

Chapter 6 Basin Plan Fish Monitoring Summary (2014/15 – 2023/24): Macquarie-Castlereagh Water Resource Planning Area

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Introduction

This report spans 2014/15 to 2023/24 and uses all suitable fish assemblage data collected by NSW DPIRD Fisheries using standardized electrofishing monitoring techniques. The format of the report follows and expands upon the previous reports (Schilling & Crook 2023, 2024). This report focusses on the Macquarie-Castlereagh Water Resource Planning Area (WRPA) shown in Figure 6.1.

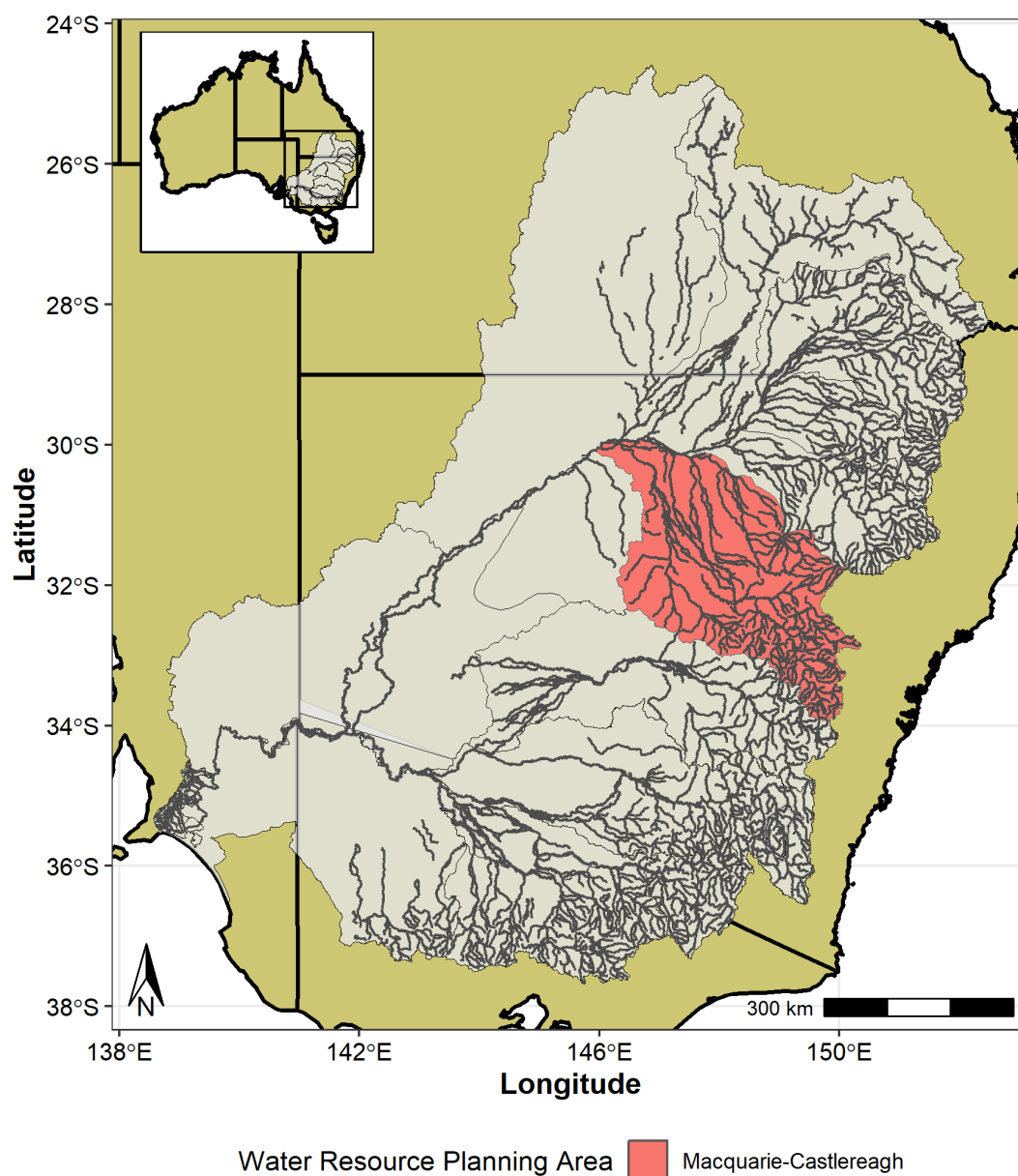


Figure 6.1: Murray-Darling Basin with the key region of this report highlighted. Inset map shows the whole of Australia with a box around the MDB.

What This Report Includes

This report starts with an overview of the standardised monitoring programs 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 Macquarie-Castlereagh WRP. 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 collected 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 and *relative biomass* (a unit-less measure representing the number (or biomass) of fish in an area) information is adapted from 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 updated analysis uses generalised linear mixed models to generate annual indices of relative abundance and biomass for each WRP. In this report we present the modelled time series of relative abundance showing the predicted number (or biomass) of fish observed per 90 second shot of electrofishing. The abundance and biomass trends for the Macquarie-Castlereagh WRP are contrasted with the overall NSW MDB dataset. It should be noted that these are modelled estimates of relative abundance/biomass, not absolute abundance/biomass as absolute estimates would require extensive calibration surveys that are not included in the monitoring program.

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. 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 Macquarie-Castlereagh WRP and greater MDB (excluding the Macquarie-Castlereagh WRP).

Distribution maps are provided for each species to show the observed distribution of each species from electrofishing samples. 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 standardised monitoring programs in the Macquarie-Castlereagh WRP during the reporting 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 are used during routine fish monitoring surveys: boat electrofishing, backpack electrofishing and bait traps. This report mainly includes the electrofishing data with bait trap samples informing the distribution of small bodied species. The electrofishing was conducted using the standard methodology implemented in the Sustainable Rivers Audit (SRA; Davies et al. 2010). This usually includes 12 shots of 90 seconds “power on” during each sampling event.

As parts of this report compile data from multiple projects, there is some variation in how sites were chosen and the effort of sampling conducted each year (Table 6.1). Details of which projects contributed data to this report can be seen in Table 6.7. 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 10 unbaited bait traps set in edge margins. Most sampling occurred between the months of September and May.

Table 6.1: Sampling effort (Number of sites sampled) each sampling season in the Macquarie-Castlereagh WRPA. Variation in sampling effort is due to different numbers of projects and interruptions to planned sampling such as flooding, site desiccation, and extreme weather.

