Department of Primary Industries
Department of Regional NSW

Chapter 7 Basin Plan Environmental Outcomes Monitoring for Fish (2014/15 – 2019/20): Murrumbidgee Water Resource Planning Area

Citation Details

Please cite the overall report when referring to this chapter:

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Chapter cover image credit: Samuel Nolan (UNSW); Fish images credit: Gunther Schmida

Acknowledgements

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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 Murrumbidgee Water Resource Planning Area (WRPA) shown in Figure 7.1.

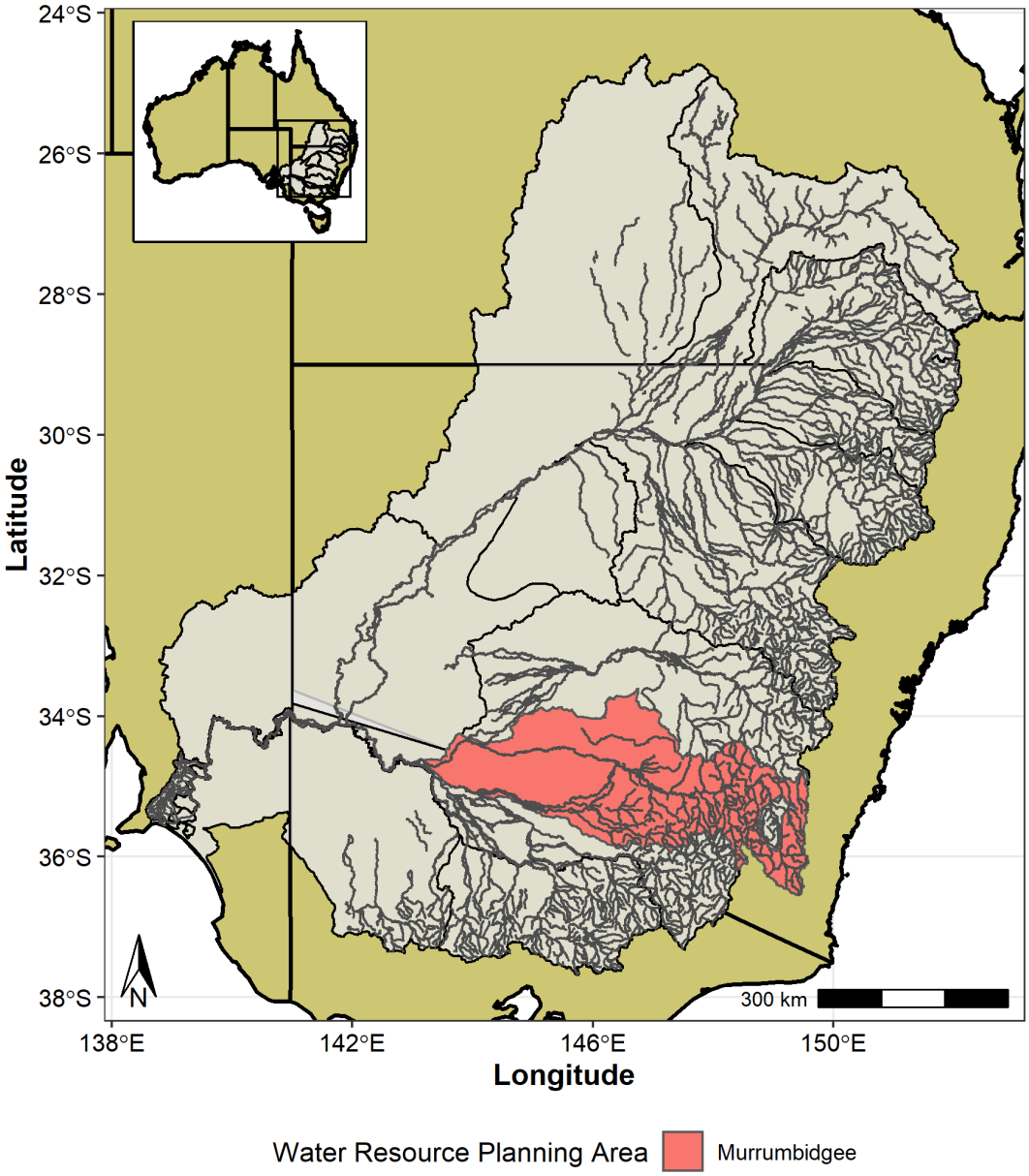

Figure 7.1: Murray-Darling Basin with the key region of this report highlighted. Inset map shows the whole of Australia with a box around the MDB.

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 Murrumbidgee 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 Murrumbidgee 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 Murrumbidgee WRPA and greater MDB (excluding the Murrumbidgee 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 Murrumbidgee 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 (Table 7.1). 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 7.1: 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	18 (0)
2015/2016	41 (0)
2016/2017	36 (2)
2017/2018	48 (15)
2018/2019	34 (16)
2019/2020	30 (0)

The sites sampled during the reporting period are shown in Figure 7.2. A breakdown of sites sampled each sampling season is shown in the Appendix (Figure 7.38).

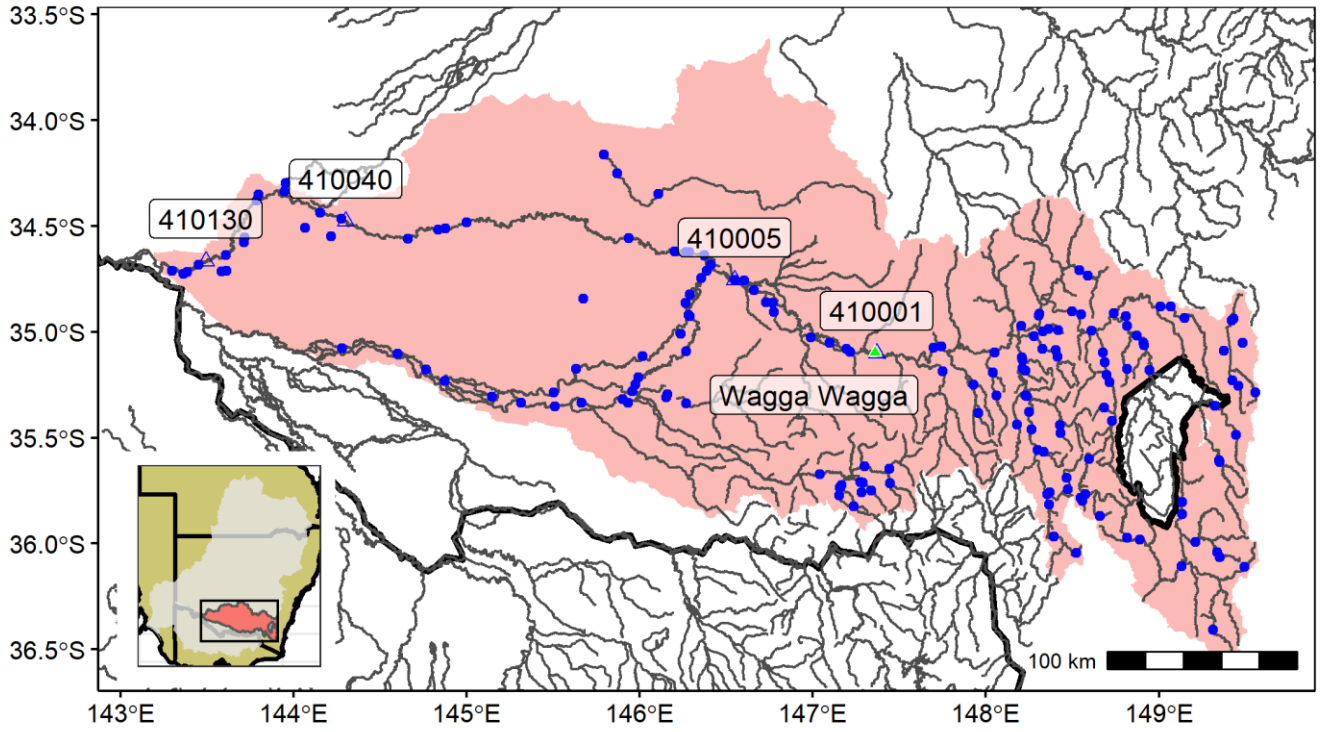

Figure 7.2: Sites (dots) sampled during the BPEOM-F program. Triangles show key flow gauges along with their gauge ID number. Dry sites are not shown.

Each sampling method has a different effectiveness at sampling each species. Table 7.2 shows the total amount of each species caught by each method.

Table 7.2: 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	Backpack Electrofishing	Boat Electrofishing	Bait Trap
Murray cod	5	191	0
Golden perch	1	156	1
Freshwater catfish	0	1	0
Bony herring	0	348	0
Australian smelt	30	1,354	0
Common carp	607	3,141	113

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 7.3 shows the number of biological measurements taken each year for the six species.

Table 7.3: Number of biological measurements taken for the key species each sampling season.

	Murray cod	Golden perch	Freshwater catfish	Bony herring	Australian smelt	Common carp
2014/2015	8	12	0	6	229	236
2015/2016	51	31	0	110	356	474
2016/2017	19	18	0	70	254	1,043
2017/2018	20	39	0	77	229	412
2018/2019	71	38	0	40	152	370
2019/2020	27	20	1	45	32	486

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. As an example, 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 Murrumbidgee WRPA (Figure 7.3).

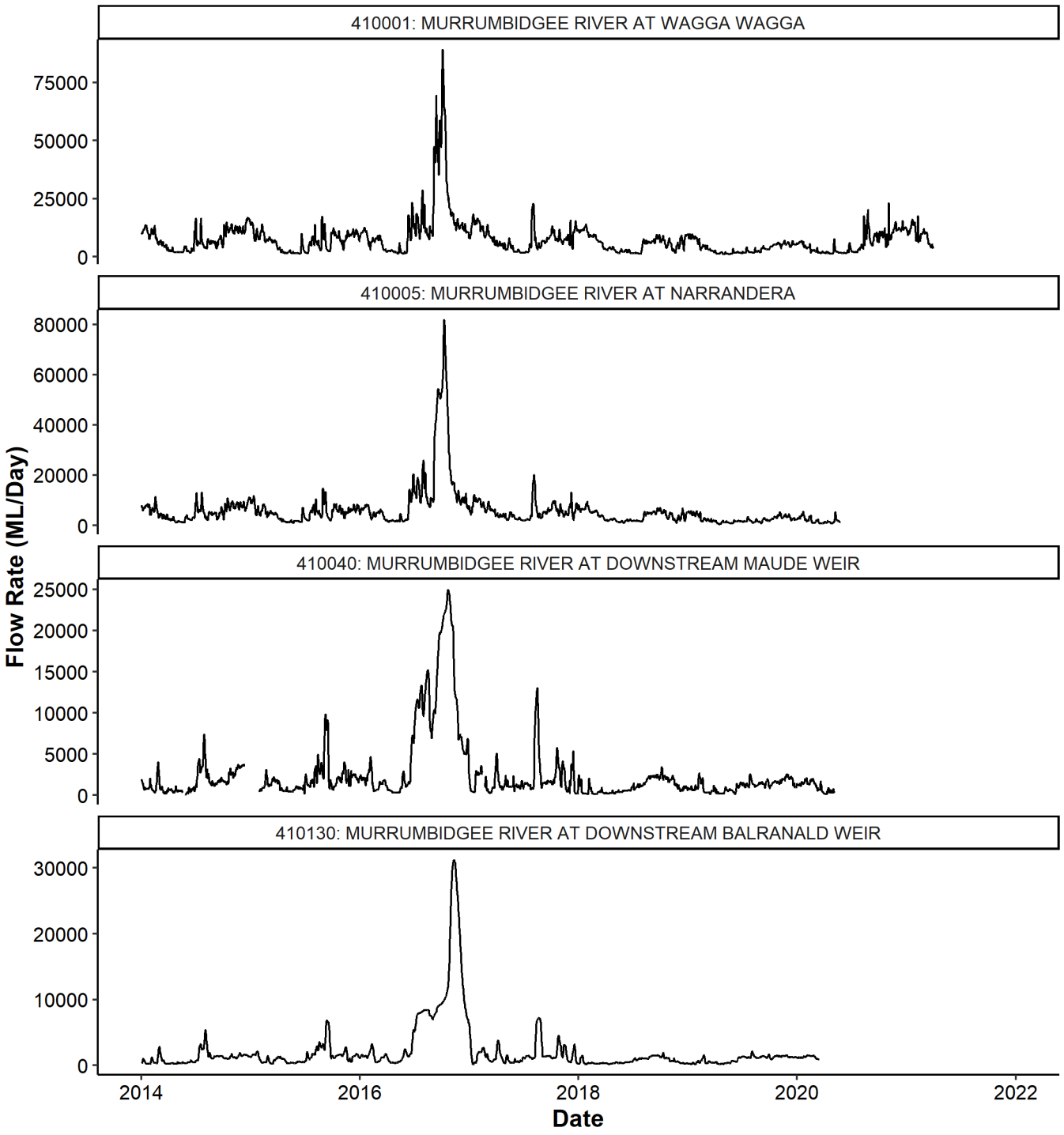

Figure 7.3: Flow data from various gauges in the Murrumbidgee WRPA over the reporting period. Gauge locations can be seen on Figure 7.2. Note the differing scales on the y-axis.

Water temperature data, where available, are also shown in Figure 7.4.

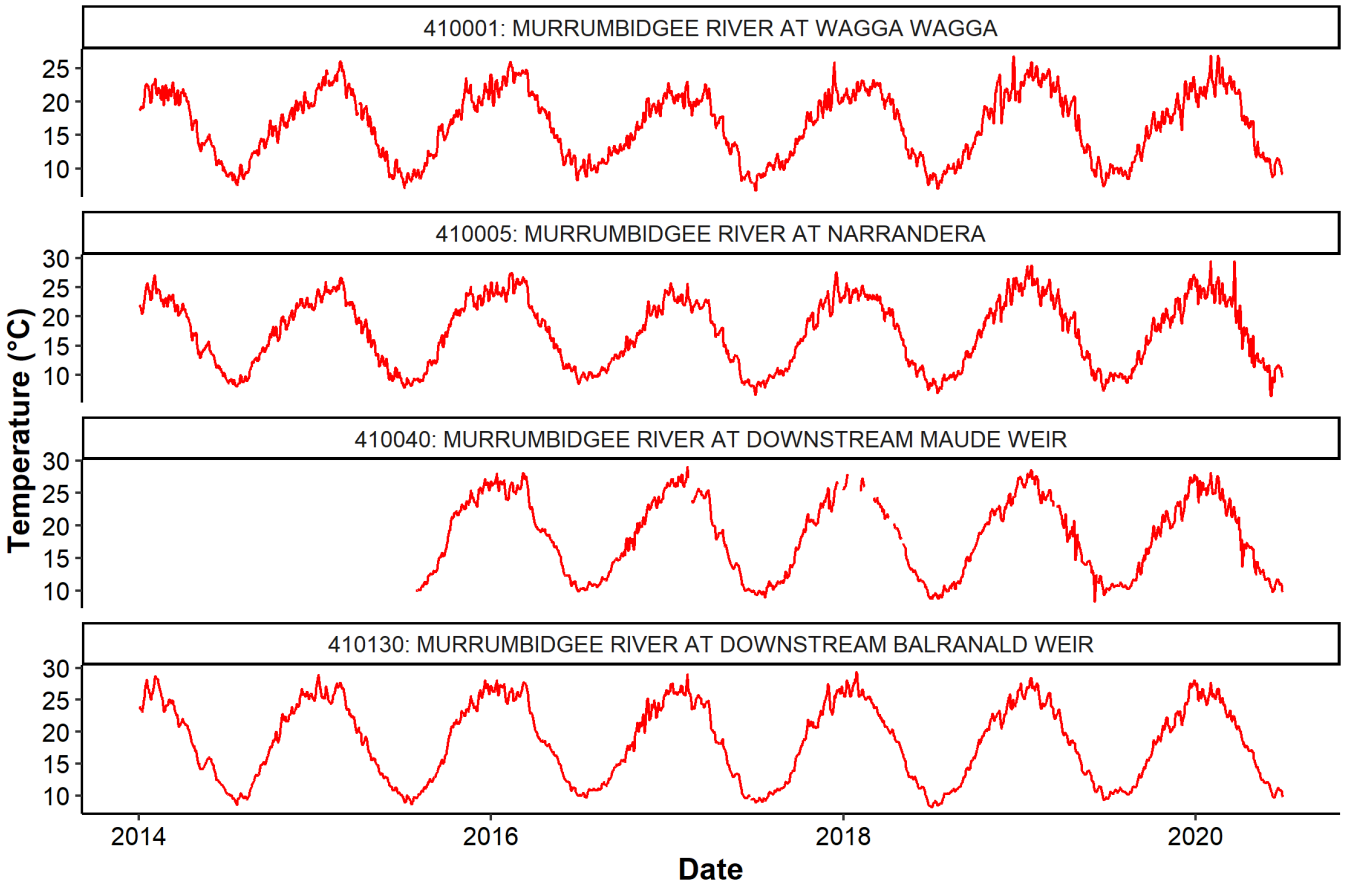

Figure 7.4: Water temperature data from various gauges in the Murrumbidgee WRPA over the reporting period. Gauge locations can be seen on Figure 7.2. Note the differing scales on the y-axis.

Species Diversity

A total of 26 fish species were observed across the Murrumbidgee WRPA including seven alien species. Figure 7.5 shows the number of native and alien species found at each site. The full list of species caught and observed is in Table 7.7.

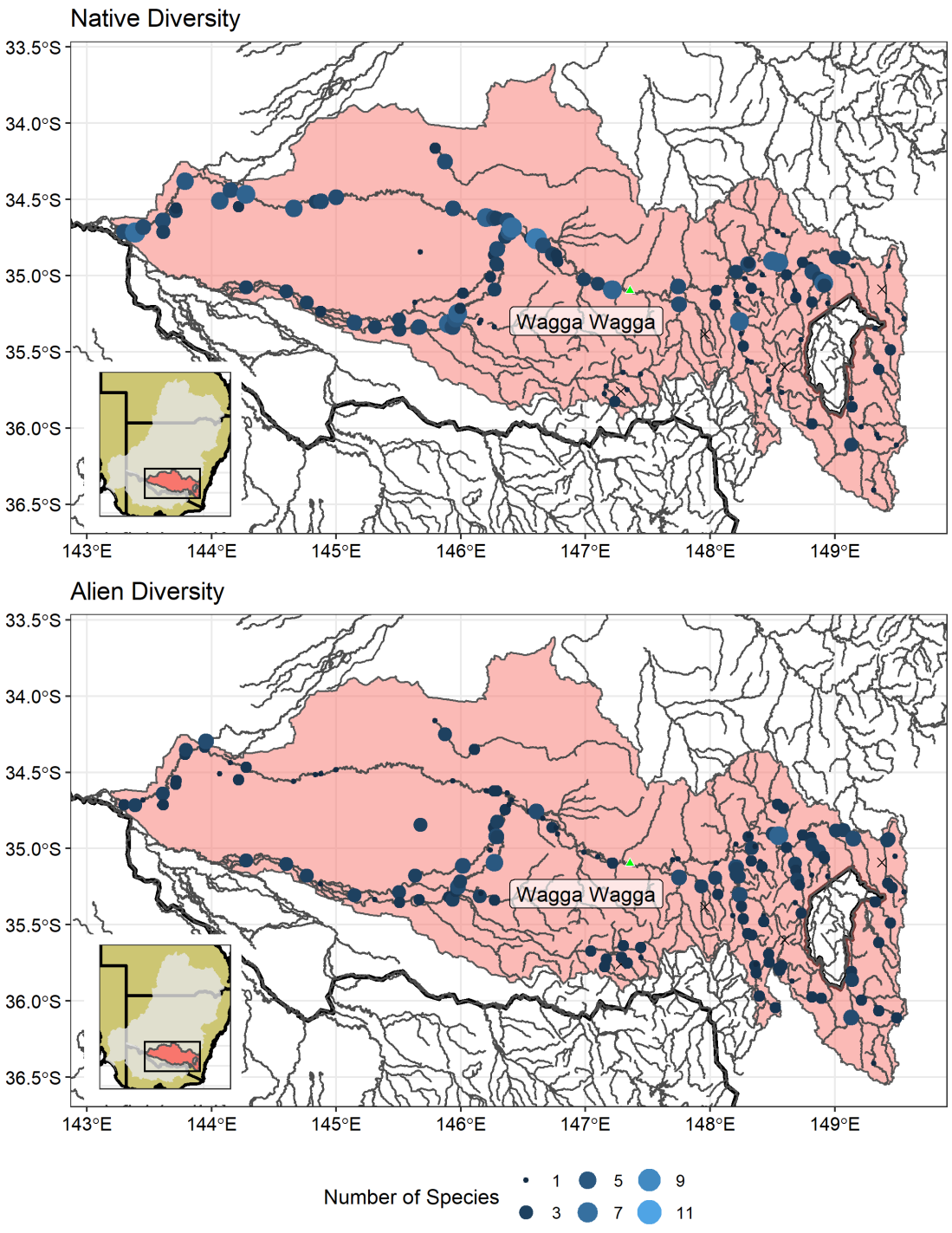

Figure 7.5: Diversity across all sampling sites. Bubble size represents the number of unique species observed at each site across all sampling methods and events. X represents a site that had water and was sampled, but no fish species were caught at all. Dry sites are excluded.

