW DPI Fisheries Freshwater Ecosystem research database). Species are listed under either the NSW Fisheries Management Act 1994 (FMA) or the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (EPBC).

Genus, species	Common Name	EPBC Status	FMA Status
<i>Ambassis agassizii</i>	Agassiz's glassfish, olive perchlet, western New South Wales population	NA	Endangered Population
<i>Bidyanus bidyanus</i>	Silver Perch, Bidyan	Critically Endangered	Vulnerable
<i>Craterocephalus fluviatilis</i>	Murray Hardyhead	Endangered	Critically Endangered
<i>Galaxias rostratus</i>	Flathead Galaxias, Beaked Minnow, Flat-headed Galaxias, Flat-headed Jollytail, Flat-headed Minnow	Critically Endangered	Critically Endangered
<i>Galaxias tantangara</i>	Stocky Galaxias	NA	Critically Endangered
<i>Maccullochella macquariensis</i>	Trout Cod	Endangered	Endangered
<i>Maccullochella peelii</i>	Murray Cod	Vulnerable	NA
<i>Macquaria australasica</i>	Macquarie Perch	Endangered	Endangered
<i>Mogurnda adspersa</i>	Southern Purple Spotted Gudgeon	NA	Endangered
<i>Nannoperca australis</i>	Southern Pygmy Perch	Vulnerable	Endangered
<i>Tandanus tandanus</i>	Freshwater catfish, eel tailed catfish, Murray-Darling Basin population	NA	Endangered Population

Table 2.10 shows all fish species detected during this survey period across all programs and methods. Due to variations in project methods protocols, this data is presented only to give a complete list of species observed in the region. The Expected from modelling column identifies species which are possible to occur based upon MaxENT habitat modelling (likelihood threshold > 0.33; NA represents no modelling was undertaken). Species that were possible from the modelling but not observed during BPEOM sampling in the Barwon-Darling Watercourse WRPA were: Olive perchlet, Unspecked hardyhead, Southern purple-spotted gudgeon, Hyrtl's catfish, Freshwater catfish. It should be noted that the MaxENT modelling actually models habitat availability and is not always a reliable index of abundance, it merely indicates possible distribution based upon habitat. A list of species caught as part of BPEOM-F during this period is in Table 2.6.

Table 2.10: Total catch of each species by all sampling programs and all methods in the region. Note these include projects with sampling not representative of the community and the data should not be interpreted.

Common name	Expected from modelling	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20
Australian smelt	YES	2	3	0	1	1	53
Bony herring	YES	451	533	1,434	2,380	3,594	1,865
Carp-gudgeon species complex	YES	657	28	23	115	5,022	7,551
Common carp	NA	42	48	302	224	245	248
Eastern Gambusia	NA	18	10	16	39	254	231
Golden perch	YES	34	9	56	86	177	235
Goldfish	NA	2	3	106	34	94	74
Murray-Darling rainbowfish	YES	9	18	12	37	144	41
Murray cod	YES	8	4	4	15	11	12
Silver perch	YES	0	0	0	1	0	0
Spangled perch	YES	1	1	41	7	219	13