Sampling Season	Number of Boat Electrofishing Sites	Number of Backpack Electrofishing Sites	Number of Hybrid Sites	Total
2014/2015	24	7	9	40
2015/2016	27	11	6	44
2016/2017	35	16	15	66
2017/2018	11	15	13	39
2018/2019	14	9	13	36
2019/2020	5	8	13	26
2020/2021	13	3	1	17
2021/2022	13	7	10	30
2022/2023	17	9	13	39
2023/2024	13	8	12	33

The sites sampled during the reporting period are shown in Figure 6.2. A breakdown of sites sampled each sampling season is shown in the Appendix (Figure 6.39).

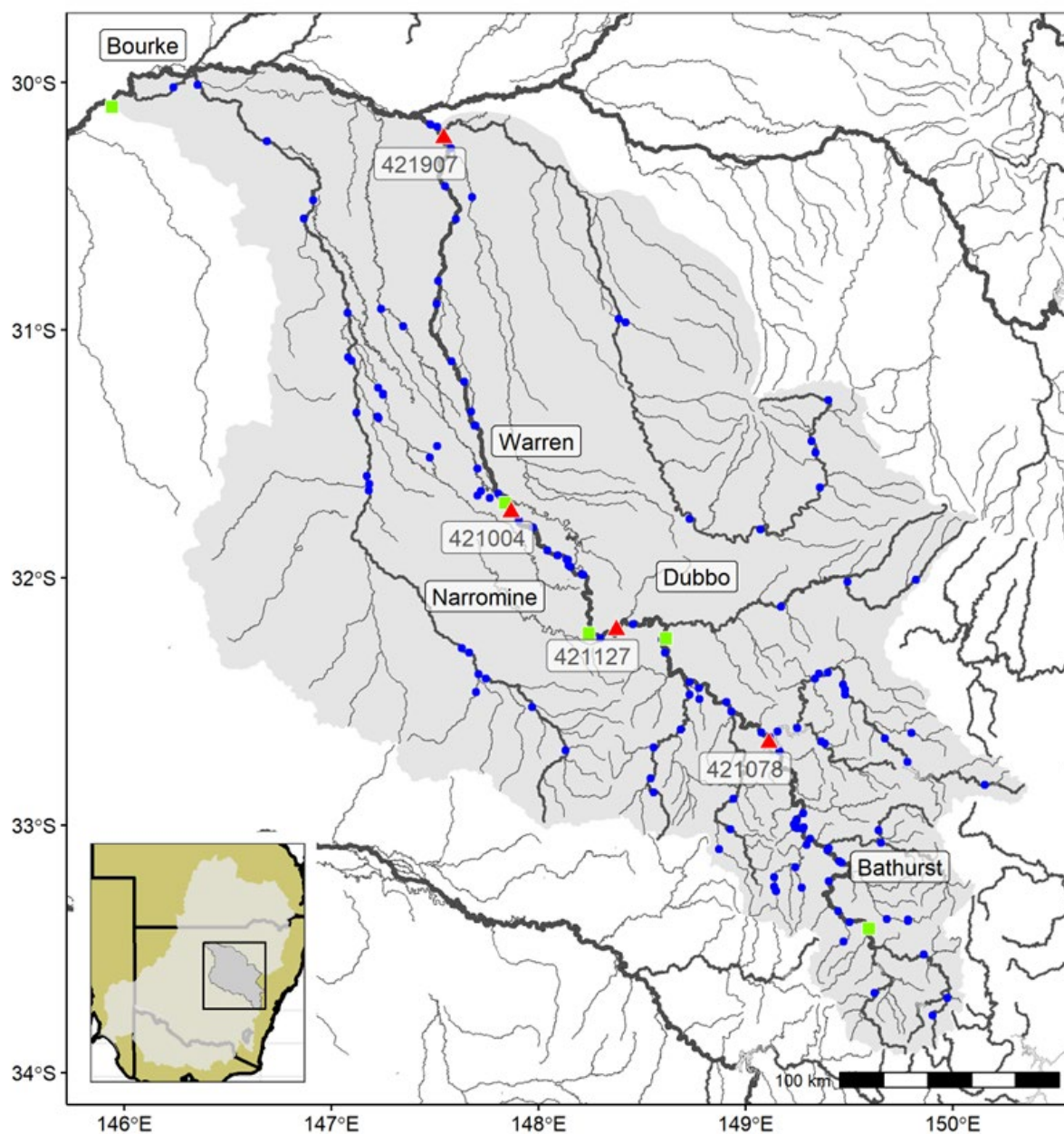


Figure 6.2: Sites (dots) sampled during the reporting period in the Macquarie-Castlereagh WRP. Triangles show key flow gauges along with their gauge ID number. Green squares show major towns.

Each sampling method has a different effectiveness at sampling each species. Table 6.2 shows the total numbers of each key species caught by each method.

Table 6.2: Number of each key species caught by sample method over the whole program in the Macquarie-Castlereagh WRPA. Further data on total catch is provided in the Appendix.

Common name	Boat Electrofishing	Backpack Electrofishing	Bait Trap
Australian smelt	2,542	276	1
Bony herring	2,695	112	11
Common carp	9,110	1,022	723
Freshwater catfish	101	19	0
Golden perch	845	10	3
Murray cod	1,434	18	1

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

Table 6.3: Number of biological measurements taken for the key species each sampling season in the Macquarie-Castlereagh WRPA.

Sampling Season	Australian smelt	Bony herring	Common carp	Freshwater catfish	Golden perch	Murray cod
2014/2015	567	211	1,183	32	172	299
2015/2016	274	104	722	8	93	187
2016/2017	389	455	2,595	19	235	203
2017/2018	51	127	629	6	39	101
2018/2019	56	44	642	10	38	98
2019/2020	42	26	451	2	12	39
2020/2021	100	60	142	4	25	176
2021/2022	77	119	546	4	111	114
2022/2023	73	257	1,017	11	83	129
2023/2024	77	174	590	4	69	116

Climate Overview

The following is a summary of the climatic conditions during the reporting period 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 including 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.

2021

New South Wales had its 6th wettest year on record, with 2021 rainfall 30 % above average. This included significant floods along the east coast in March, and the state's wettest November on record. It was the state's coolest year since 1996, at 0.15 °C above the 1961–1990 average.