Summary Statement:

Native diversity was highest in the central and western areas of the Murrumbidgee WRPA region while the alien diversity was generally consistent across the region.

Murray cod

Population Structure

Figure 7.6 shows the observed length frequency plot for Murray cod for each of the sampling seasons. The observed numbers of Young of the Year (YOY) ranged from 0 to 23, and 0% to 37% 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 12% (451 out of 3,654).

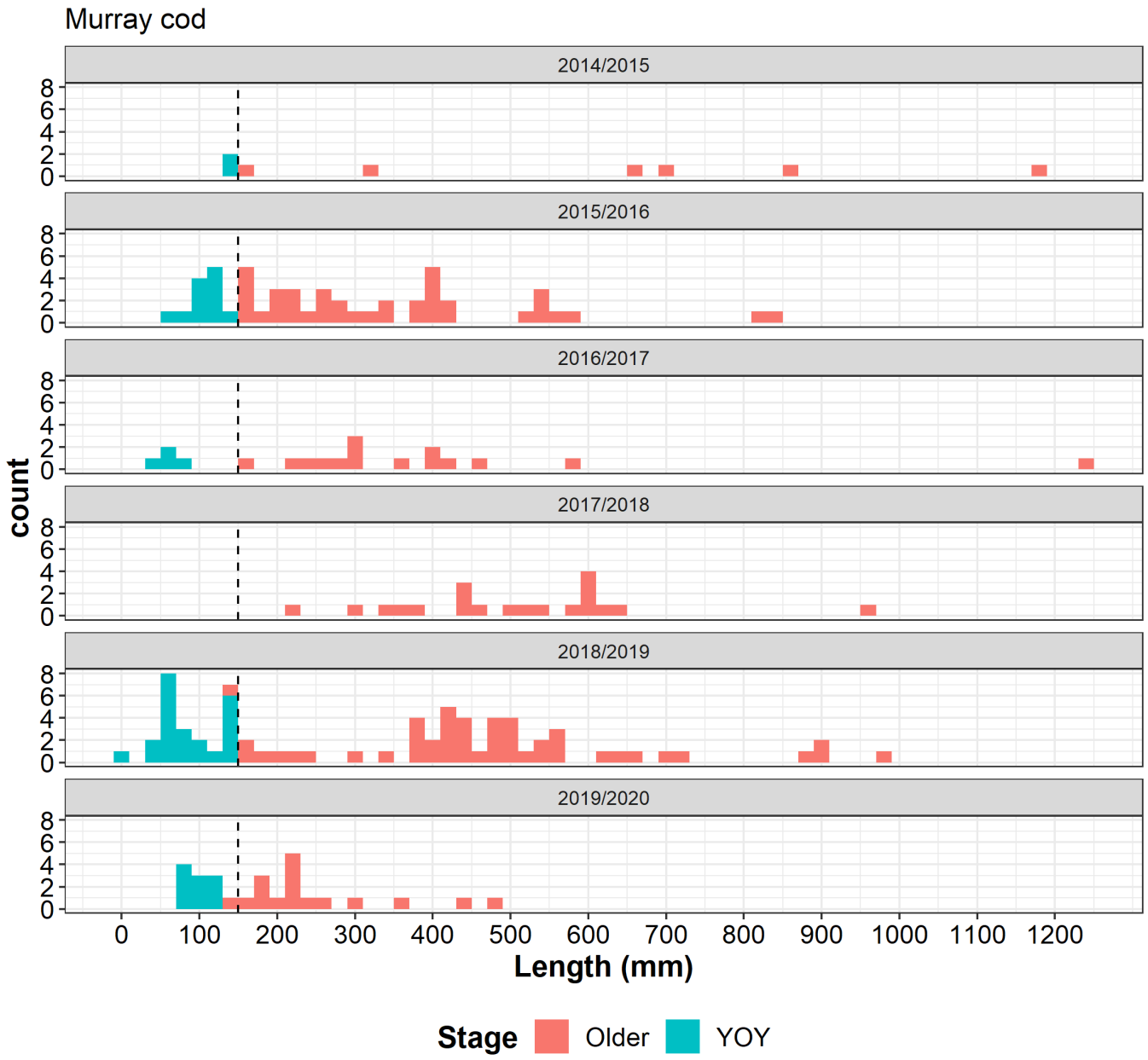

Figure 7.6: Length frequency plots for Murray cod by sampling season. YOY represents Young of the Year fish.

Summary Statement:

Regular recruitment but variable numbers of YOY, with a range of size classes but relatively few large fish (no fish above 500mm in 2019/20). There appears to have been recruitment failure in 2017/18.

Stocking

A total of 876,899 Murray cod were stocked into the waterways of the Murrumbidgee WRPA during the reporting period. Of these fish, 575,586 (66%) were stocked into impoundments while 301,313 (34%) were stocked into rivers or creeks. Table 7.4 shows the detailed breakdown of stocking by season, location and life stage while Figure 7.7 shows the locations of stocking.

Table 7.4: Number and life stage of stocked Murray cod each sampling season.

Sampling Season	River/Creek or Impoundment	Life Stage	Number Stocked
2014/2015	Impoundment	Fry	96,776
2014/2015	River/Creek	Fry	68,267
2015/2016	Impoundment	Fry	91,300
2015/2016	River/Creek	Fry	71,757
2016/2017	Impoundment	Fingerling	6,198
2016/2017	Impoundment	Fry	104,788
2016/2017	River/Creek	Fingerling	61,348
2016/2017	River/Creek	Fry	4,000
2017/2018	Impoundment	Fry	3,444
2017/2018	River/Creek	Fry	28,322
2018/2019	Impoundment	Fry	64,670
2018/2019	River/Creek	Fry	46,178
2019/2020	Impoundment	Fry	208,410
2019/2020	River/Creek	Fry	21,441

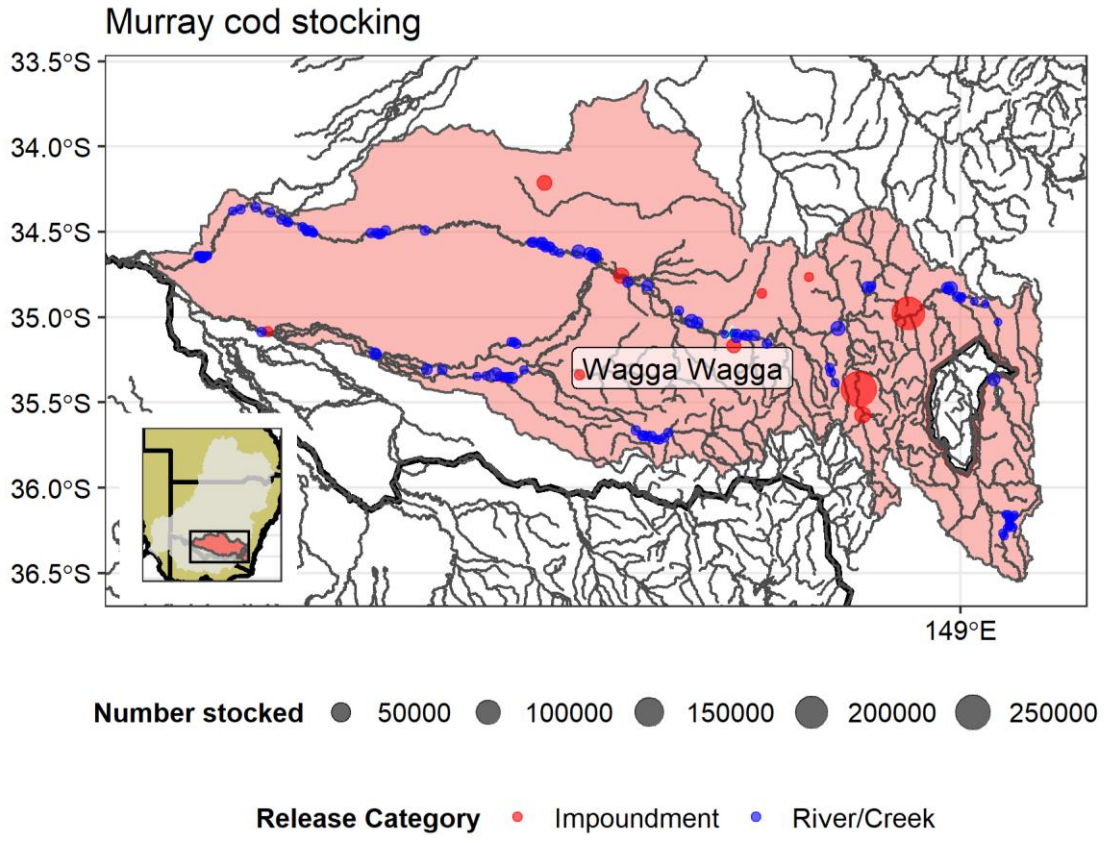

Figure 7.7: Locations of Murray cod stocking. Colours show whether a site was a river/creek site or an impoundment while the size of the point reflects the total number of fish stocked over the reporting period.

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 7.8 shows the abundance trend for the Murrumbidgee WRPA and the right-hand panel shows the overall trend across the NSW MDB.

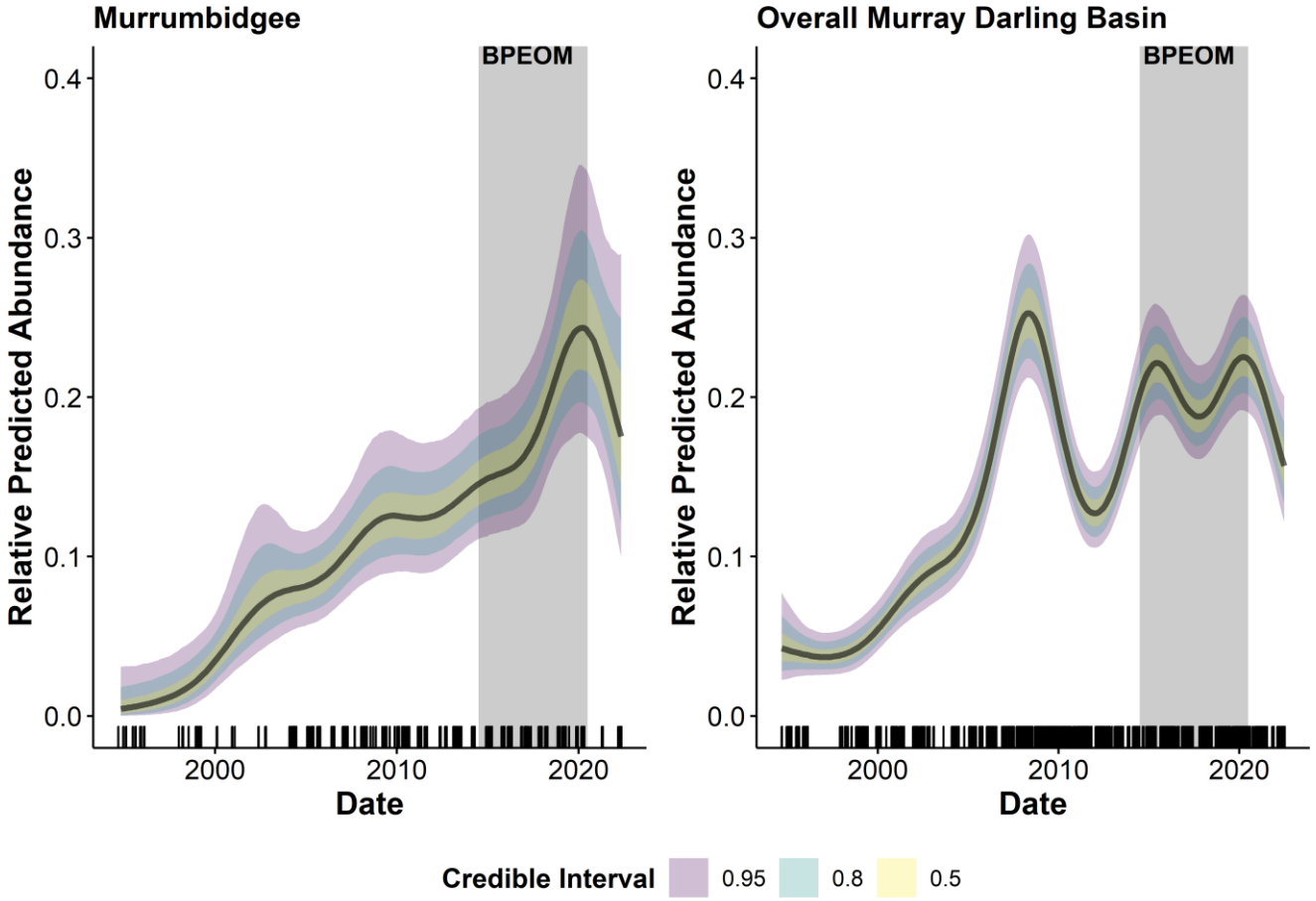

Figure 7.8: Relative abundance of Murray cod in both the Murrumbidgee WRPA and the overall NSW MDB. These are model estimates based upon all boat electrofishing data within the NSW DPI Freshwater ecosystem database and are the output of Bayesian generalised additive mixed models. The grey shaded region 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:

An overall increase in abundance since the 1990s, with a possible decline after the BPEOM period. Relative abundance approximately equal to overall abundance across the NSW MDB.

Health

The prevalence of any health issues ranged from 12% of sampled fish in 2014/2015 to 39% of sampled fish in 2015/2016 (Figure 7.9). The most common health issue for Murray cod in the Murrumbidgee WRPA was Lerneae, which was observed in a total of 50 fish, corresponding to 26% of all Murray cod measured.

Across the other NSW MDB WRPAs, 16% of Murray cod (592 out of 3,654 Murray cod) showed a health condition (excludes the Murrumbidgee WRPA).

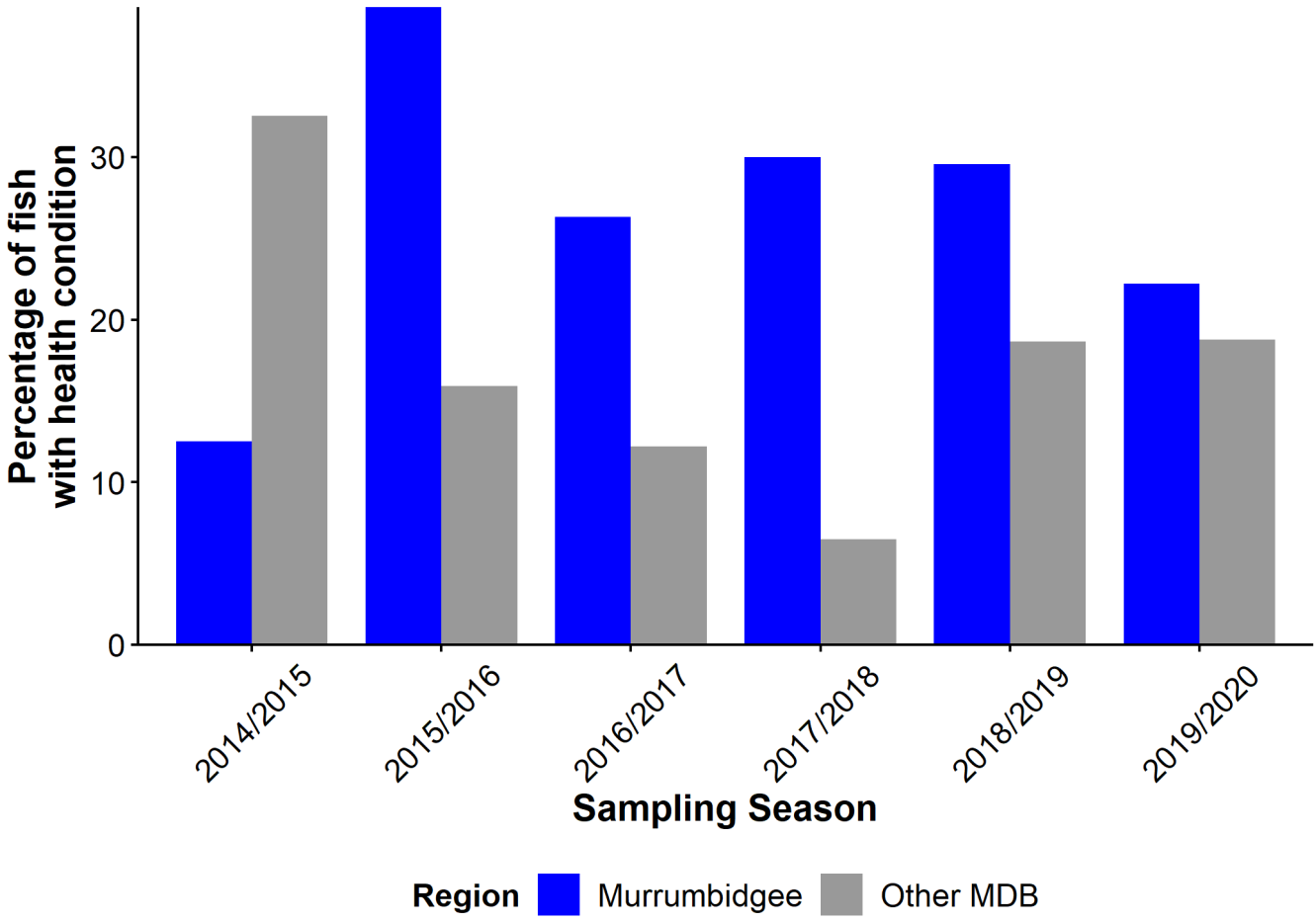

Figure 7.9: Timeseries showing the prevalence of health conditions in Murray cod. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPAs.

Summary Statement:

Presence of observable health conditions was moderate across all years but generally higher than the rest of the Murray-Darling Basin.

Distribution

Murray cod were recorded at 40 out of 165 sites in the Murrumbidgee WRPA. The maximum observed relative abundance at a site was 2 fish caught per 90 seconds of electrofishing. Figure 7.10 shows the distribution and relative abundance of Murray cod across the Murrumbidgee WRPA.