2022

2022 was exceptionally wet with the state-averaged annual total being the second-highest on record (since 1900) and many sites recording their highest annual totals on record. Maximum temperatures were lower than average with the state-averaged annual maximum temperature being the coolest since 1992. Minimum temperatures were generally warmer than average with the state-averaged annual minimum temperature being 0.73 °C above the 1961–1990 average.

2023

The state-averaged rainfall was 22.9 % below the 1961–1990 average. Rainfall was above average over small parts of the state's south, west of the Great Dividing Range, while being below average over most of the northern half of the state, especially over parts of the Northern Tablelands, Northern Rivers, Mid-North Coast, and Upper Hunter, where annual rainfall was in the lowest 10 % of historical records (since records began in 1900). State-averaged annual maximum temperature was 1.96 °C above the 1961–1990 average, which is the third highest on record.

2024

Rainfall totals in 2024 were above average to very much above average for the northern and western areas of the state, as well as central parts of the coast. Totals were below average for large parts of the south-east, as well as small parts of the state's north-east and south-west. 2024 was the third-warmest on record for all years since 1910, 1.55 °C above the 1961–1990 average.

Flow Data

Below shows a summary of flow data from a variety of flow gauges in the Macquarie-Castlereagh WRP (Figure 6.3).

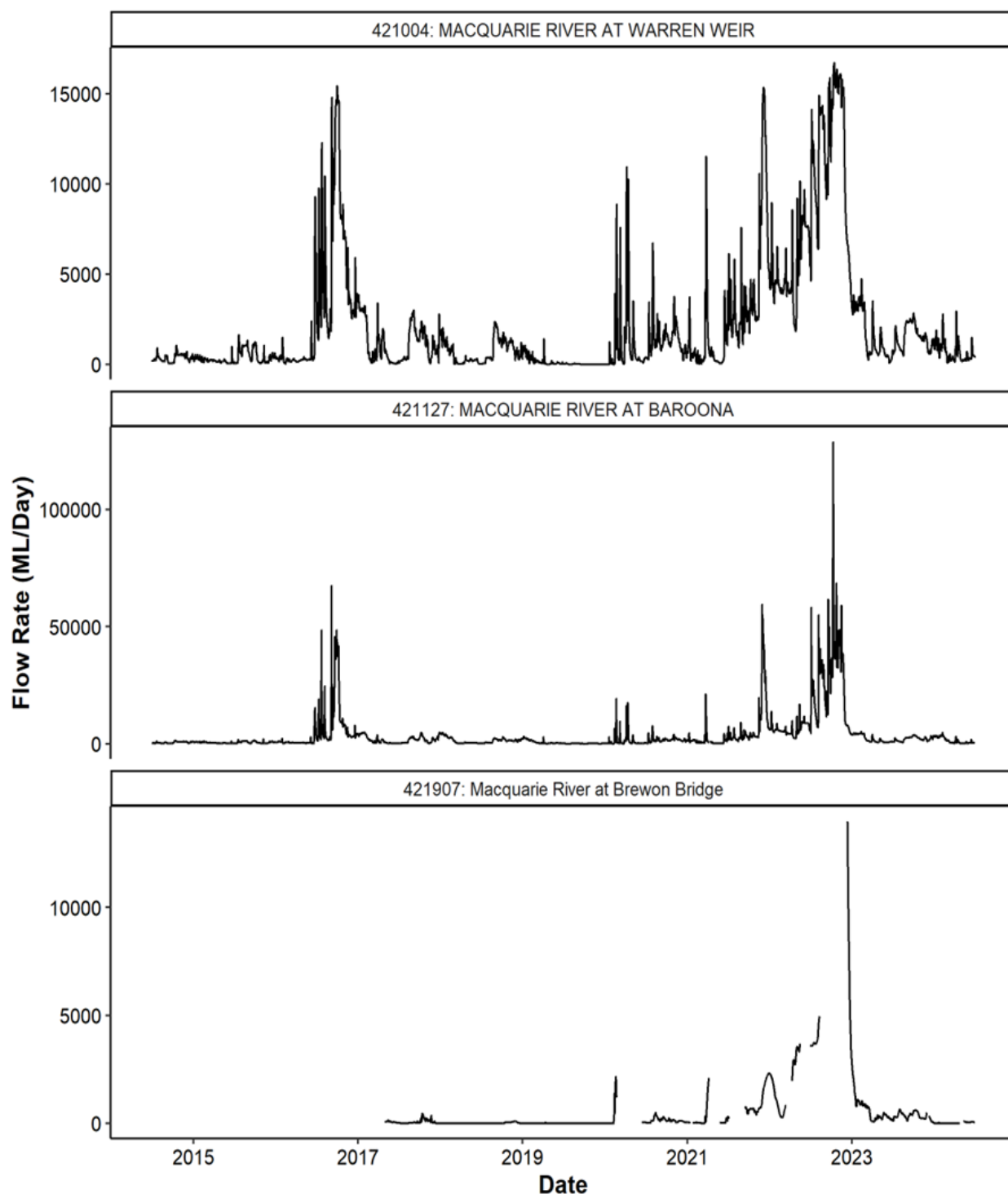


Figure 6.3: Flow data from various gauges in the Macquarie-Castlereagh WRP over the reporting period. Gauge locations can be seen on Figure 6.2. Note the differing scales on the y-axis.

Water temperature data, where available, are also shown in Figure 6.4.

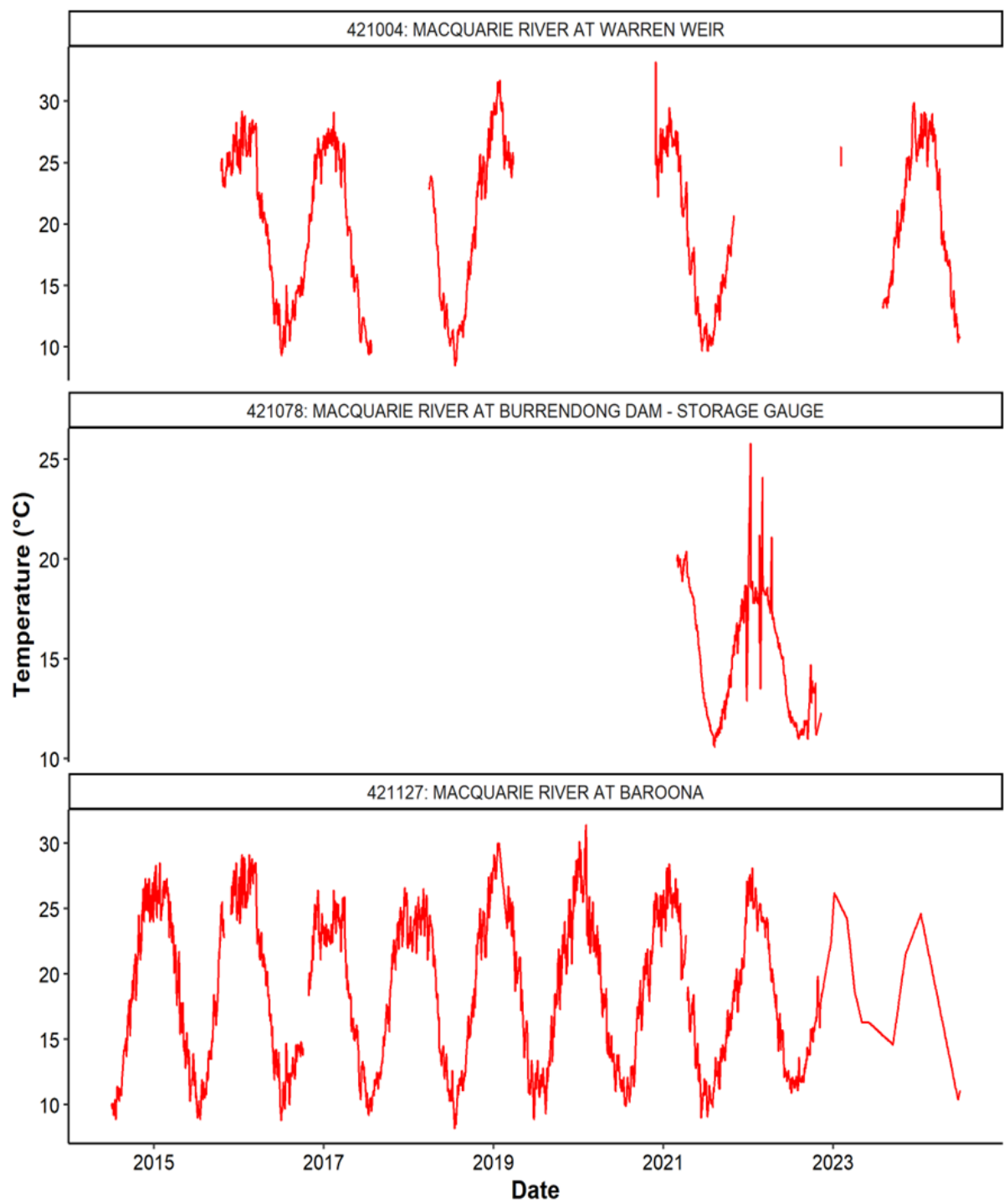


Figure 6.4: Water temperature data from various gauges in the Macquarie-Castlereagh WRPB over the reporting period. Gauge locations can be seen on Figure 6.2. Note the differing scales on the y-axis.

Species Diversity

A total of 24 fish species were observed across the Macquarie-Castlereagh WRPA including seven alien species. Figure 6.5 shows the number of native species found at each site while Figure 6.6 shows the number of alien species found at each site. The full list of species caught and observed is presented in Table 6.8.

Summary Statement:

Native diversity was highest in the central area of the Macquarie-Castlereagh region while the alien diversity was generally consistent across the region.