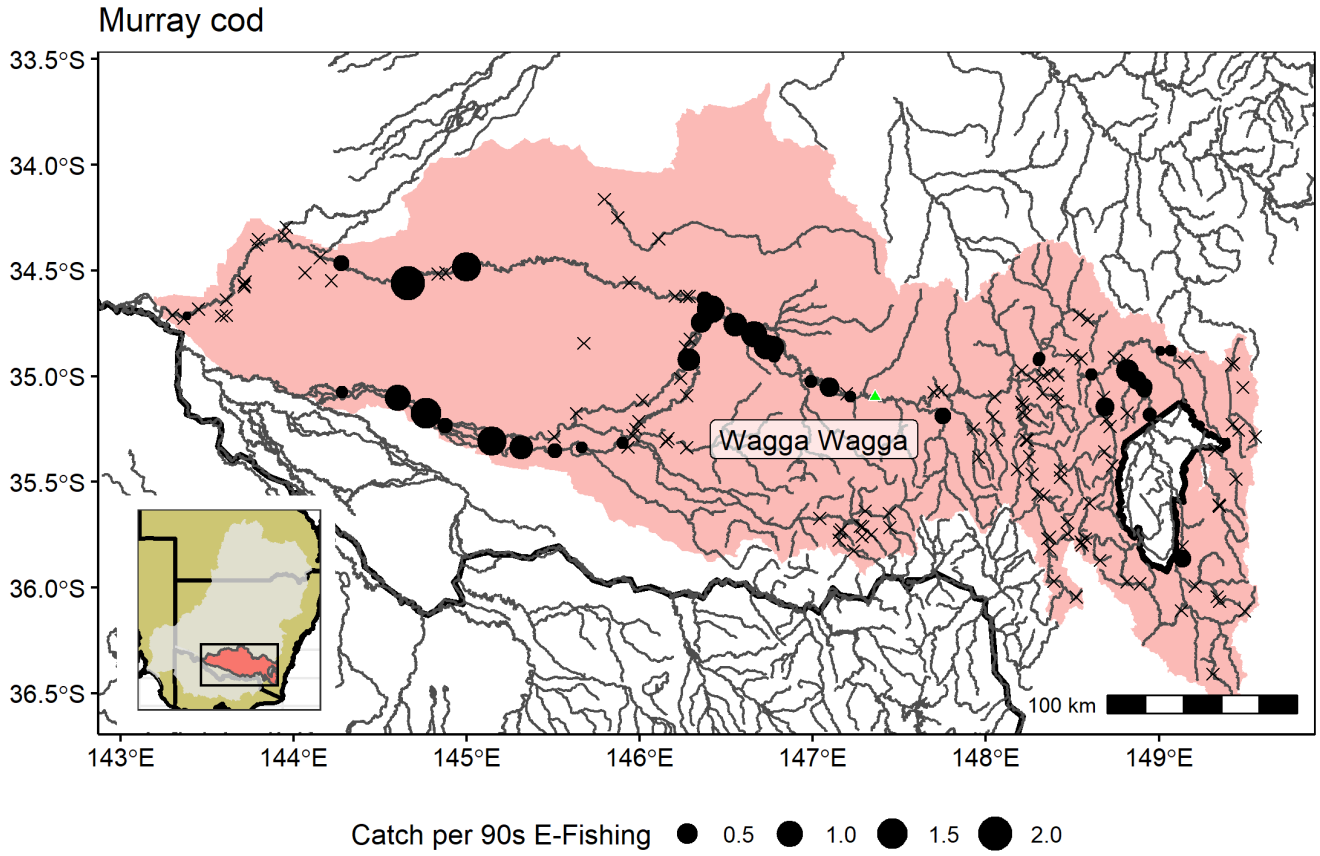

Figure 7.10: Distribution of Murray cod. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X.

Summary Statement:

Murray cod were recorded across the Murrumbidgee WRPA but most abundant in the mid-reaches.

Golden perch

Population Structure

Figure 7.11 shows the observed length frequency plot for Golden perch for each of the sampling seasons. The observed numbers of Young of the Year (YOY) ranged from 0 to 2, and 0% to 6% 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% (263 out of 2,143).

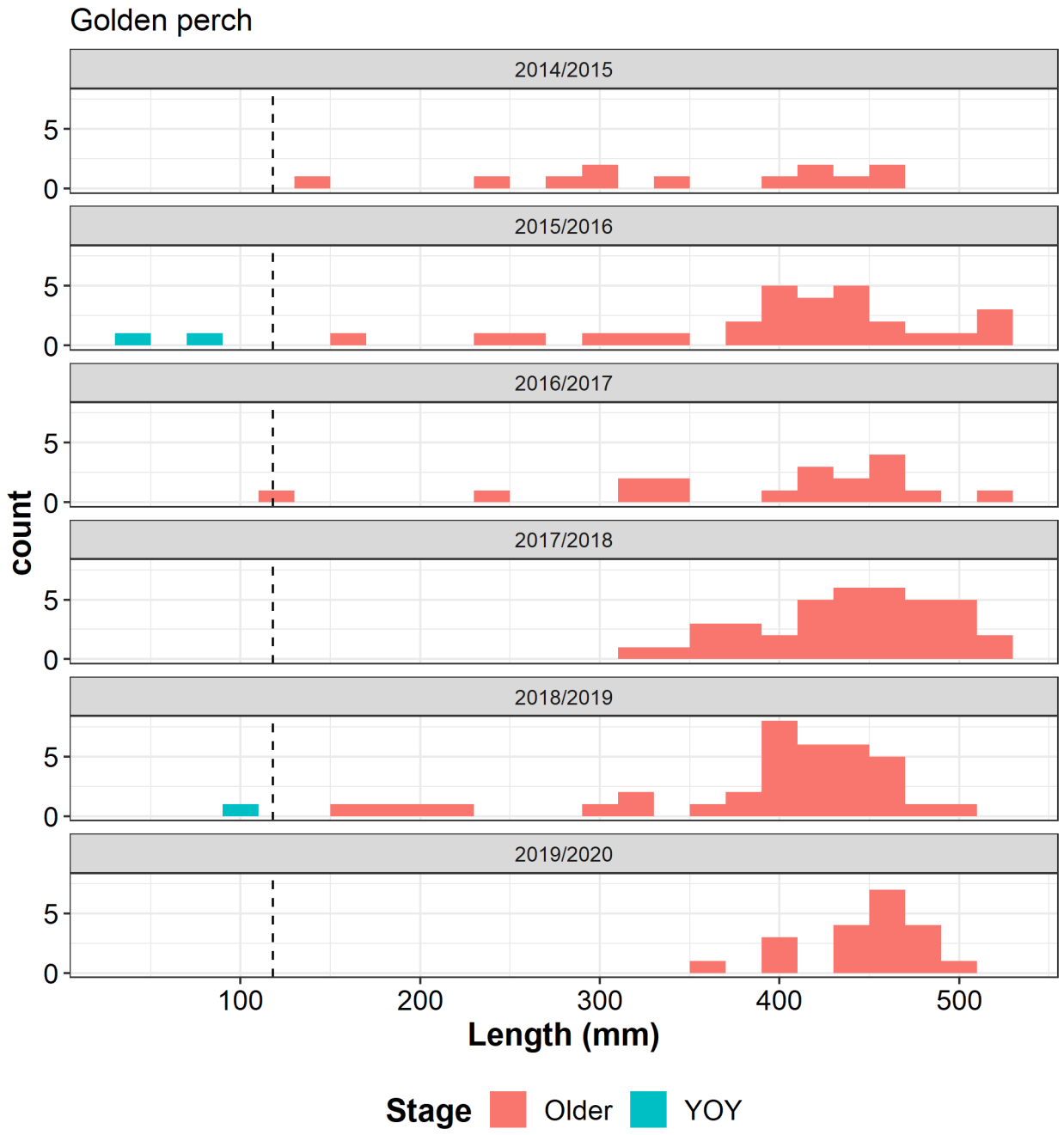

Figure 7.11: Length frequency plots for Golden perch by sampling season. YOY represents Young of the Year fish.

Summary Statement:

Limited or poor recruitment in most years with young of the year only observed in 2015/16 and 2018/19. Suggests recruitment limitation in most years. Population structure dominated by larger (older) fish.

Stocking

A total of 1,700,351 Golden perch were stocked into the waterways of the Murrumbidgee WRPA during the reporting period. Of these fish, 1007346 (59%) were stocked into impoundments while 693,005 (41%) were stocked into rivers or creeks. Table 7.5 shows the detailed breakdown of stocking by season, location and life stage while Figure 7.12 shows the locations of stocking.

Table 7.5: Number and life stage of stocked Golden perch each sampling season.

Sampling Season	River/Creek or Impoundment	Life Stage	Number Stocked
2014/2015	Impoundment	Fry	154261
2014/2015	River/Creek	Fry	110971
2015/2016	Impoundment	Fry	136000
2015/2016	River/Creek	Fry	140290
2016/2017	Impoundment	Fingerling	5682
2016/2017	Impoundment	Fry	235576
2016/2017	River/Creek	Fingerling	167515
2016/2017	River/Creek	Fry	5000
2017/2018	Impoundment	Fry	222071
2017/2018	River/Creek	Fry	154936
2018/2019	Impoundment	Fry	130000
2018/2019	River/Creek	Fry	68838
2019/2020	Impoundment	Fry	123756
2019/2020	River/Creek	Fry	45455

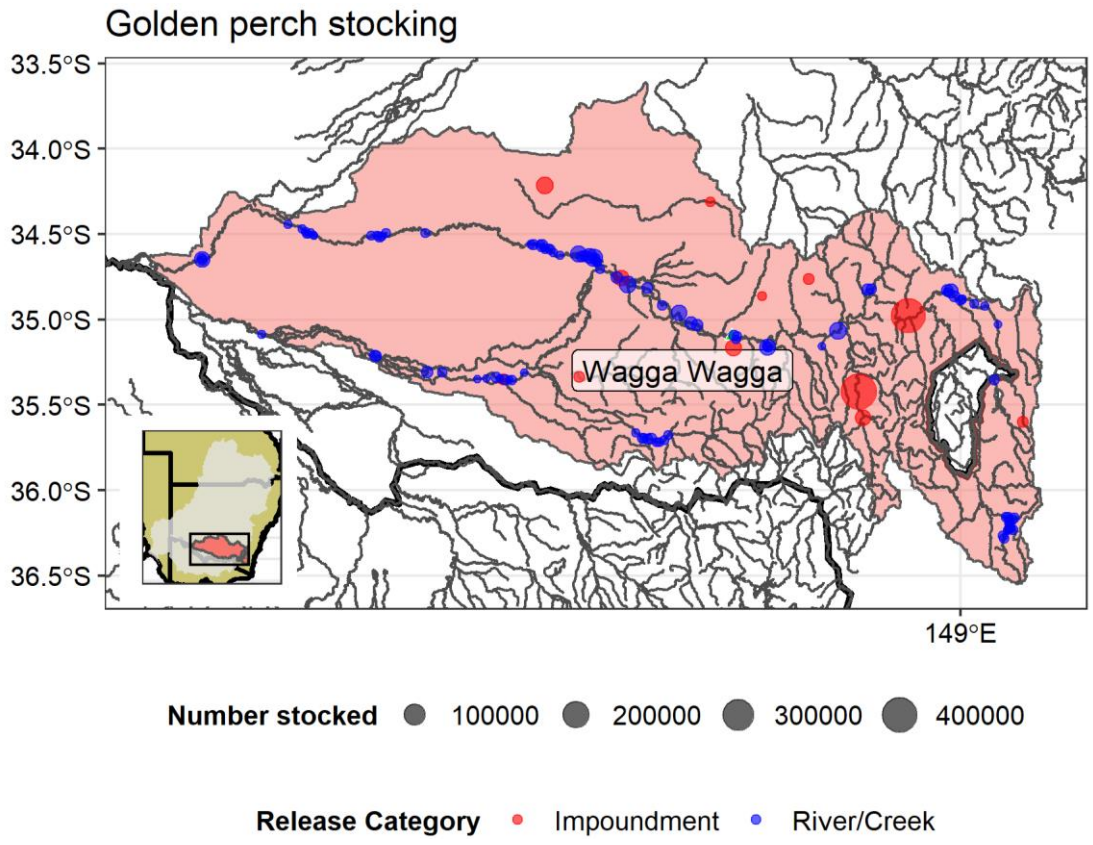

Figure 7.12: Locations of Golden perch stocking. Colours show whether a site was a river/creek site or an impoundment while the size of the point reflects the total number of fish stocked over the reporting period.

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 7.13 shows the abundance trend for the Murrumbidgee WRPA and the right-hand panel shows the overall trend across the NSW MDB.

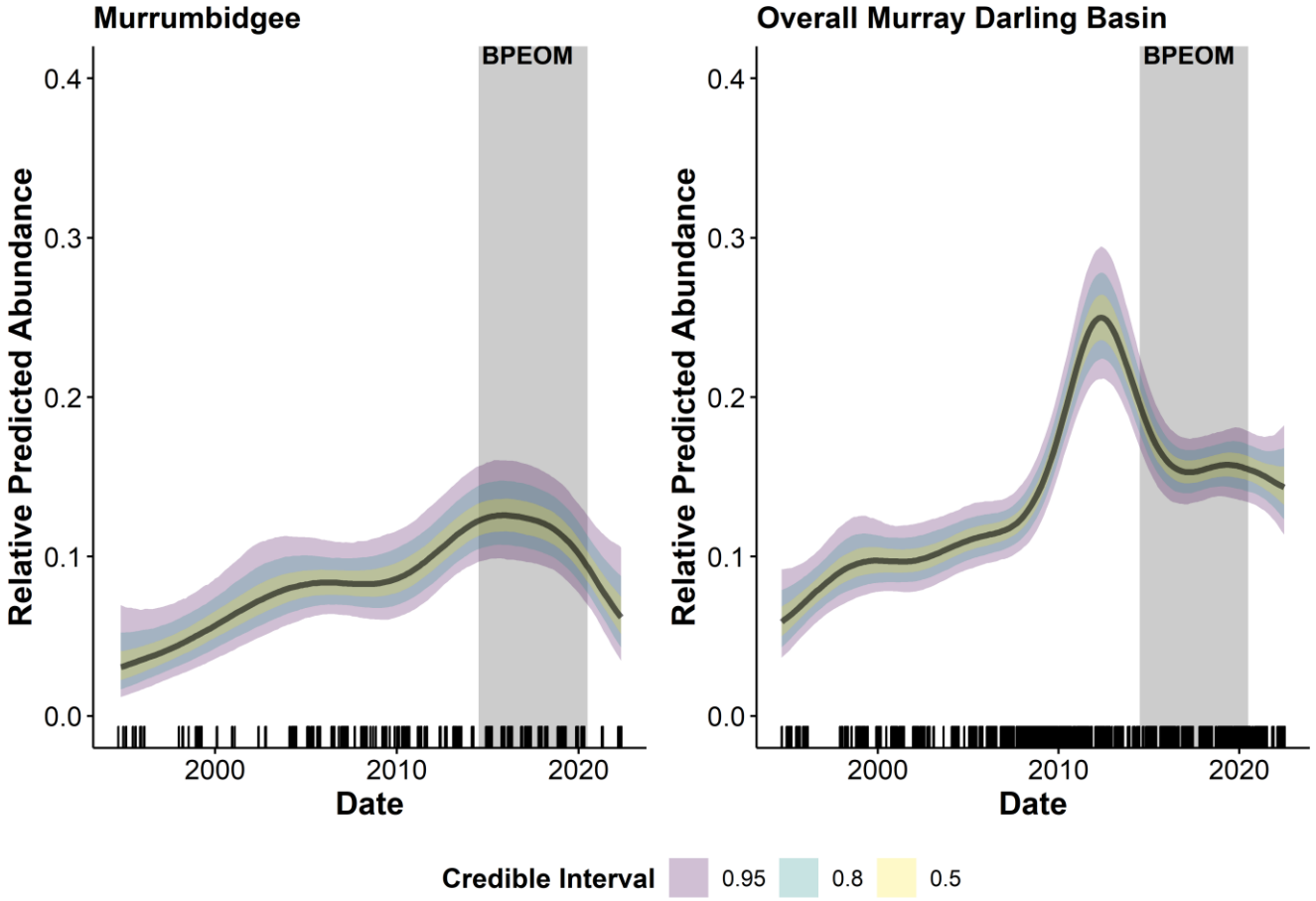

Figure 7.13: Relative abundance of Golden perch in both this valley and the overall Murray-Darling Basin. These are model estimates based upon all boat electrofishing data within the NSW DPI Freshwater ecosystem database and the output of Bayesian generalised additive mixed models. The grey shaded region 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:

Current abundance slightly higher than 1994 levels. Abundance previously peaked around 2017 but has since declined. Relative abundance is lower than the overall abundance across the MDB, which peaked around 2012.

Health

The prevalence of any health issues ranged from 25% of sampled fish in 2014/2015 to 65% of sampled fish in 2019/2020 (Figure 7.14). The most common health issue for Golden perch in the Murrumbidgee water resource planning area was Lerneae, which was observed in a total of 39 fish, corresponding to 25% of all Golden perch measured.

Across the other WRPAs, 33% of Golden perch (704 out of 2,143 Golden perch) showed a health condition (excludes Murrumbidgee).

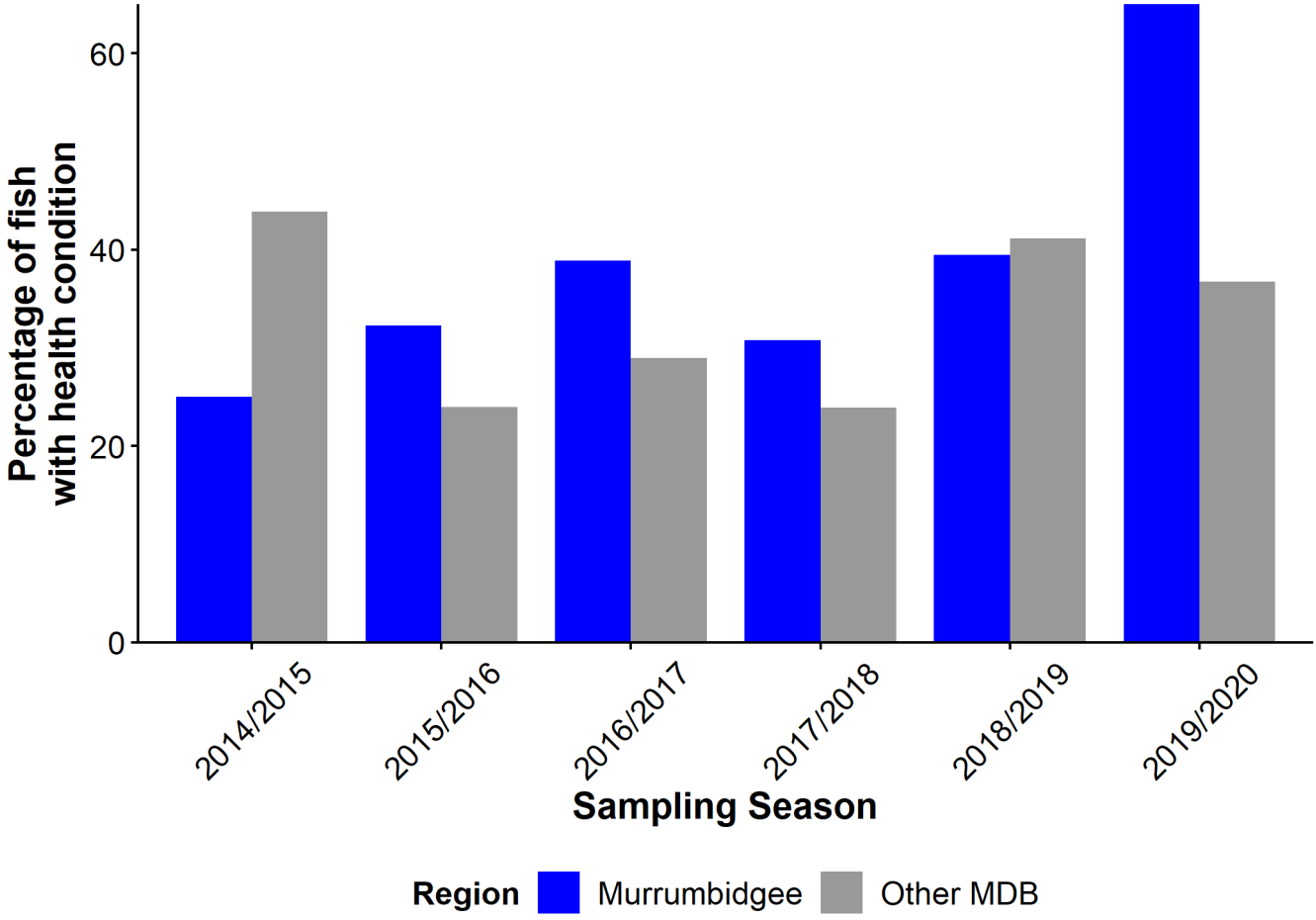

Figure 7.14: Timeseries showing the prevalence of health conditions in Golden perch. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPAs.