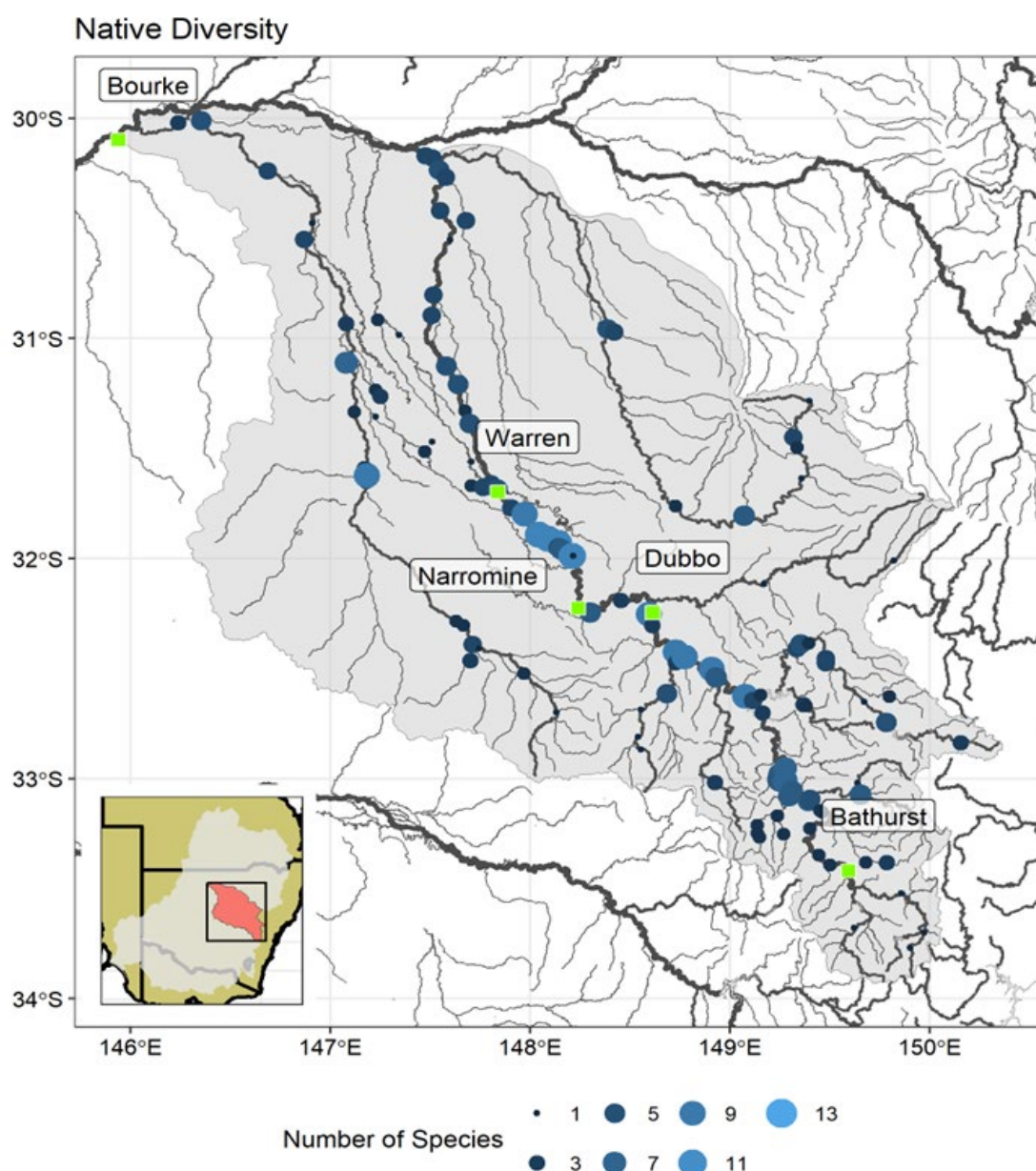


Figure 6.5: Native diversity across all sampling sites in the Macquarie-Castlereagh WRPA. Bubble size represents the number of unique species observed at each site across all sampling methods and events. X represents a site that had water and was sampled, but no fish species were caught at all. Dry sites are excluded. Green squares represent key towns.

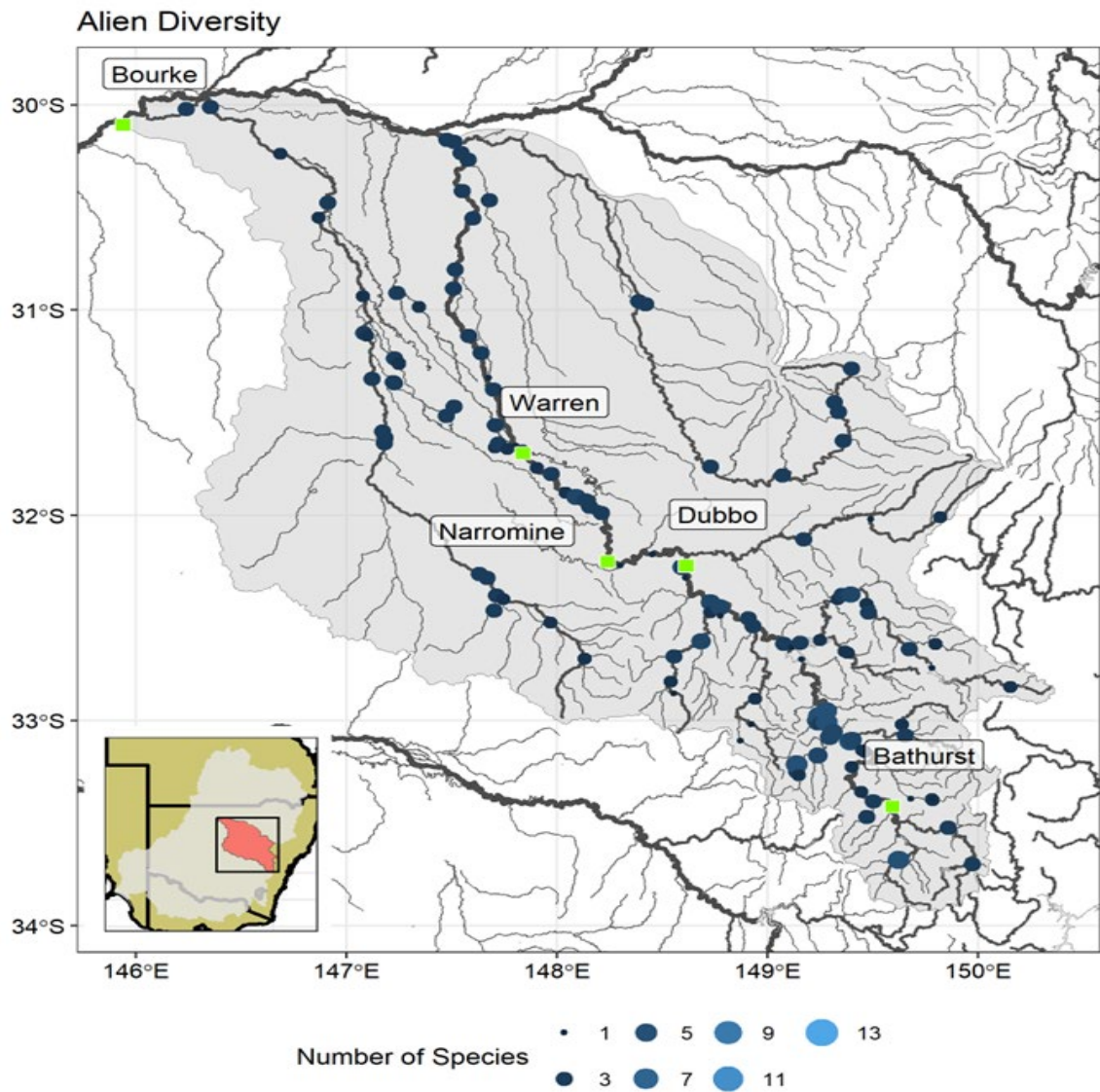


Figure 6.6: Alien diversity across all sampling sites in the Macquarie-Castlereagh WRP. Bubble size represents the number of unique species observed at each site across all sampling methods and events. X represents a site that had water and was sampled, but no fish species were caught at all. Dry sites are excluded. Green squares represent key towns.

Murray cod



Population Structure

Figure 6.7 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 2 to 55, and 1 % to 31 % of measured fish within a season, with a mean percentage YOY of 11 %.

Overall, during the reporting period, across all the MDB water resource planning areas, the percentage YOY for Murray cod was 13 % (1,282 out of 10,089).