Summary Statement:

The presence of observable health conditions for Golden perch in the Murrumbidgee WRPA was moderate to high, similar to the overall NSW MDB. 2019/20 had a substantially higher prevalence of health issues compared to the wider NSW MDB.

Distribution

Golden perch were recorded at 46 out of 165 sites in the Murrumbidgee WRPA. The maximum observed relative abundance at a site was 0.9 fish caught per 90 seconds of electrofishing. Figure 7.15 shows the distribution and relative abundance of Golden perch across the Murrumbidgee WRPA.

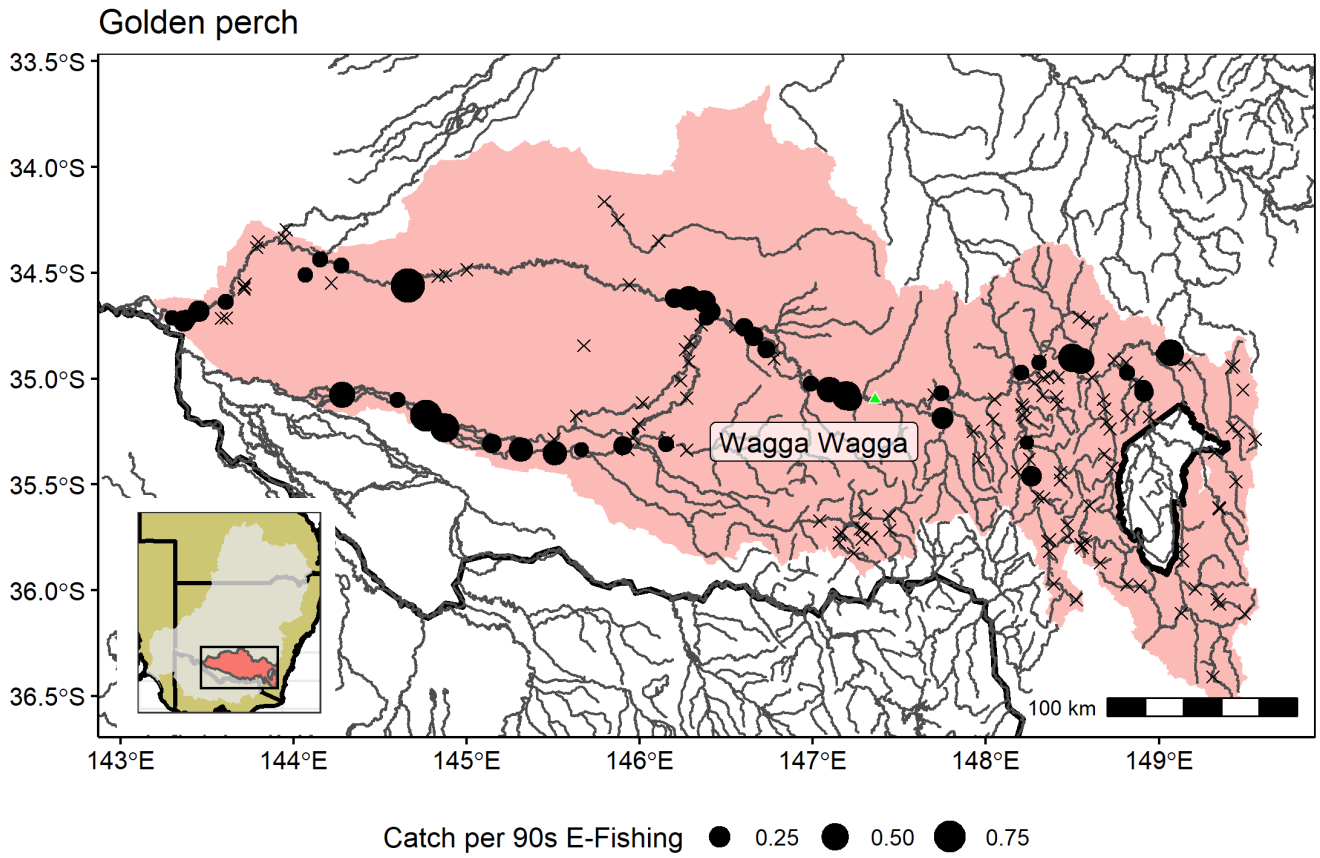

Figure 7.15: Distribution of Golden perch. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X.

Summary Statement:

Golden perch were distributed across the Murrumbidgee WRPA with the reduced abundance in upland areas.

Freshwater catfish

Population Structure

Figure 7.16 shows the observed length frequency plot for Freshwater catfish for each of the sampling seasons. Only 1 individual was observed (2019/20). It was of mature size.

Overall, during the BPEOM-F program, across all the MDB water resource planning areas, the percentage YOY for Freshwater catfish was 44% (283 out of 643).

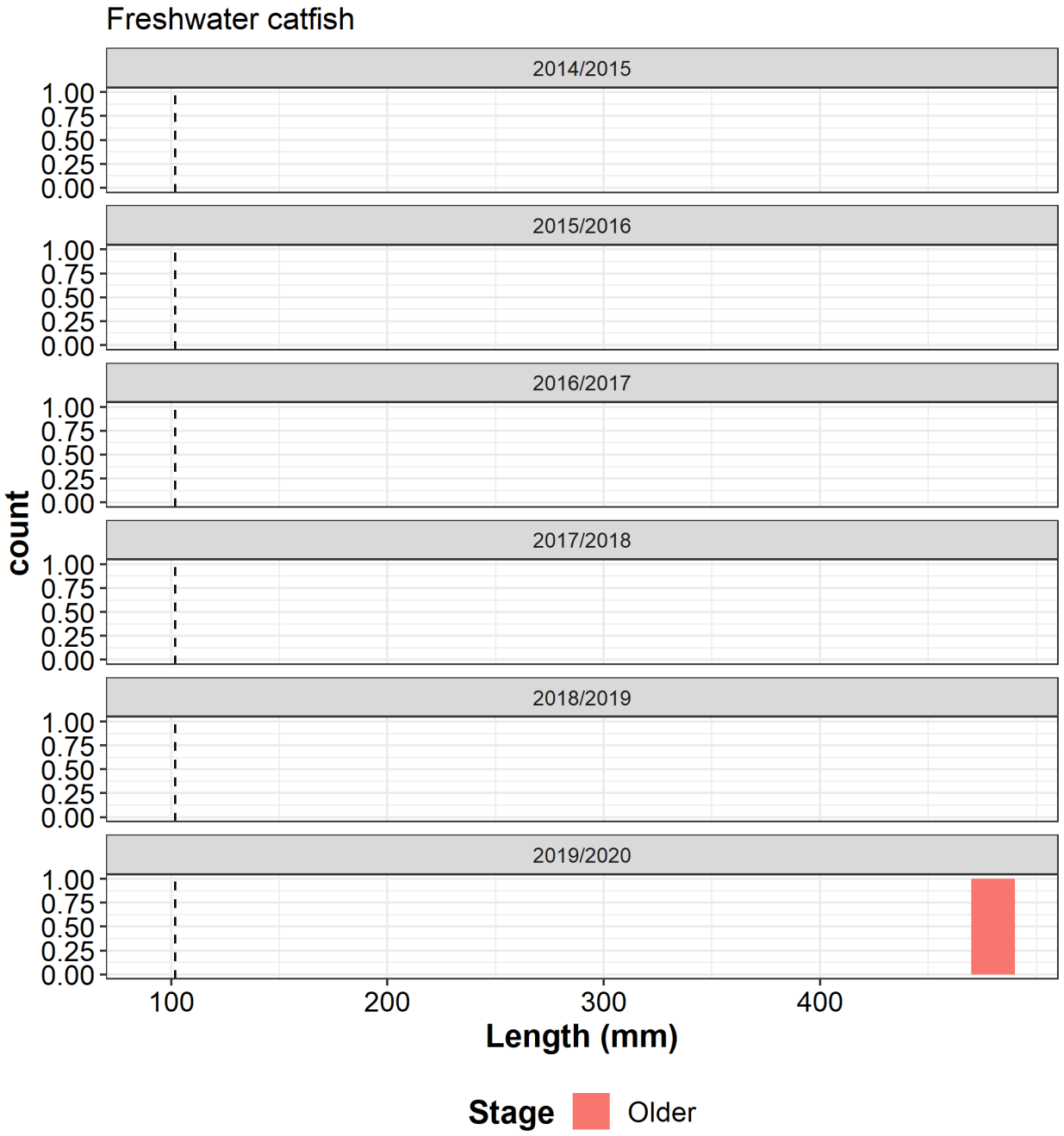

Figure 7.16: Length frequency plots for Freshwater catfish by sampling season. YOY represents Young of the Year fish.

Summary Statement:

Only 1 adult Freshwater catfish was caught, suggesting very low abundance and limited recruitment.

Temporal Trends in Abundance

We have modelled the relative abundance of Freshwater catfish since 1994 based on all suitable boat and backpack electrofishing data. There was insufficient data to model any abundance trends in the Murrumbidgee for Freshwater catfish (Figure 7.17).

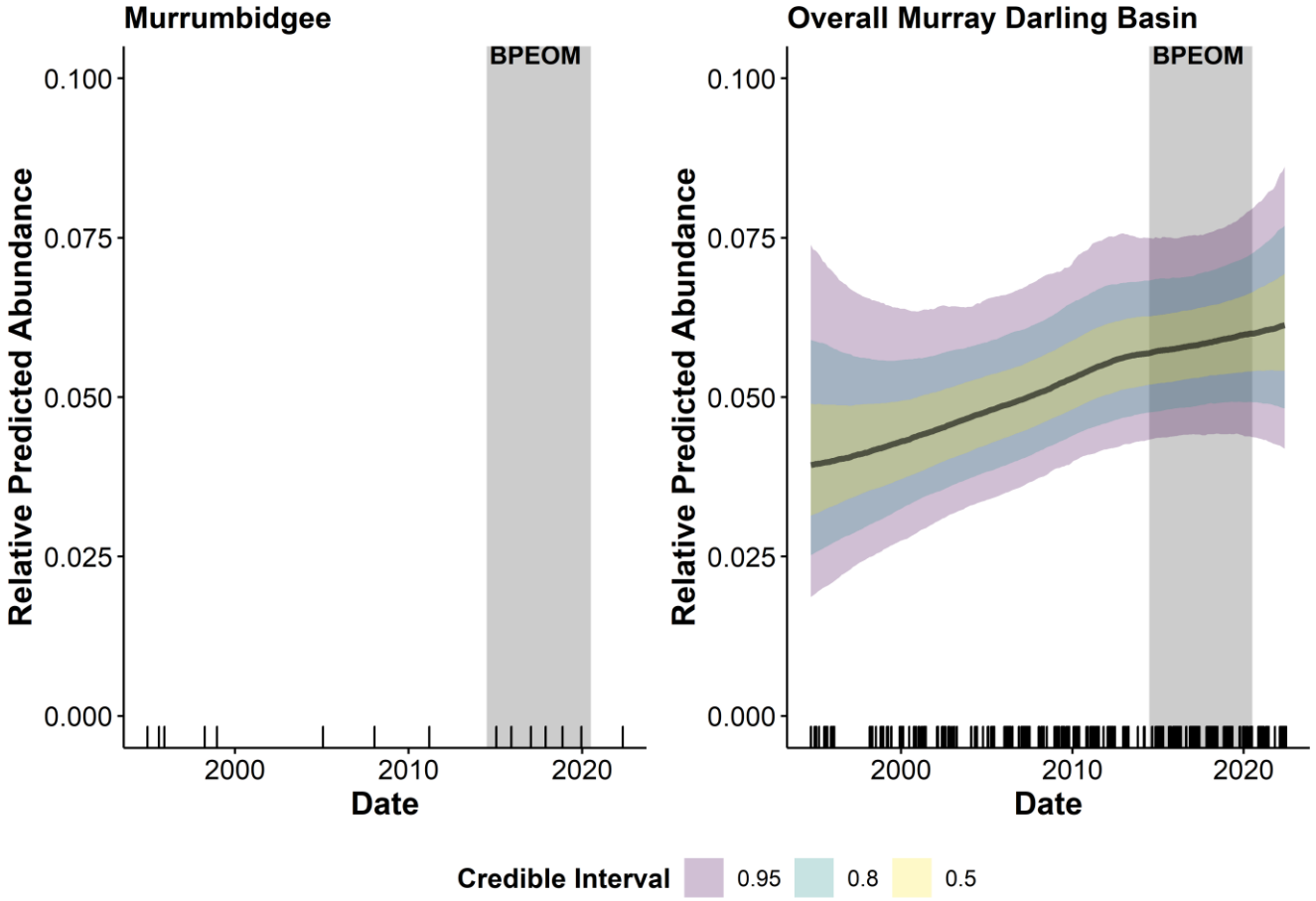

Figure 7.17: Relative abundance of Freshwater catfish in both this valley and the overall Murray-Darling Basin. Note there was insufficient data to model the abundance of Freshwater catfish, hence the empty plot. These are model estimates based upon all electrofishing data within the NSW DPI Freshwater 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:

There is insufficient data to draw any conclusions abundance trends of Freshwater catfish in the Murrumbidgee WRPA but abundance is likely to be very low.

Health

The single Freshwater catfish sampled in the Murrumbidgee WRPA did not show any health conditions (Figure 7.18).

Across the other WRPAs, 1% of Freshwater catfish (8 out of 643 Freshwater catfish) showed a health condition (excludes Murrumbidgee).

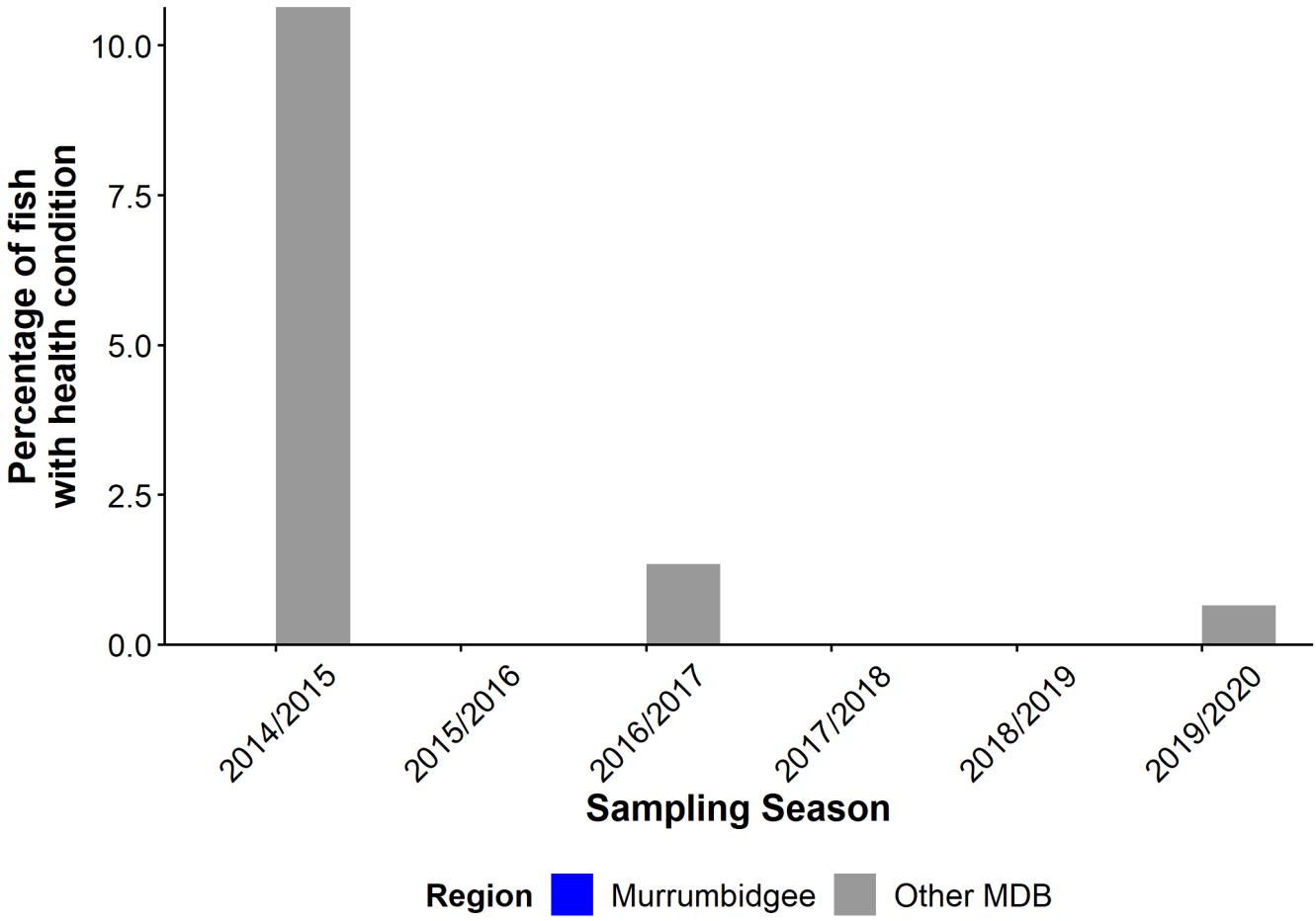

Figure 7.18: Timeseries showing the prevalence of health conditions in Freshwater catfish. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPAs.

Summary Statement:

No health issues were observed in the single Freshwater catfish caught. Overall, in the NSW MDB Freshwater catfish have few observed health issues.

Distribution

Freshwater catfish were recorded at 1 out of 165 sites in the Murrumbidgee WRPA. The maximum observed relative abundance at a site was 0.02 fish caught per 90 seconds of electrofishing. Figure 7.19 shows the distribution and relative abundance of Freshwater catfish across the Murrumbidgee WRPA.

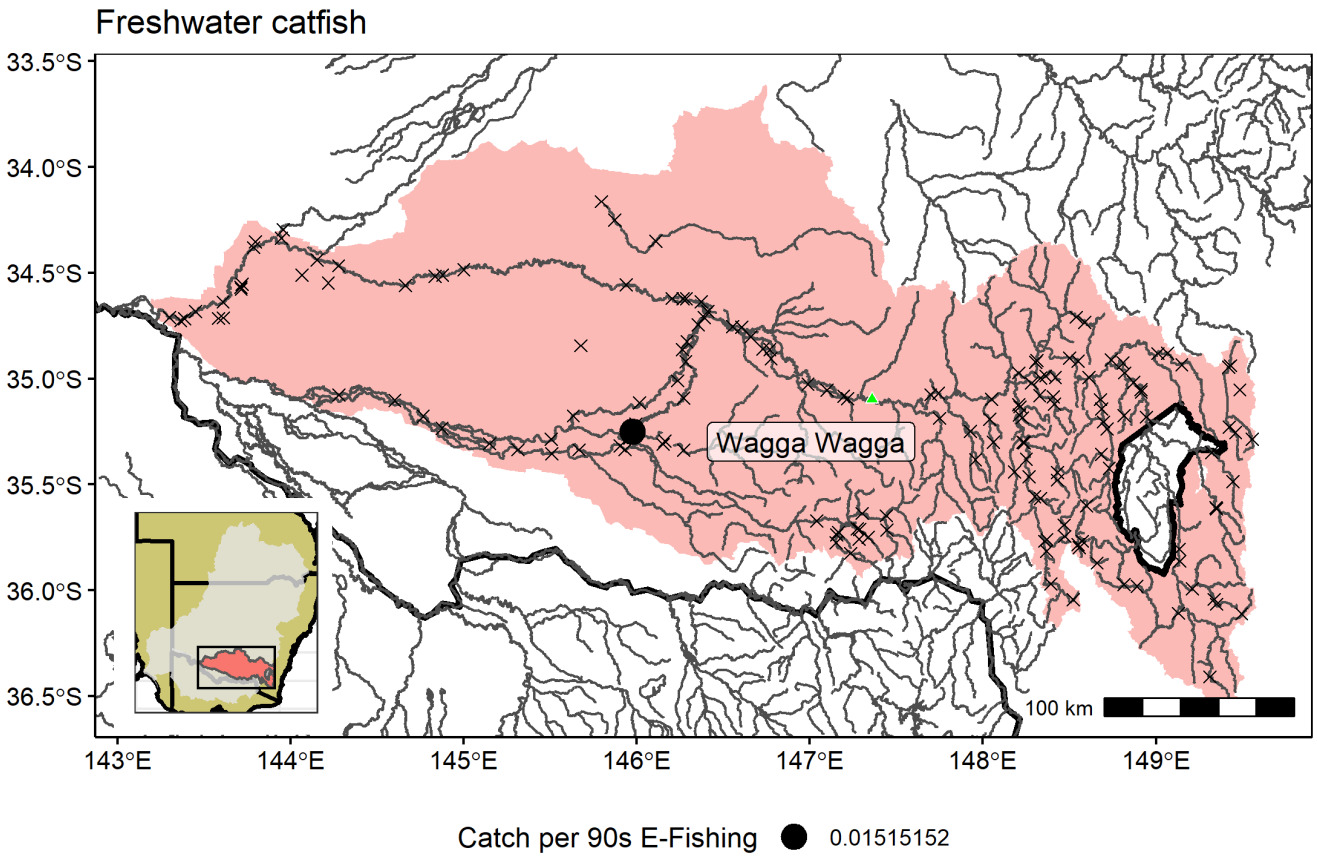

Figure 7.19: Distribution of Freshwater catfish. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X.

Summary Statement:

Freshwater catfish appear to be in very low abundance and possibly restricted to the area surrounding Columbo Creek, being absent in most of the region.

Bony herring

Population Structure

Figure 7.20 shows the observed length frequency plot for Bony herring for each of the sampling seasons. The observed numbers of Young of the Year (YOY) ranged from 0 to 41, and 0% to 53% 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 31% (4,946 out of 16,050). Bony herring are not a stocked species.

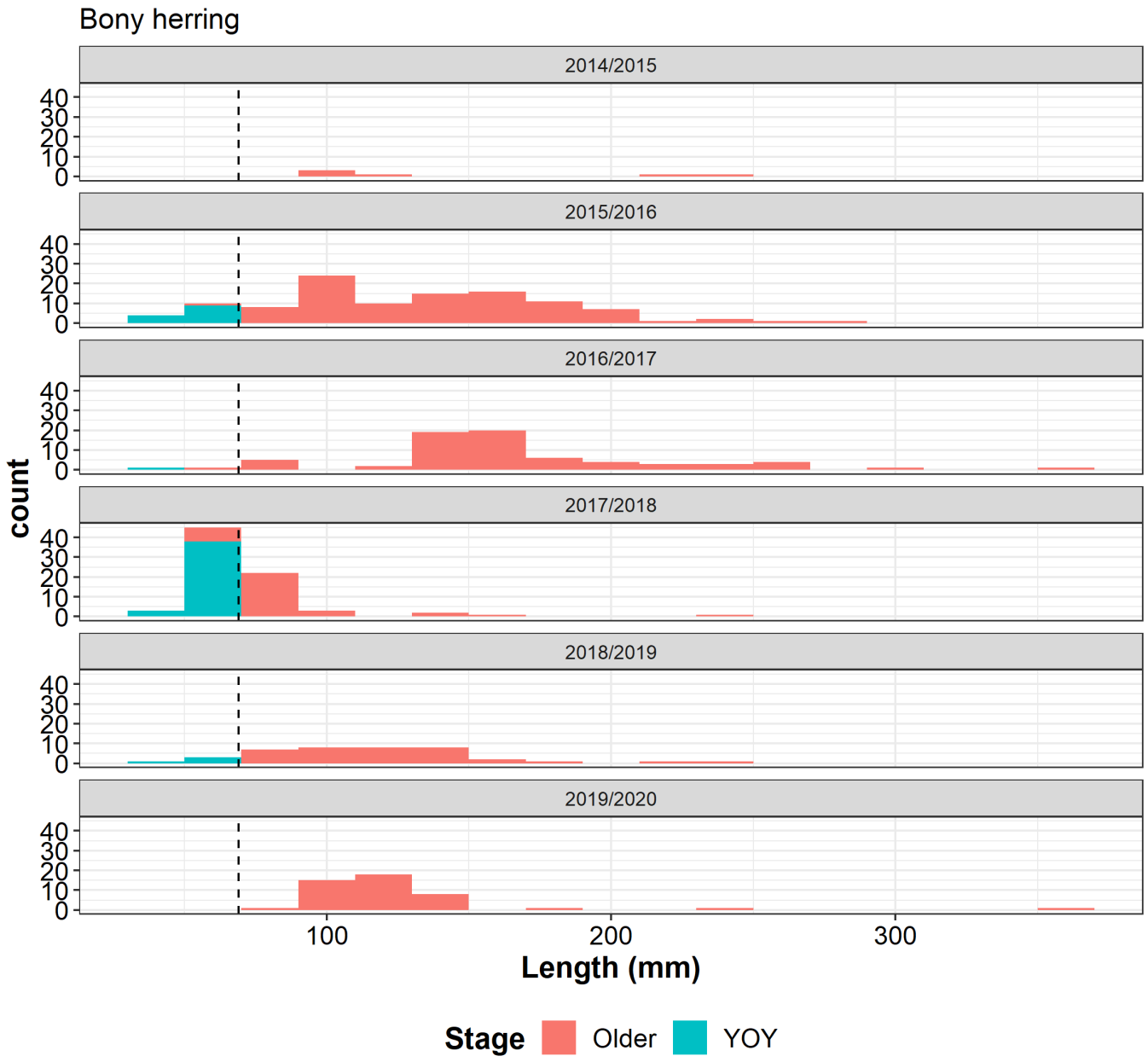

Figure 7.20: Length frequency plots for Bony herring by sampling season. YOY represents Young of the Year fish.

Summary Statement:

Variable recruitment with possible recruitment failure in 2014/15 and 2019/20. 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 7.21 shows the abundance trend for the Murrumbidgee WRPA and the right-hand panel shows the overall trend across the NSW MDB.

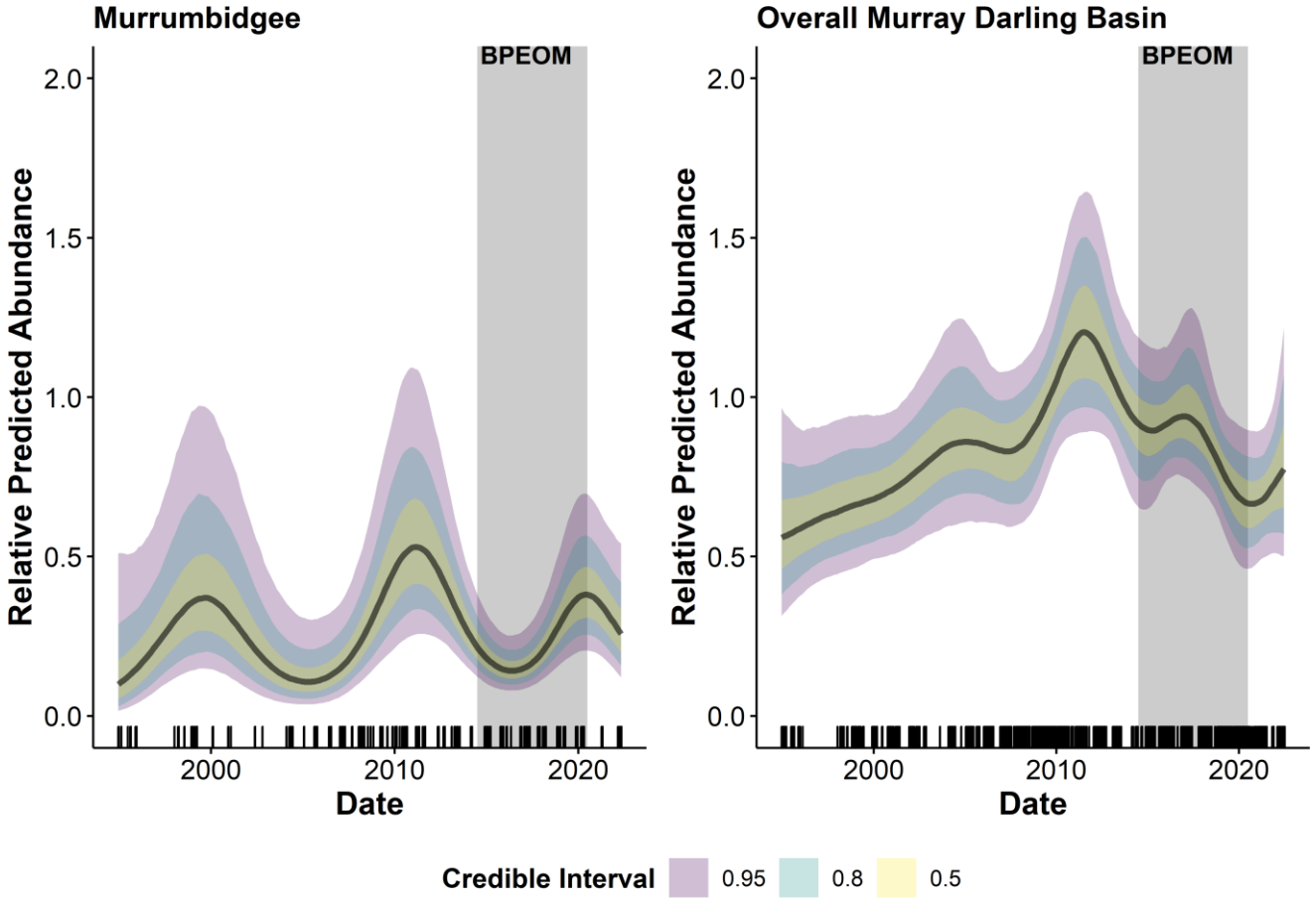

Figure 7.21: Relative abundance of Bony herring in both the Murrumbidgee WRPA and the overall NSW MDB. These are model estimates based upon all boat electrofishing data within the NSW DPI Freshwater ecosystem database and the output of Bayesian generalised additive mixed models. The grey shaded region 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:

Abundance likely to be slightly higher than 1994 levels but recent years have seen large fluctuations. Abundance is currently lower than the overall NSW MDB.

Health

The prevalence of any health issues ranged from 0 % of sampled fish in 2014/2015 to 1% of sampled fish in 2016/2017 (Figure 7.22). The most common health issue for Bony herring in the Murrumbidgee WRPA was Lerneae, which was observed in a total of 1 fish, corresponding to <1% of all Bony herring measured.

Across the other NSW MDB WRPAs, 1.2% of Bony herring (191 out of 16,050 Bony herring) showed a health condition (excludes the Murrumbidgee WRPA).

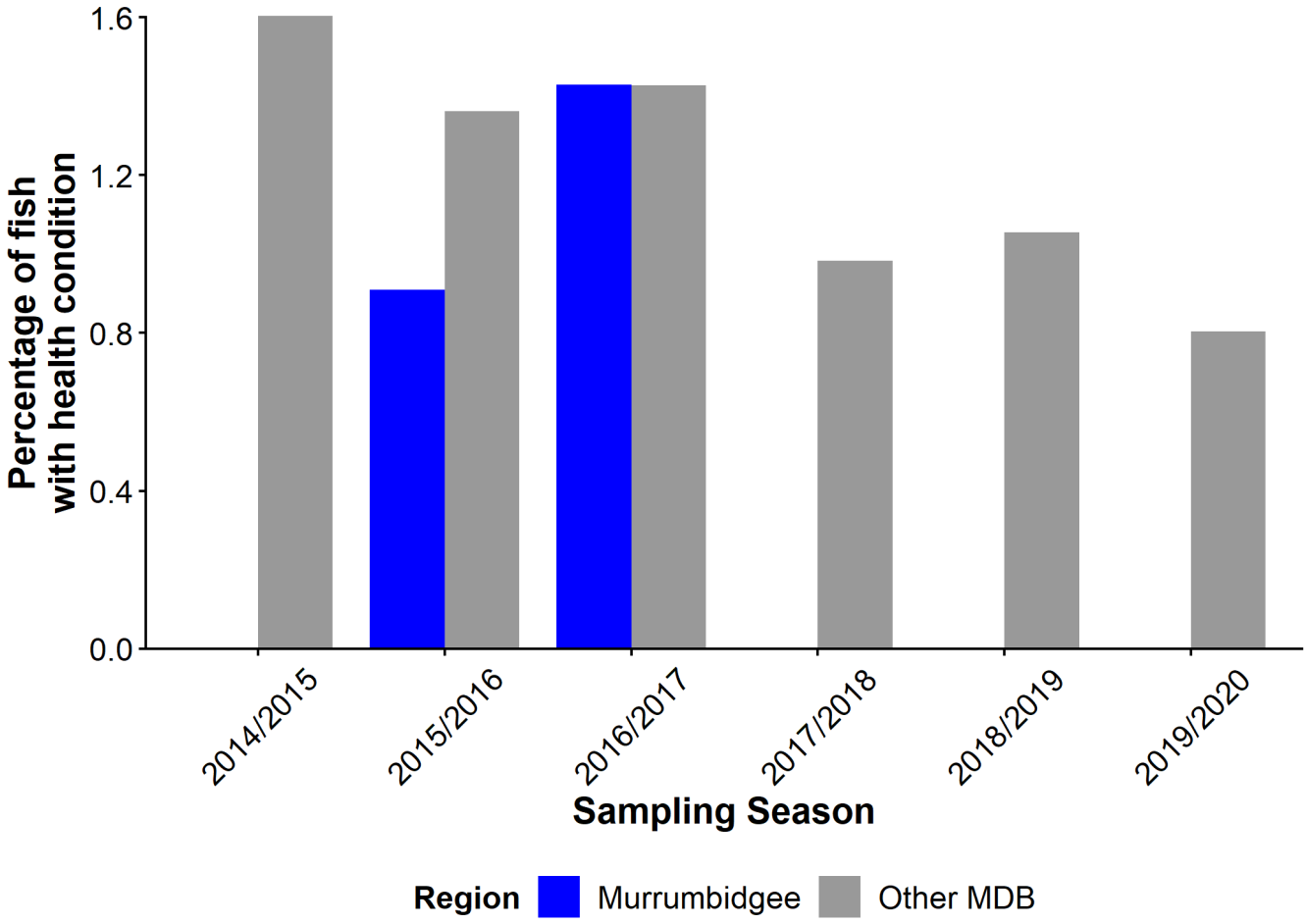

Figure 7.22: Timeseries showing the prevalence of health conditions in Bony herring. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPAs.

Summary Statement:

Presence of observable health conditions was low overall and lower or equal to the rest of the NSW MDB in all years.

Distribution

Bony herring were recorded at 21 out of 165 sites in the Murrumbidgee WRPA. The maximum observed relative abundance at a site was 4.75 fish caught per 90 seconds of electrofishing. Figure 7.23 shows the distribution and relative abundance of Bony herring across the Murrumbidgee WRPA.

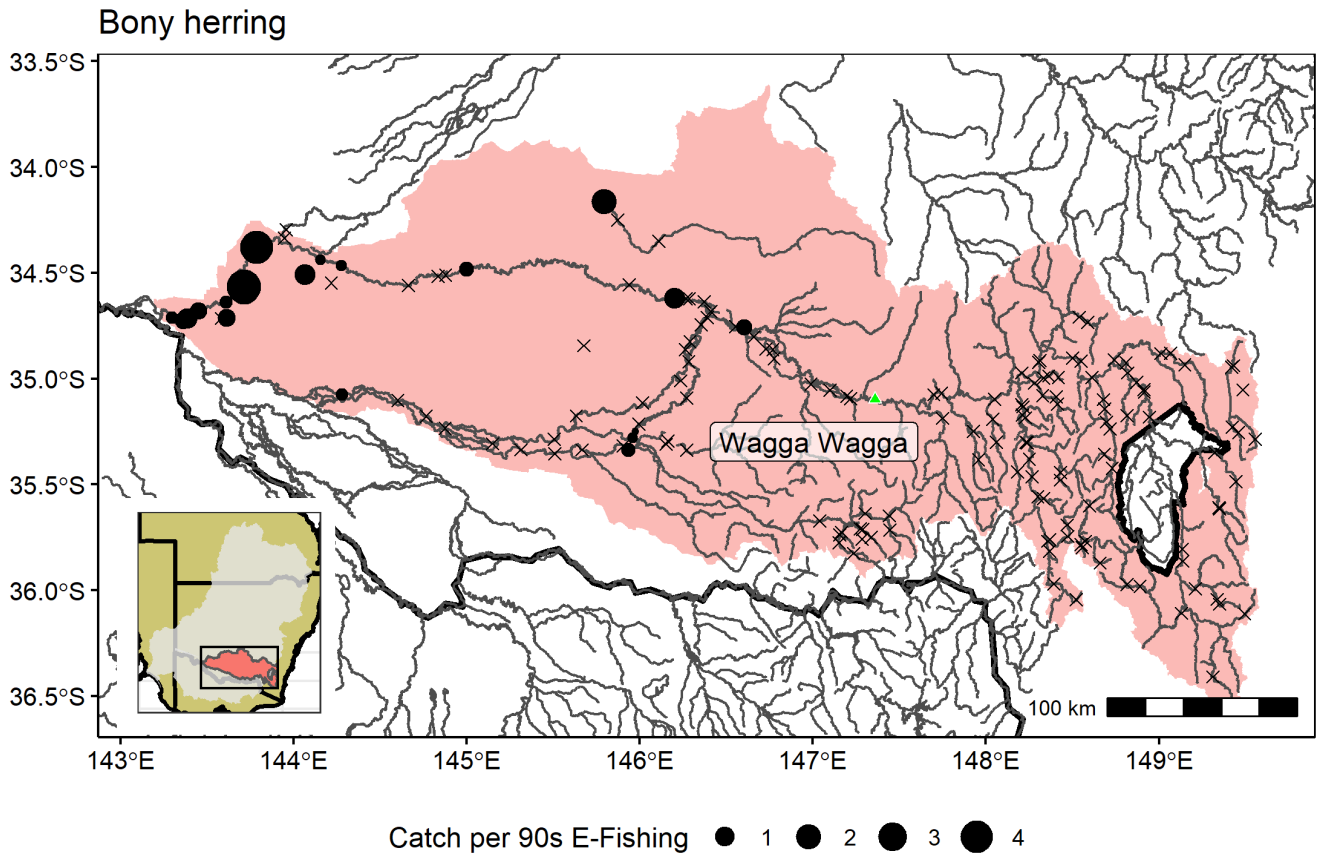

Figure 7.23: Distribution of Bony herring. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X.

Summary Statement:

Bony herring were recorded across western half of the Murrumbidgee WRPA but absent in eastern and upland sites. Abundance was highest in the downstream reaches.

Australian smelt

Population Structure

Figure 7.24 shows the observed length frequency plot for Australian smelt for each of the sampling seasons. The observed numbers of Young of the Year (YOY) ranged from 8 to 156, and 10% to 44% 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 46% (3,329 out of 7,290). Australian smelt are not a stocked species.