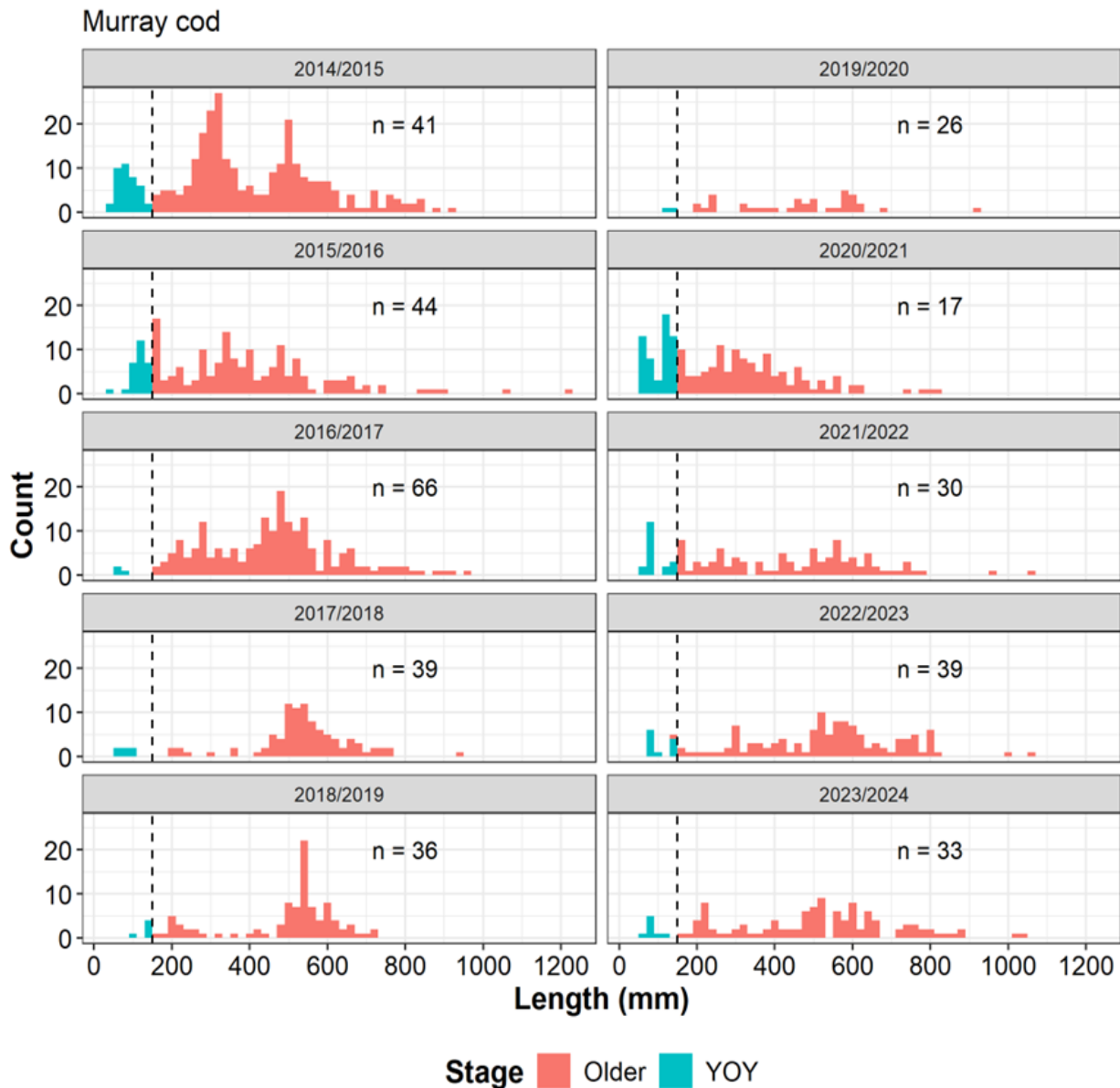


Figure 6.7: Length frequency plots for Murray cod by sampling season in the Macquarie-Castlereagh WRPA. YOY represents Young of the Year fish. n shows the number of sites sampled in the WRPA in a sampling season.

Summary Statement:

Low levels of recruitment evident in most years with stronger recruitment in 2014/15, 2015/16 and 2020/21. A good range of size classes in most years. A few YOY and a wide range of size classes in 2023/24.

Stocking

A total of 1,571,813 Murray cod were stocked into the waterways of the Macquarie-Castlereagh WRPAs during the reporting period. Of these fish, 999,731 (64 %) were stocked into impoundments while 572,082 (36 %) were stocked into rivers or creeks. Table 6.4 shows the detailed breakdown of stocking by season, location and life stage while Figure 6.8 shows the locations of stocking.

Table 6.4: Number and life stage of stocked Murray cod each sampling season in the Macquarie-Castlereagh WRPAs.

Sampling Season	River/Creek or Impoundment	Life Stage	Number Stocked
2014/2015	Impoundment	Fry	83,000
2014/2015	River/Creek	Fry	30,709
2015/2016	Impoundment	Fry	59,000
2015/2016	River/Creek	Fry	35,621
2016/2017	Impoundment	Fingerling	48,957
2016/2017	Impoundment	Fry	197,000
2016/2017	River/Creek	Fingerling	30,229
2016/2017	River/Creek	Fry	10,000
2017/2018	Impoundment	Fry	14,274
2017/2018	River/Creek	Fry	37,629
2018/2019	Impoundment	Fry	47,000
2018/2019	River/Creek	Fry	26,583
2019/2020	Impoundment	Fry	60,000
2019/2020	River/Creek	Fry	13,792
2020/2021	Impoundment	Fry	57,600
2020/2021	River/Creek	Fry	85,160
2021/2022	Impoundment	Fry	204,400
2021/2022	River/Creek	Fry	109,000
2022/2023	Impoundment	Fry	176,500
2022/2023	River/Creek	Fingerling	109,000
2022/2023	River/Creek	Fry	48,466
2023/2024	Impoundment	Fingerling	52,000
2023/2024	River/Creek	Fingerling	35,893