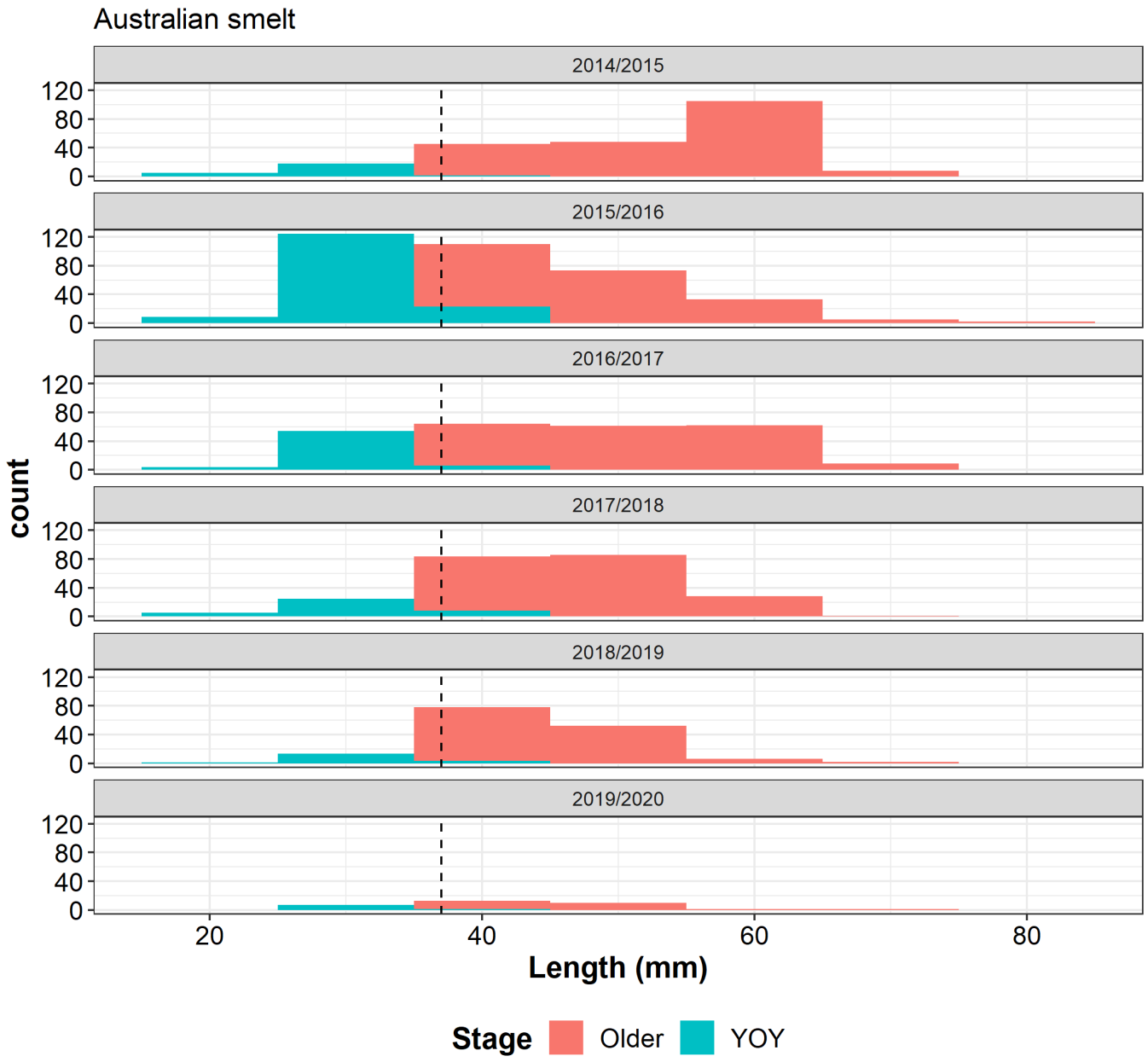

Figure 7.24: Length frequency plots for Australian smelt by sampling season. YOY represents Young of the Year fish.

Summary Statement:

Evidence of recruitment in all years with a peak in 2015/16.

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 7.25 shows the abundance trend for the Murrumbidgee WRPA and the right-hand panel shows the overall trend across the NSW MDB.

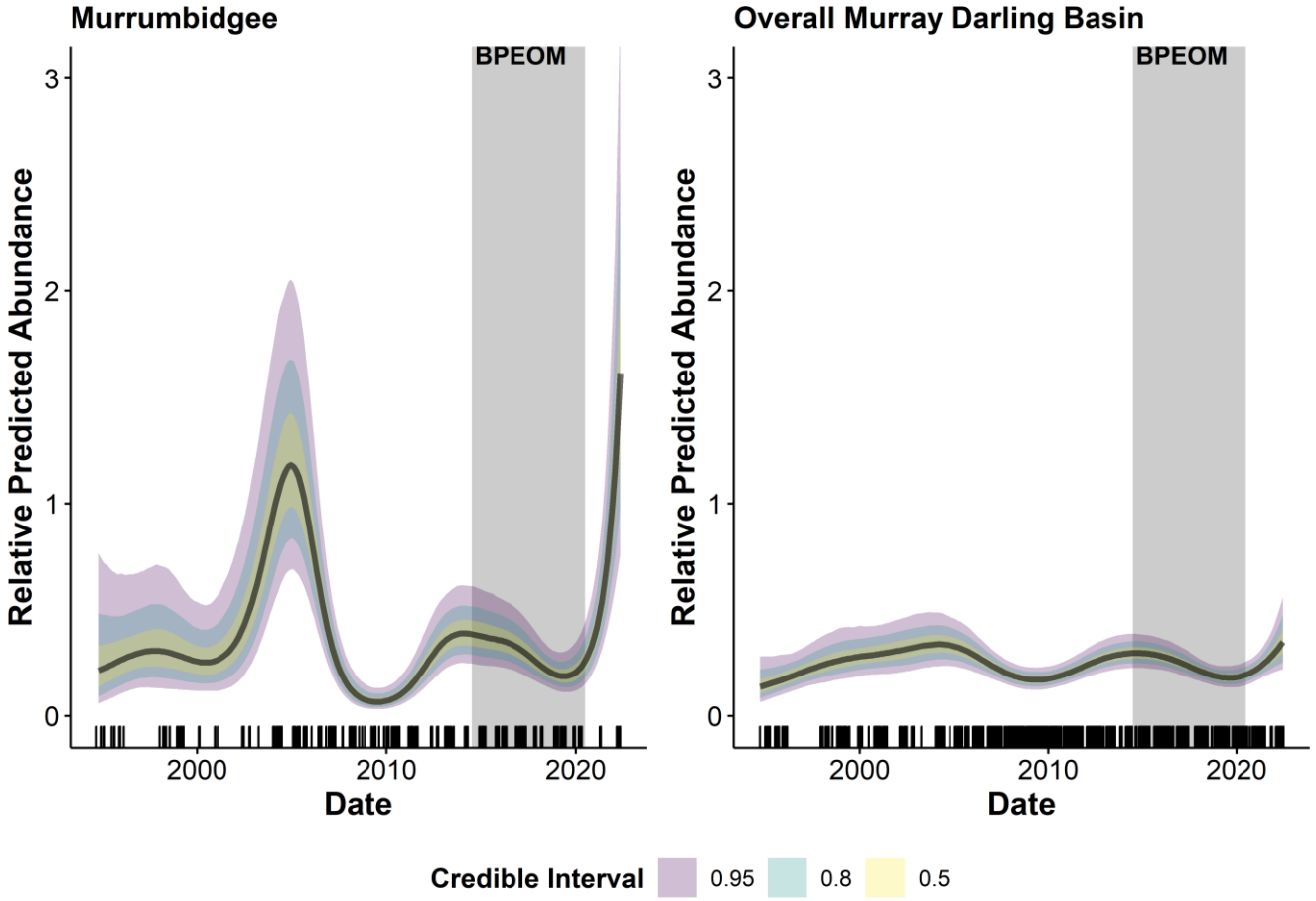

Figure 7.25: Relative abundance of Australian smelt in both the Murrumbidgee WRPA and the overall NSW MDB. These are model estimates based upon all boat electrofishing data within the NSW DPI Freshwater ecosystem database and the output of Bayesian generalised additive mixed models. The grey shaded region 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:

Abundance has increased substantially since the 1990s (driven by an increase post-2020) and is currently higher than the overall NSW MDB. During the BPEOM-F period, abundance was slightly higher than the overall NSW MDB.

Health

The prevalence of any health issues ranged from 0% of sampled fish in 2014/2015 to 1% of sampled fish to 2018/2019 (Figure 7.26). The most common health issue for Australian smelt in the Murrumbidgee WRPA was Deformity, which was observed in a total of 2 fish, corresponding to <1% of all Australian smelt measured.

Across the other NSW MDB WRPAs, 1% of Australian smelt (51 out of 7,290 Australian smelt) showed a health condition (excludes the Murrumbidgee WRPA).

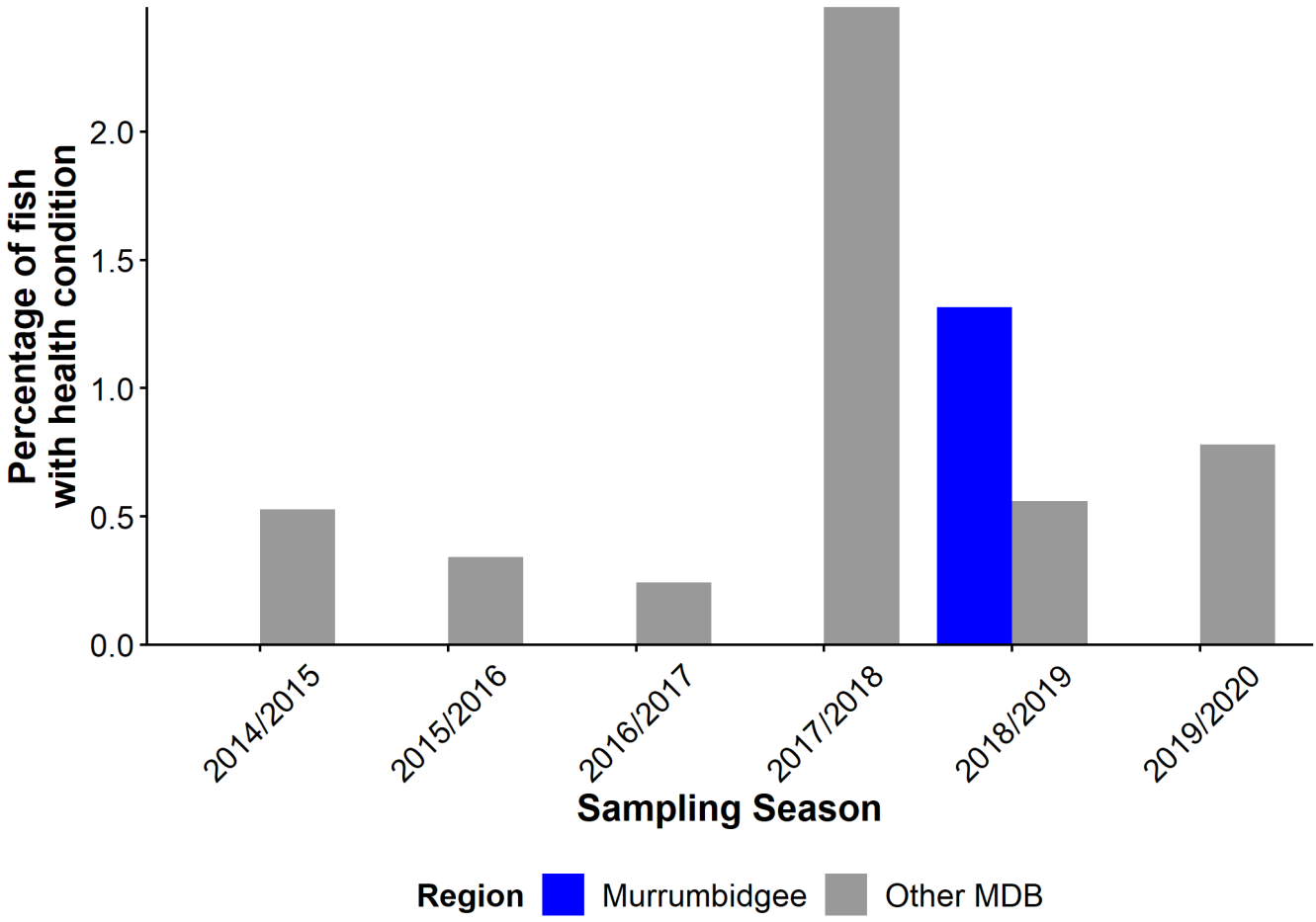

Figure 7.26: Timeseries showing the prevalence of health conditions in Australian smelt. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPAs.

Summary Statement:

Presence of observable health conditions was low and generally similar to or lower than the rest of the NSW MDB.

Distribution

Australian smelt were recorded at 56 out of 165 sites in the Murrumbidgee WRPA. The maximum observed relative abundance at a site was 12.25 fish caught per 90 seconds of electrofishing. Figure 7.27 shows the distribution and relative abundance of Australian smelt across the Murrumbidgee WRPA.

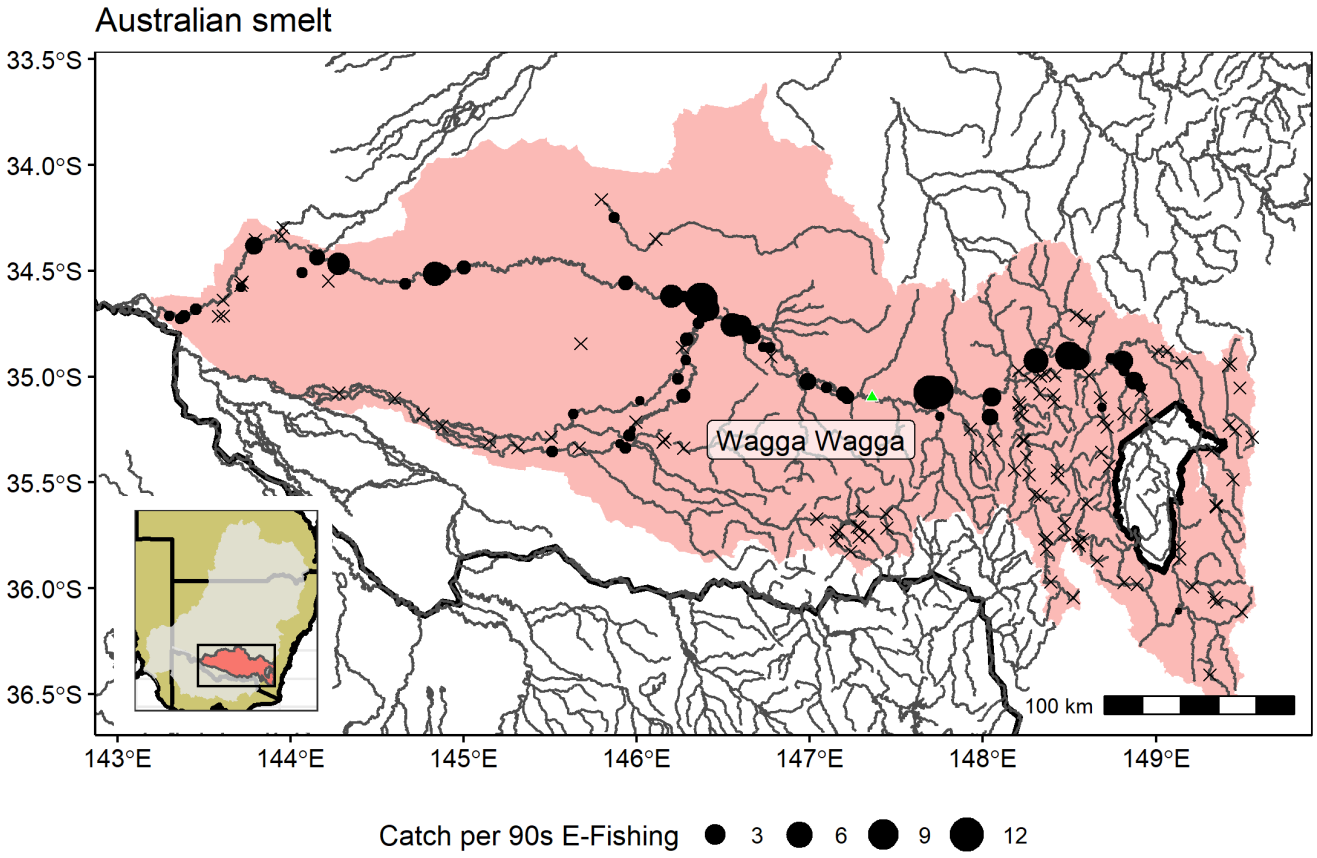

Figure 7.27: Distribution of Australian smelt. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X.

Summary Statement:

Australian smelt were recorded across the Murrumbidgee WRPA but less abundant or absent in southeastern upland sites.

Common carp

Population Structure

Figure 7.28 shows the observed length frequency plot for Common carp for each of the sampling seasons. The observed numbers of Young of the Year (YOY) ranged from 67 to 699, and 18% to 67% 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 59% (10,734 out of 18,182). Common carp are not a stocked species.

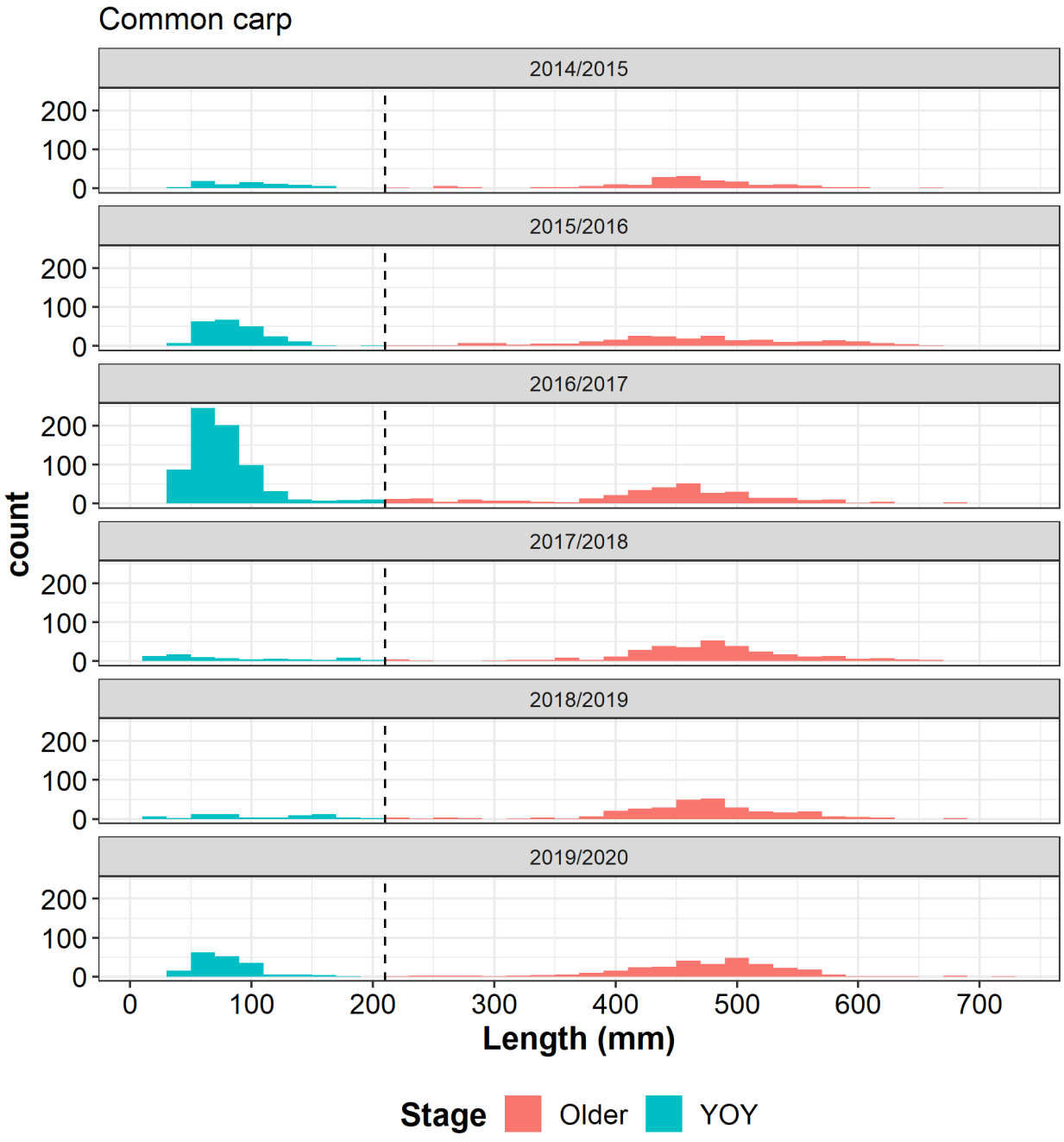

Figure 7.28: Length frequency plots for common carp by sampling season. YOY represents Young of the Year fish.