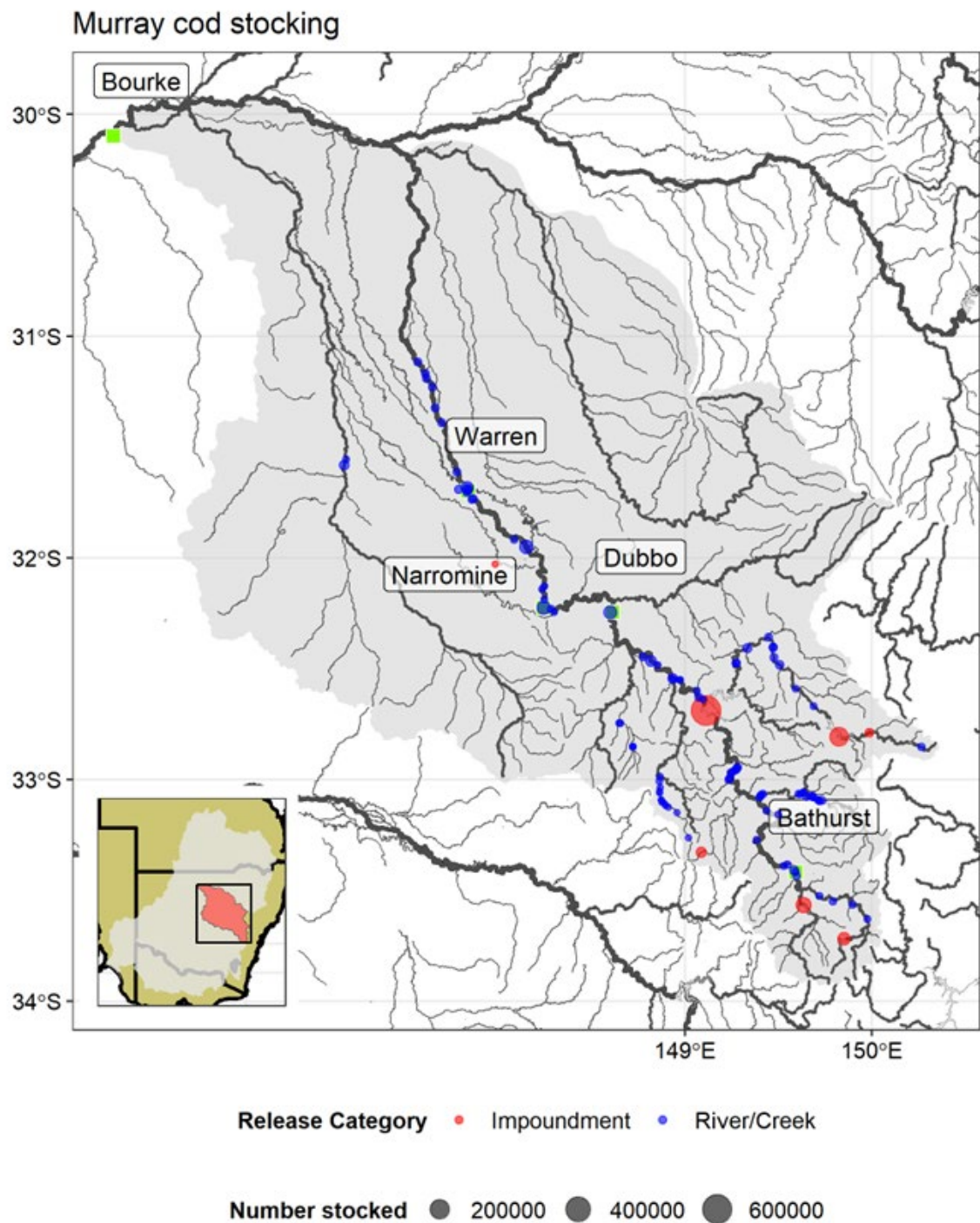


Figure 6.8: Locations of Murray cod stocking in the Macquarie-Castlereagh WRP. Colours show whether a site was a river/creek site or an impoundment, while the size of the point reflects the total number of fish stocked over the reporting period. Green squares represent key towns.

Temporal Trends in Abundance

The relative abundance and biomass of Murray cod since 1994 was modelled based on all suitable boat electrofishing data. The left-hand panels of Figure 6.9 show the abundance and biomass trends for the Macquarie-Castlereagh WRPAs and the right-hand panels show the overall trends across the NSW MDB.