Summary Statement:

Regular recruitment with a peak in 2016/17. Large fish present in all years but relatively low recruitment in 2014/15, 2017/18 and 2018/19.

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 7.29 shows the abundance trend for the Murrumbidgee WRPA and the right-hand panel shows the overall trend across the NSW MDB.

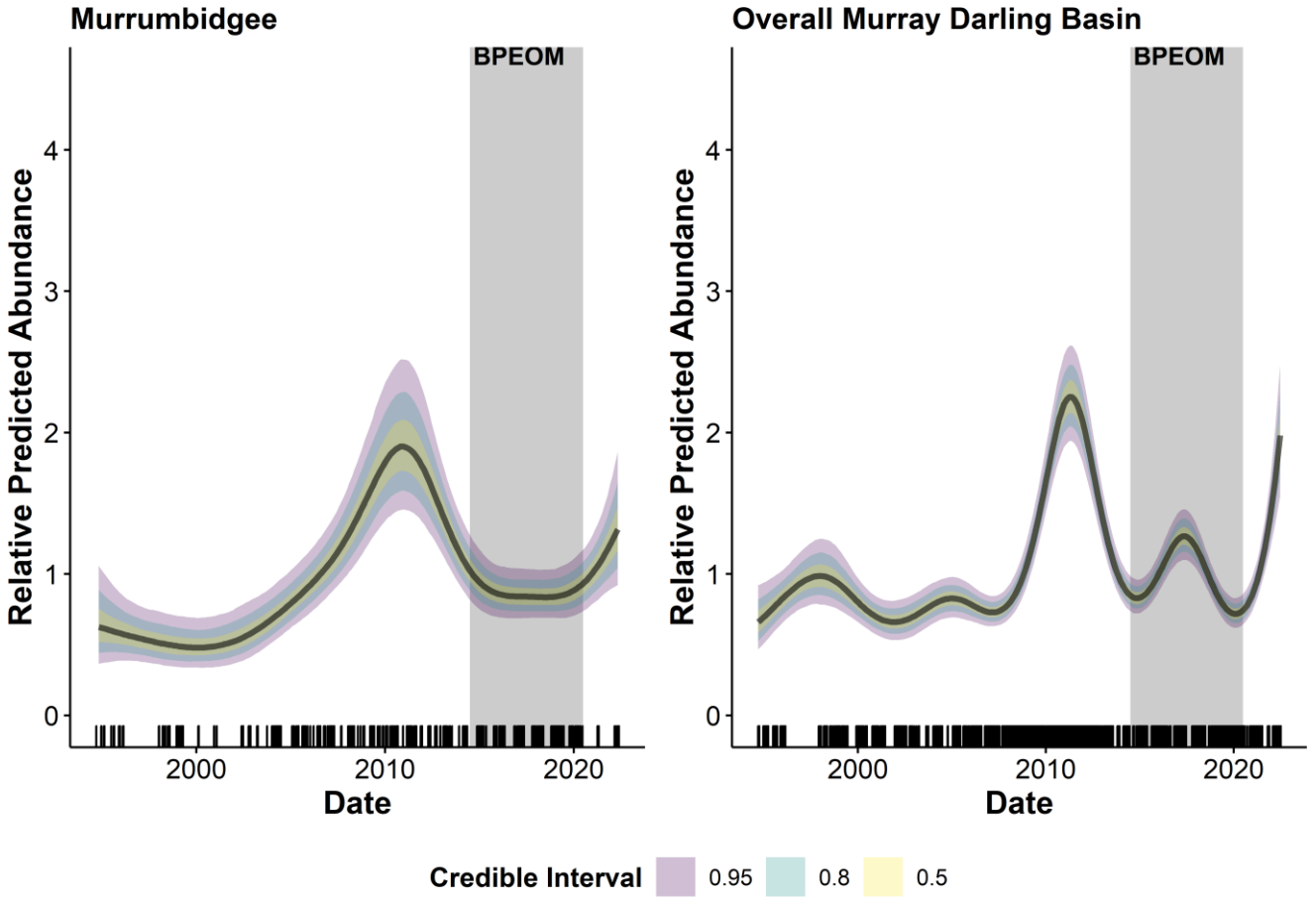

Figure 7.29: Relative abundance of Common carp in both this valley and the overall Murray-Darling Basin. These are model estimates based upon all electrofishing data within the NSW DPI Freshwater ecosystem database and the output of Bayesian generalised additive mixed models. The grey shaded region represents 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:

Current abundance higher than 1994 levels. Abundance peaked in approximately 2012. Recent increase in abundance corresponds to a recent decline in relative biomass suggesting the increase in abundance is driven by a large proportion of juveniles (NSW DPI unpubl.). Current relative abundance slightly lower than the overall NSW MDB.

Health

The prevalence of any health issues ranged from 7% of sampled fish in 2017/2018 to 16% of sampled fish in 2018/2019 (Figure 7.30). The most common health issue for Common carp in the Murrumbidgee water resource planning area was Lerneae, which was observed in a total of 145 fish, corresponding to 5% of all Common carp measured.

Across the other WRPAs, 5% of Common carp (891 out of 18,183 Common carp) showed a health condition (excludes Murrumbidgee).

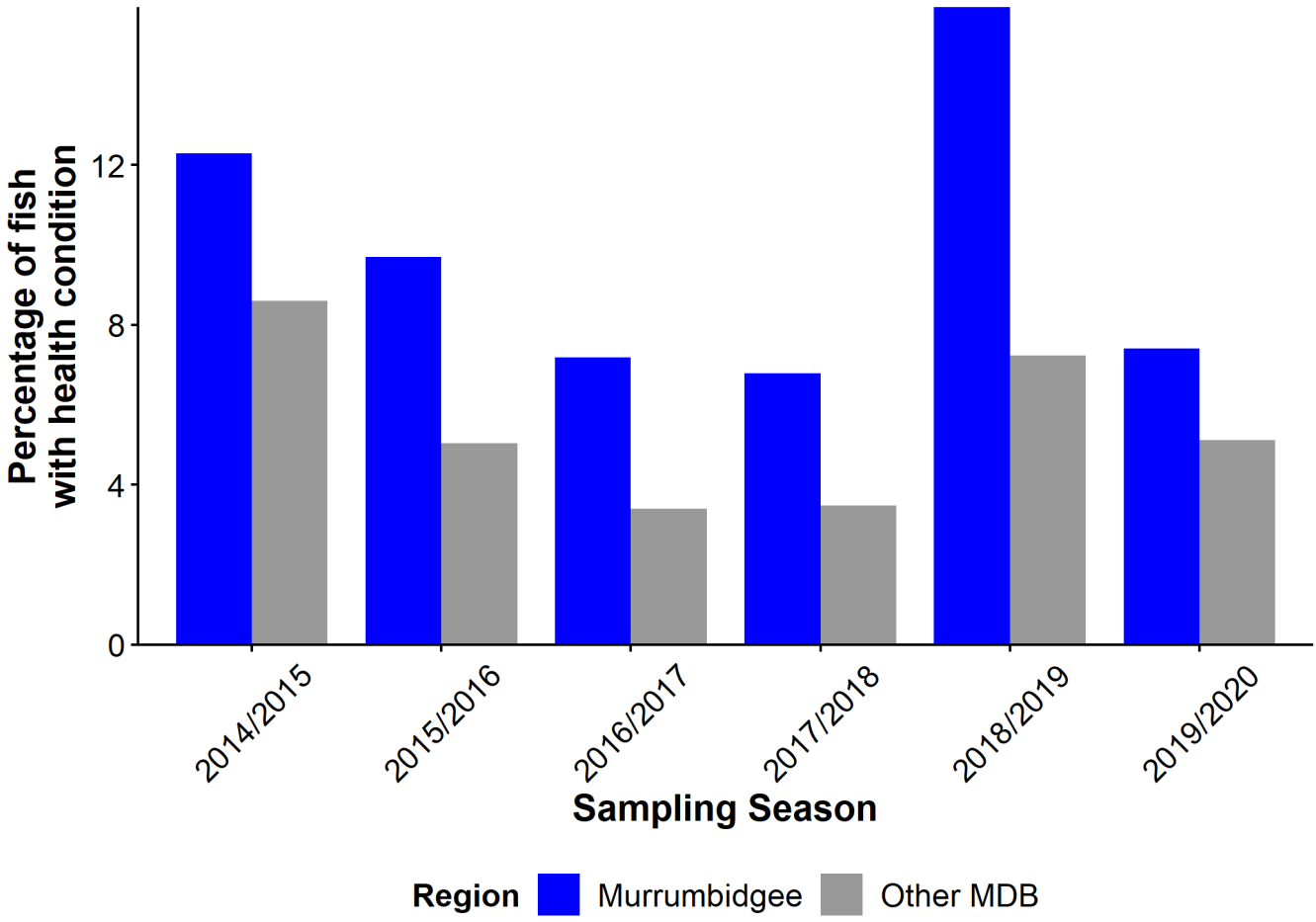

Figure 7.30: Timeseries showing the prevalence of health conditions in Common carp. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPAs.

Summary Statement:

Presence of observable health conditions in the Murrumbidgee was moderate and generally slightly higher that the rest of the NSW MDB.

Distribution

Common carp were recorded at 117 out of 165 sites in the Murrumbidgee WRPA. The maximum observed relative abundance at a site was 26 fish caught per 90 seconds of electrofishing. Figure 7.31 shows the distribution and relative abundance of Common carp across the Murrumbidgee WRPA.

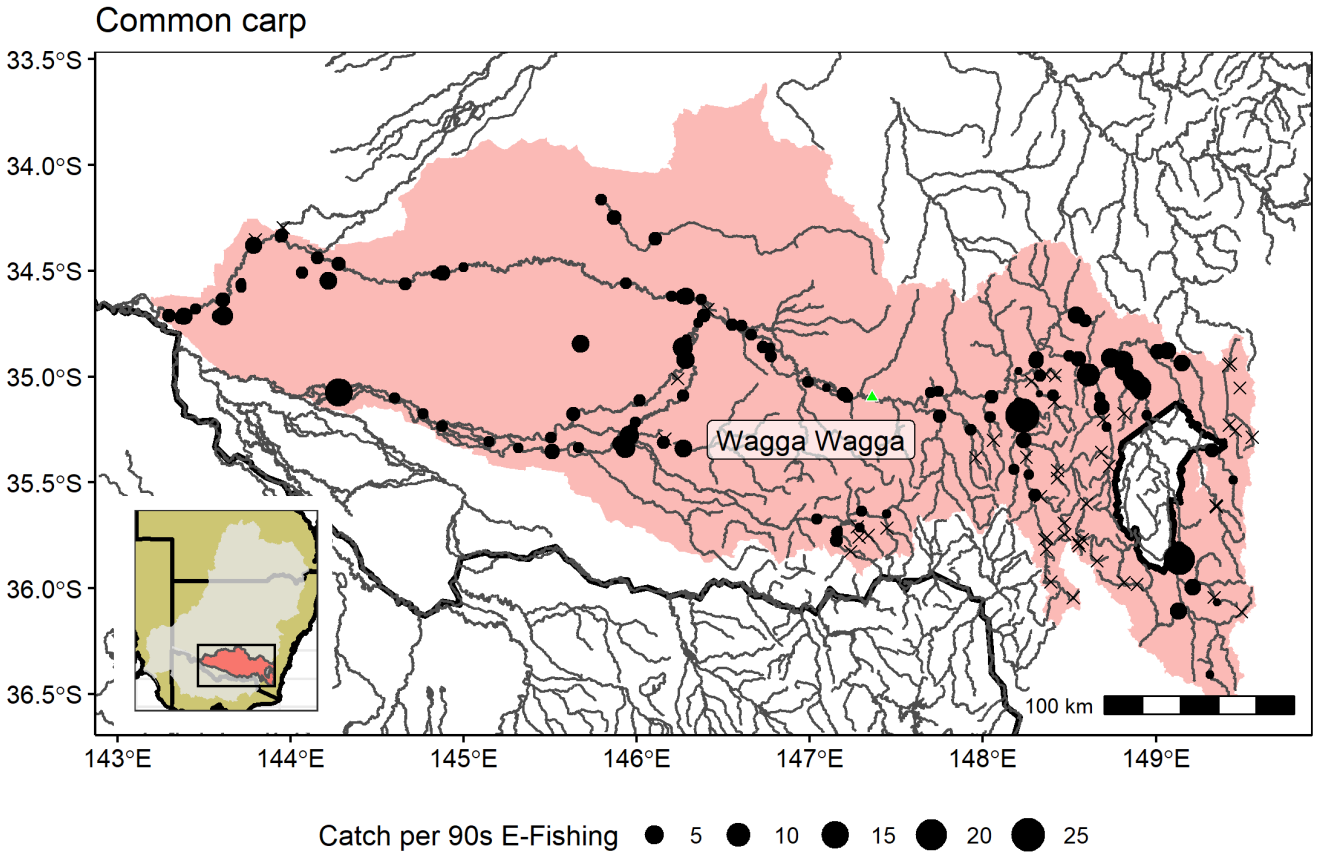

Figure 7.31: Distribution of Common carp. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X.

Summary Statement:

Present across the Murrumbidgee WRPA with the exception of some upland areas.

Threatened Species

The following table (Table 7.6) 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 Murrumbidgee Water Resource Planning Area during the BPEOM 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 7.9.

Table 7.6: Listed species which were observed in this region during the BPEOM-F program. (* = FMA, # = EPBC)

Species	Common name	Total caught (observed)
Bidyanus bidyanus	Silver perch*#	3 (0)
Maccullochella macquariensis	Trout cod*#	5 (0)
Maccullochella peelii	Murray cod#	196 (32)
Macquaria australasica	Macquarie perch*#	72 (7)
Nannoperca australis	Southern pygmy perch*#	1 (0)
Tandanus tandanus	Freshwater catfish*	1 (1)

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

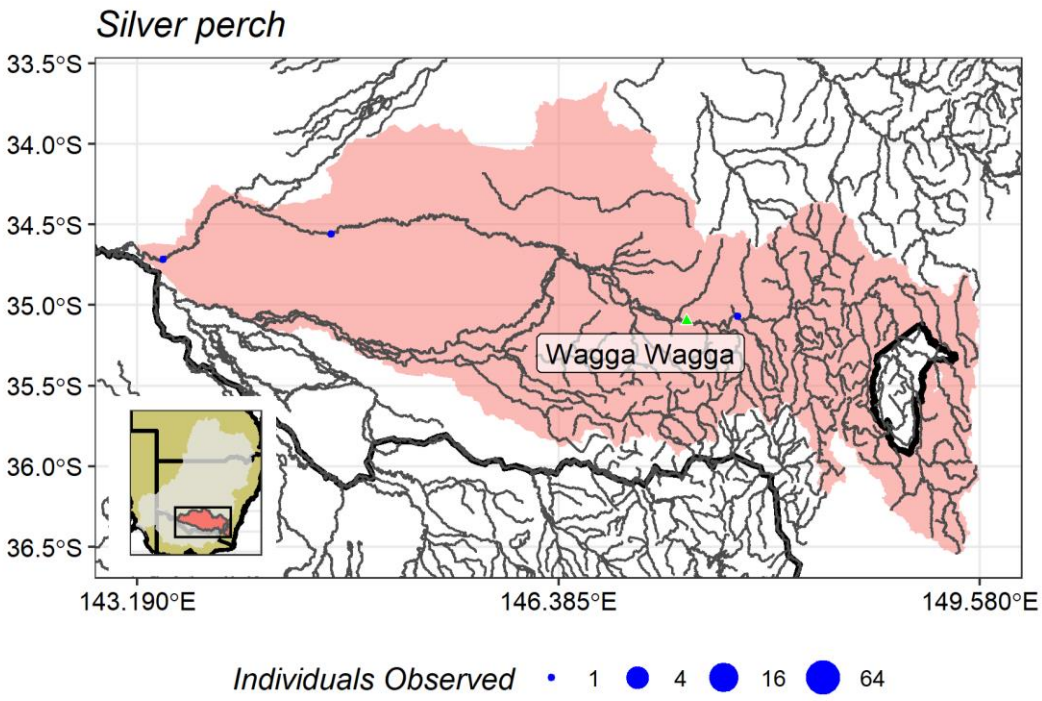

Figure 7.32: Distribution of Silver perch. Filled circles show sites where the species was present and the size of the circle represents number of observed individuals abundance.

Summary Statement:

A total of three Silver perch were caught across three different sites (one each in 2014, 2016 & 2019) on the Murrumbidgee River.

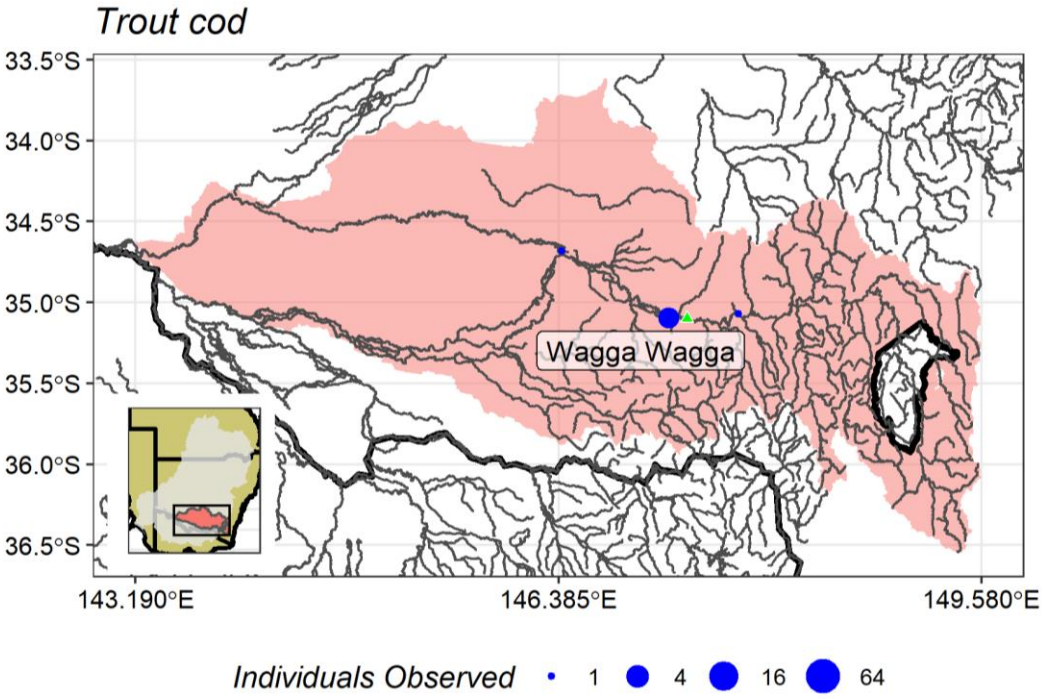

Figure 7.33: Distribution of Trout cod. Filled circles show sites where the species was present and the size of the circle represents number of observed individuals abundance.

Summary Statement:

Five Trout cod were caught across three sites on the central Murrumbidgee River.

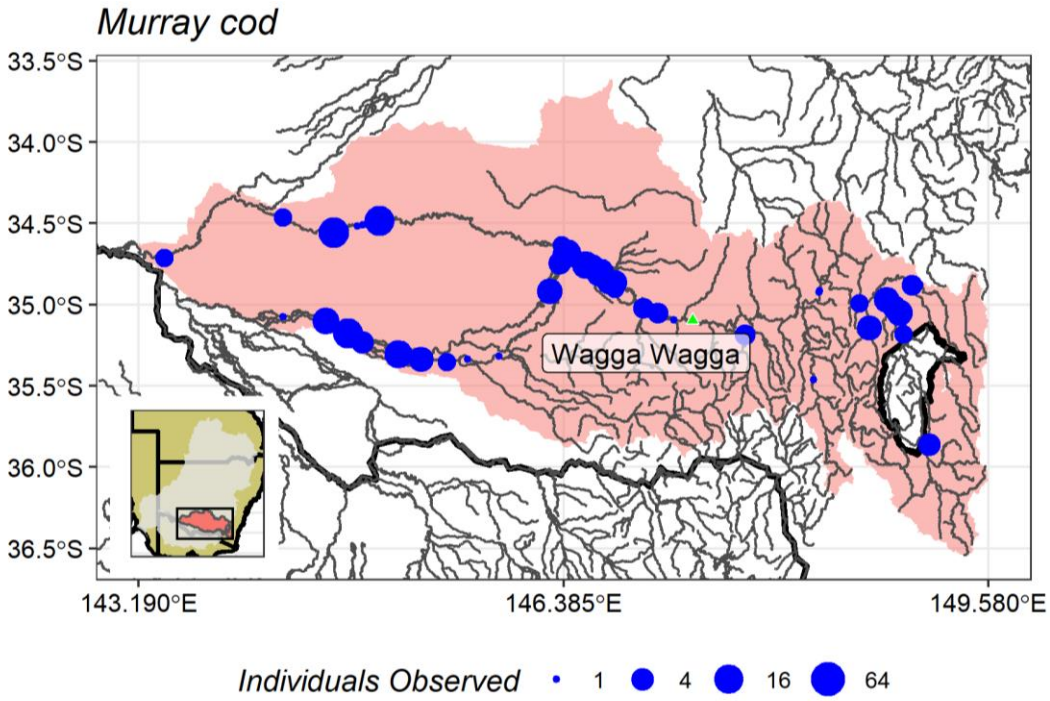

Figure 7.34: Distribution of Murray cod. Filled circles show sites where the species was present and the size of the circle represents number of observed individuals abundance. Note the bottom image shows a juvenile Murray cod.

Summary Statement:

A total of 228 Murray cod were caught or observed across 44 sites, spread over the whole the Murrumbidgee WRPA.

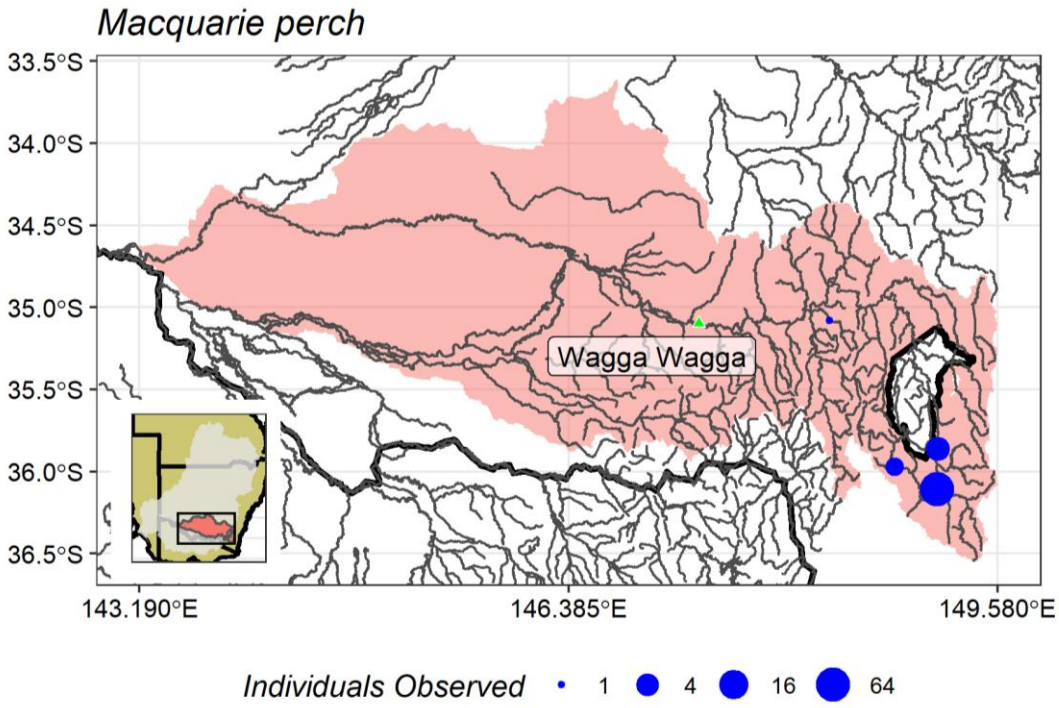

Figure 7.35: Distribution of Macquarie perch. Filled circles show sites where the species was present and the size of the circle represents number of observed individuals abundance.

Summary Statement:

A total of 79 Macquarie perch were caught or observed at four sites in the Upland areas. All but one of the fish were caught in the upper Murrumbidgee River.

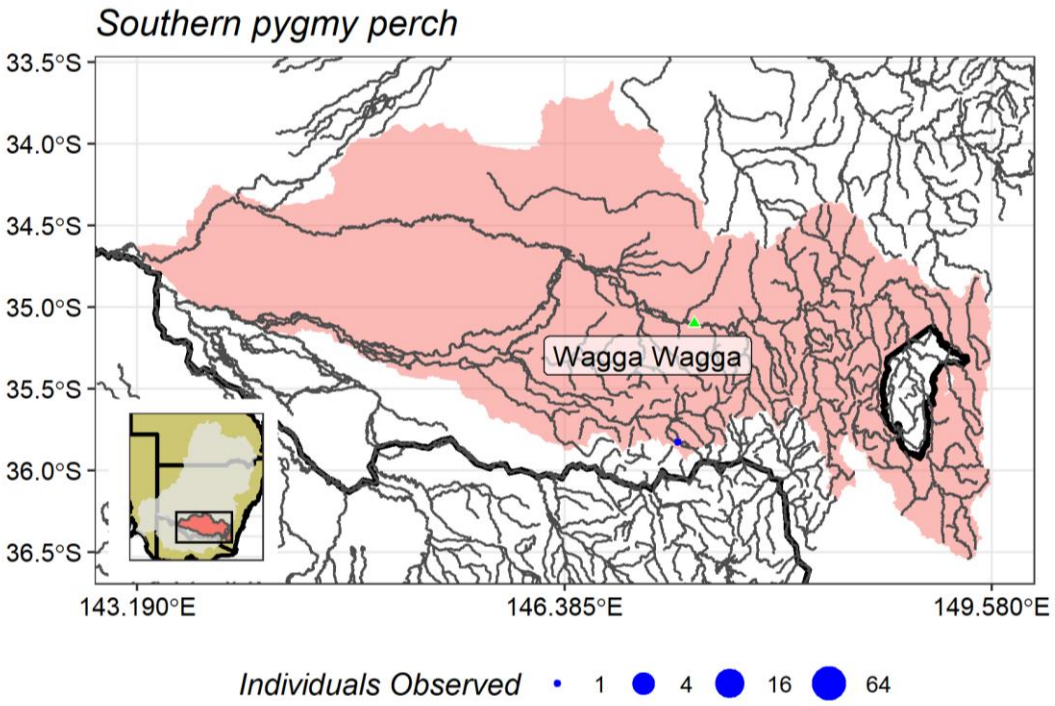

Figure 7.36: Distribution of Southern pygmy perch. Filled circles show sites where the species was present and the size of the circle represents number of observed individuals abundance.

Summary Statement:

One Southern pygmy perch was caught in Mountain Creek in 2014.

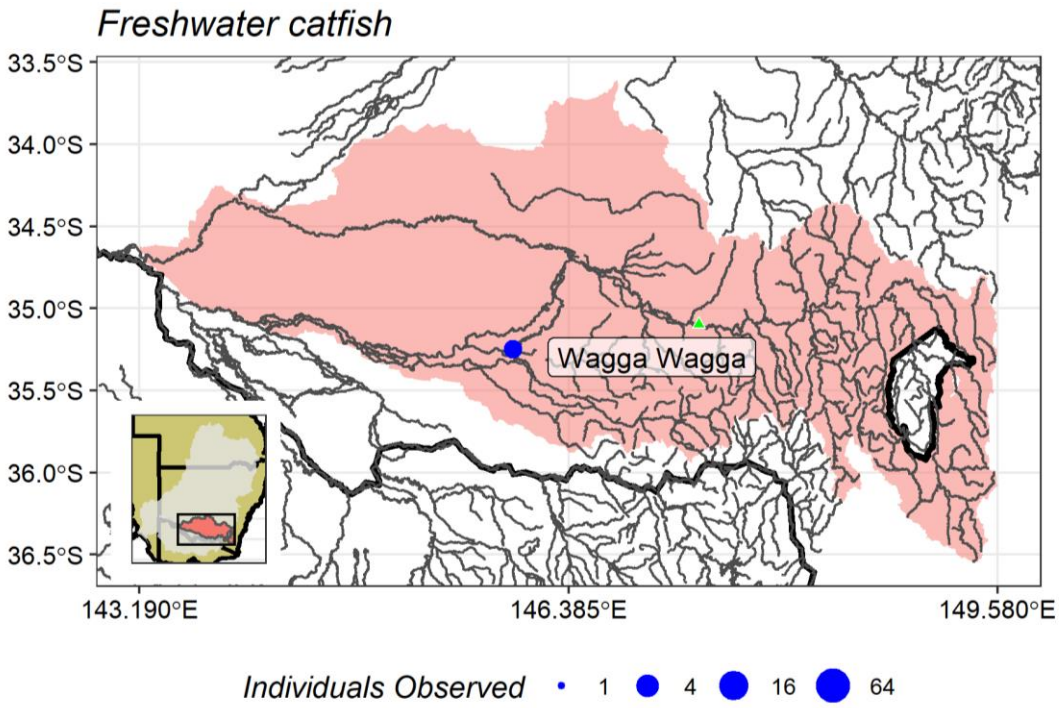

Figure 7.37: Distribution of Freshwater catfish. Filled circles show sites where the species was present and the size of the circle represents number of observed individuals abundance.

Summary Statement:

Two Freshwater catfish were caught or observed in Columbo Creek in 2017 and 2019 (one of which was collected in the BPEOM-F surveys).

Appendix

Figure 7.38 shows the locations of sites sampled in each sampling season.

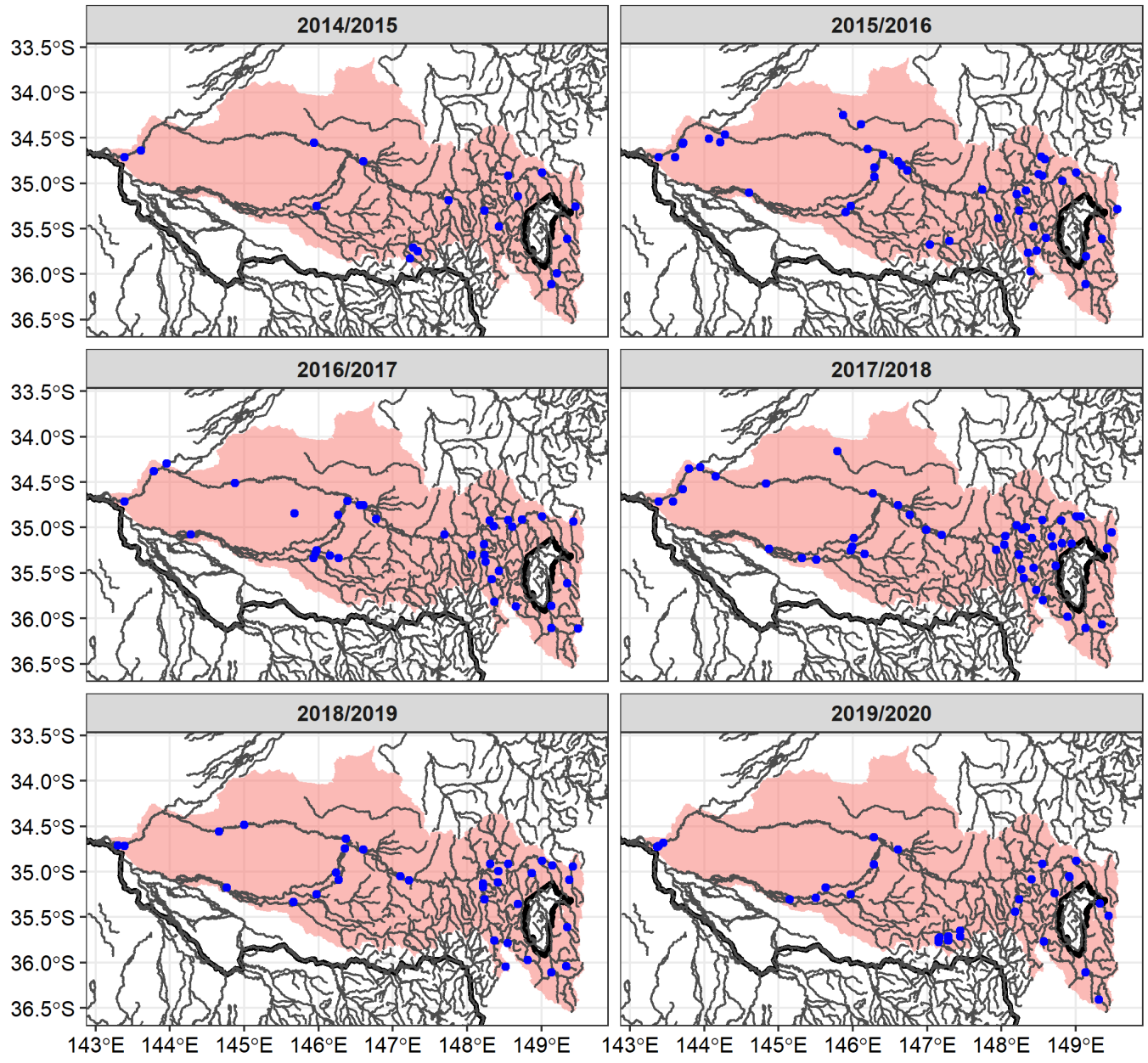

Figure 7.38: Sites sampled during the BPEOM-F program by Sampling Season. Dry sites are not shown.

Table 7.7 shows all fish species detected during this survey period as part of BPEOM-F. Note there are variations in effort between sampling seasons so this information should be considered in conjunction with Table 7.1. 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 Murrumbidgee WRPA were: Olive perchlet, Darling hardyhead, Murray hardyhead, Riffle galaxias, Obscure galaxias, Flat-headed galaxias, Spangled perch, Southern purple-spotted gudgeon. 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 7.10.

Table 7.7: 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	240	398	291	229	194	32
Bony herring	YES	6	110	70	77	40	45
Brown trout	YES	5	23	17	87	71	14
Carp-gudgeon species complex	YES	155	552	155	219	123	217
Common carp	NA	236	474	1,769	433	416	533
Common carp - Goldfish hybrid	NA	0	0	0	0	0	1
Dwarf flathead gudgeon	YES	0	1	0	31	1	0
Eastern gambusia	NA	228	260	650	506	78	184
Flathead gudgeon	YES	3	45	55	229	98	102
Freshwater catfish	YES	0	0	0	0	0	1
Galaxias spp	NA	0	0	46	0	0	18
Golden perch	YES	12	31	18	39	38	20
Goldfish	NA	11	119	182	72	34	95
Macquarie perch	YES	24	6	27	1	5	9
Mountain galaxias	YES	124	70	10	142	33	18
Murray-Darling rainbowfish	YES	9	82	49	2	28	7
Murray cod	YES	8	51	19	20	71	27
Oriental weatherloach	NA	0	1	8	146	1	1
Rainbow trout	YES	7	24	29	168	61	14
Redfin	YES	43	82	276	82	347	17
River blackfish	NA	30	75	1	66	13	10
Silver perch	YES	1	1	0	0	1	0
Southern pygmy perch	YES	1	0	0	0	0	0
Trout cod	YES	0	2	0	0	3	0
Two-spined blackfish	YES	0	33	1	3	0	0
Unspecked hardyhead	YES	43	140	43	13	64	114

The following table summarises the sampling methods by which each fish species was caught (Table 7.8).

Table 7.8: Total catch of each species by sampling method.

Common name	Backpack Electrofishing	Bait Trap	Boat Electrofishing
Australian smelt	30	0	1,354
Bony herring	0	0	348
Brown trout	132	1	84
Carp-gudgeon species complex	65	807	549
Common carp	607	113	3,141
Common carp - Goldfish hybrid	0	0	1
Dwarf flathead gudgeon	0	5	28
Eastern gambusia	813	315	778
Flathead gudgeon	206	56	270
Freshwater catfish	0	0	1
Galaxias spp	61	2	1
Golden perch	1	1	156
Goldfish	109	8	396
Macquarie perch	2	10	60
Mountain galaxias	374	10	13
Murray-Darling rainbowfish	6	0	171
Murray cod	5	0	191
Oriental weatherloach	154	0	3
Rainbow trout	225	3	75
Redfin	40	43	764
River blackfish	153	11	31
Silver perch	0	0	3
Southern pygmy perch	0	1	0
Trout cod	0	0	5
Two-spined blackfish	37	0	0
Unspecked hardyhead	3	1	413

Table 7.9: Listed threatened species recorded in the Murray-Darling Basin (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
Ambassis agassizii	Agassiz's glassfish, olive perchlet, western New South Wales population	NA	Endangered Population
Bidyanus bidyanus	Silver Perch, Bidyan	Critically Endangered	Vulnerable
Craterocephalus fluviatilis	Murray Hardyhead	Endangered	Critically Endangered
Galaxias rostratus	Flathead Galaxias, Beaked Minnow, Flat-headed Galaxias, Flat-headed Jollytail, Flat-headed Minnow	Critically Endangered	Critically Endangered
Galaxias tantangara	Stocky Galaxias	NA	Critically Endangered
Maccullochella macquariensis	Trout Cod	Endangered	Endangered
Maccullochella peelii	Murray Cod	Vulnerable	NA
Macquaria australasica	Macquarie Perch	Endangered	Endangered
Mogurnda adspersa	Southern Purple Spotted Gudgeon	NA	Endangered
Nannoperca australis	Southern Pygmy Perch	Vulnerable	Endangered
Tandanus tandanus	Freshwater catfish, eel tailed catfish, Murray-Darling Basin population	NA	Endangered Population

Table 7.10 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 Murrumbidgee WRPA were: Olive perchlet, Darling hardyhead, Murray hardyhead, Riffle galaxias, Obscure galaxias, Flat-headed galaxias, Spangled perch, Southern purple-spotted gudgeon. 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. See Table 7.7 for species caught as part of BPEOM-F.

Table 7.10. 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	2014/2015	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020
Australian smelt	YES	499	401	809	328	409	87
Bony herring	YES	637	110	249	816	718	85
Brown trout	YES	5	23	17	112	91	64
Carp-gudgeon species complex	YES	461	553	811	1,408	241	652
Common carp	NA	532	487	2124	741	719	637
Common carp - Goldfish hybrid	NA	0	0	0	0	0	1
Dwarf flathead gudgeon	YES	0	1	0	32	1	0
Eastern Gambusia	NA	1,064	260	1,030	1,008	249	420
Flathead gudgeon	YES	3	45	57	330	98	102
Freshwater catfish	YES	0	0	0	0	0	1
Galaxia spp	NA	0	0	46	0	0	18
Golden perch	YES	101	50	72	140	137	80
Goldfish	NA	48	119	188	79	40	100
Macquarie perch	YES	24	6	27	8	5	9
Mountain galaxias	YES	285	75	10	193	65	33
Murray-Darling rainbowfish	YES	654	82	204	176	160	55
Murray cod	YES	317	160	151	267	431	284
Oriental weatherloach	NA	0	1	8	148	1	1
Rainbow trout	YES	7	24	29	172	98	30
Redfin	YES	45	83	277	192	360	18
River blackfish	YES	35	76	1	148	13	10
Silver perch	YES	5	1	4	5	9	8
Southern pygmy perch	YES	12	0	0	0	0	0
Trout cod	YES	10	13	8	19	25	25
Two-spined blackfish	YES	0	33	1	3	2	10
Unidentified Maccullochella cod	NA	1	0	0	0	0	0
Unspecked hardyhead	YES	54	140	46	13	101	114