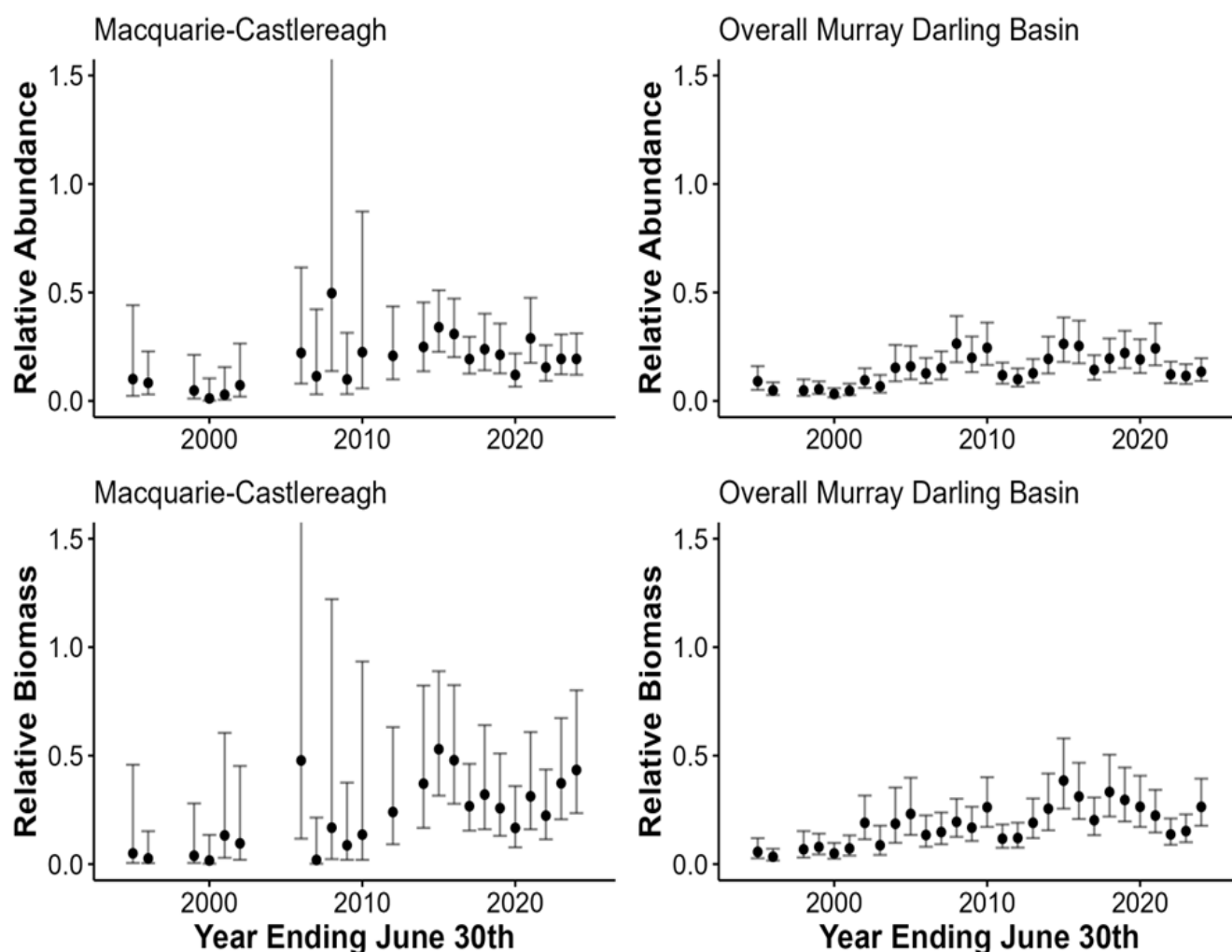


Figure 6.9: Relative abundance and biomass of Murray cod in this WRPAs and the overall NSW MDB. These are model estimates based upon all boat electrofishing data within the NSW DPIRD Freshwater ecosystem database and the output of generalised linear mixed models. Error bars show the 95 % confidence intervals around the estimates.

Summary Statement:

An overall increase in abundance and biomass since the 1990s. Both abundance and biomass have been relatively stable since the mid 2010s, although biomass is currently trending upwards.

Health

The prevalence of any health issues ranged from 10 % of sampled fish in 2020/2021 to 71 % of sampled fish in 2018/2019 (Figure 6.10). The most common health issue for Murray cod in the Macquarie-Castlereagh WRPAs was *Lernaea*, which was observed in a total of 489 fish, corresponding to 33 % of all Murray cod measured.

Across the other NSW MDB WRPA, 13 % of Murray cod (1,292 out of 10,089 Murray cod) showed a health condition (excludes the Macquarie-Castlereagh WRPAs).

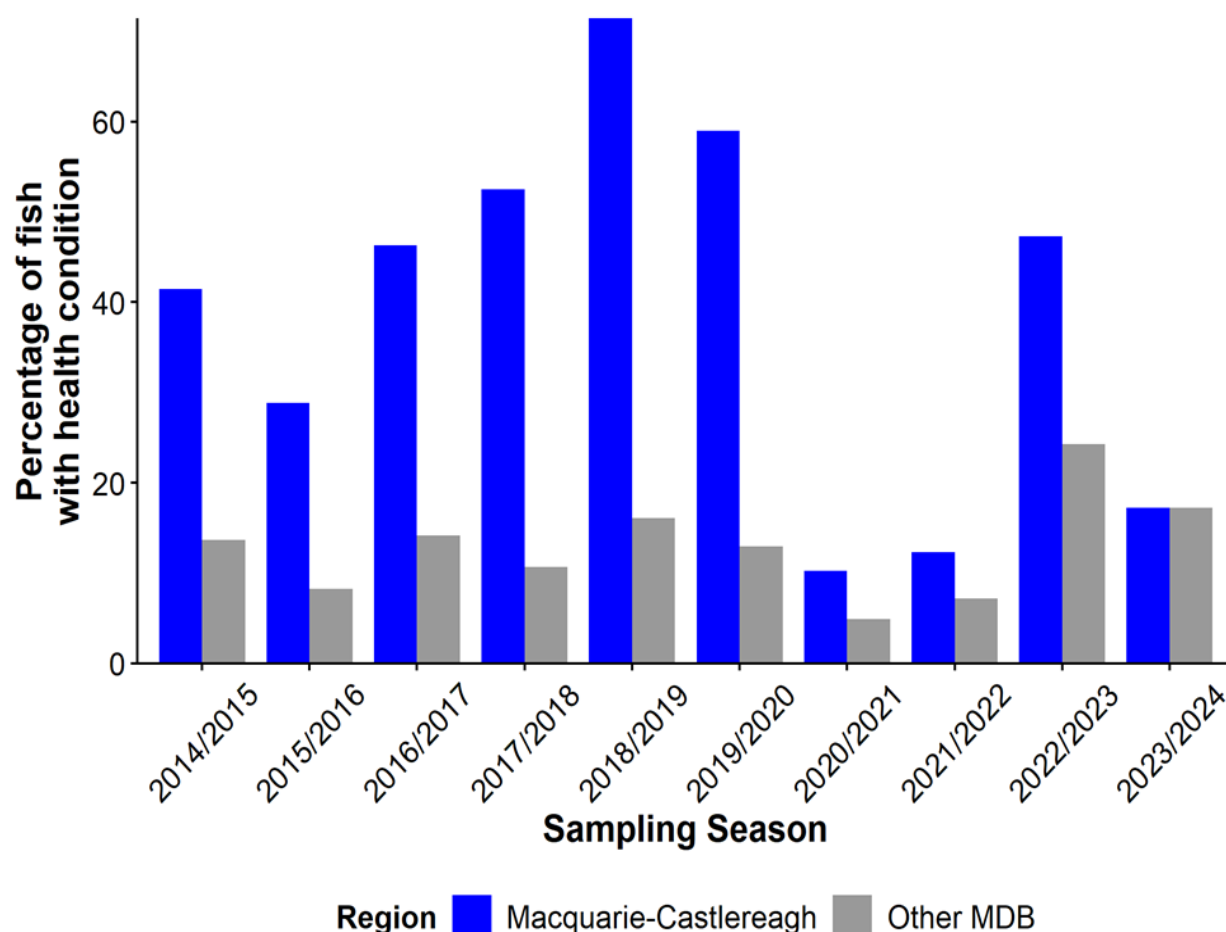


Figure 6.10: Timeseries showing the prevalence of health conditions in Murray cod. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPA.

Summary Statement:

Presence of observable health conditions was moderate to high across most years and higher than or equal to the overall Murray-Darling Basin in all years. There was a moderate level of observed health issues in 2023/24.

Distribution

Murray cod were recorded at 50 out of 141 sites in the Macquarie-Castlereagh WRP from 2013/14 to 2023/24. The maximum observed relative abundance at a site was 1.4 fish caught per 90 seconds of electrofishing. Figure 6.11 shows the distribution and relative abundance of Murray cod across the Macquarie-Castlereagh WRP.

Summary Statement:

Murray cod were recorded across the central and southern portion of the Macquarie-Castlereagh WRP but less abundant or absent in northern and south-western sites.

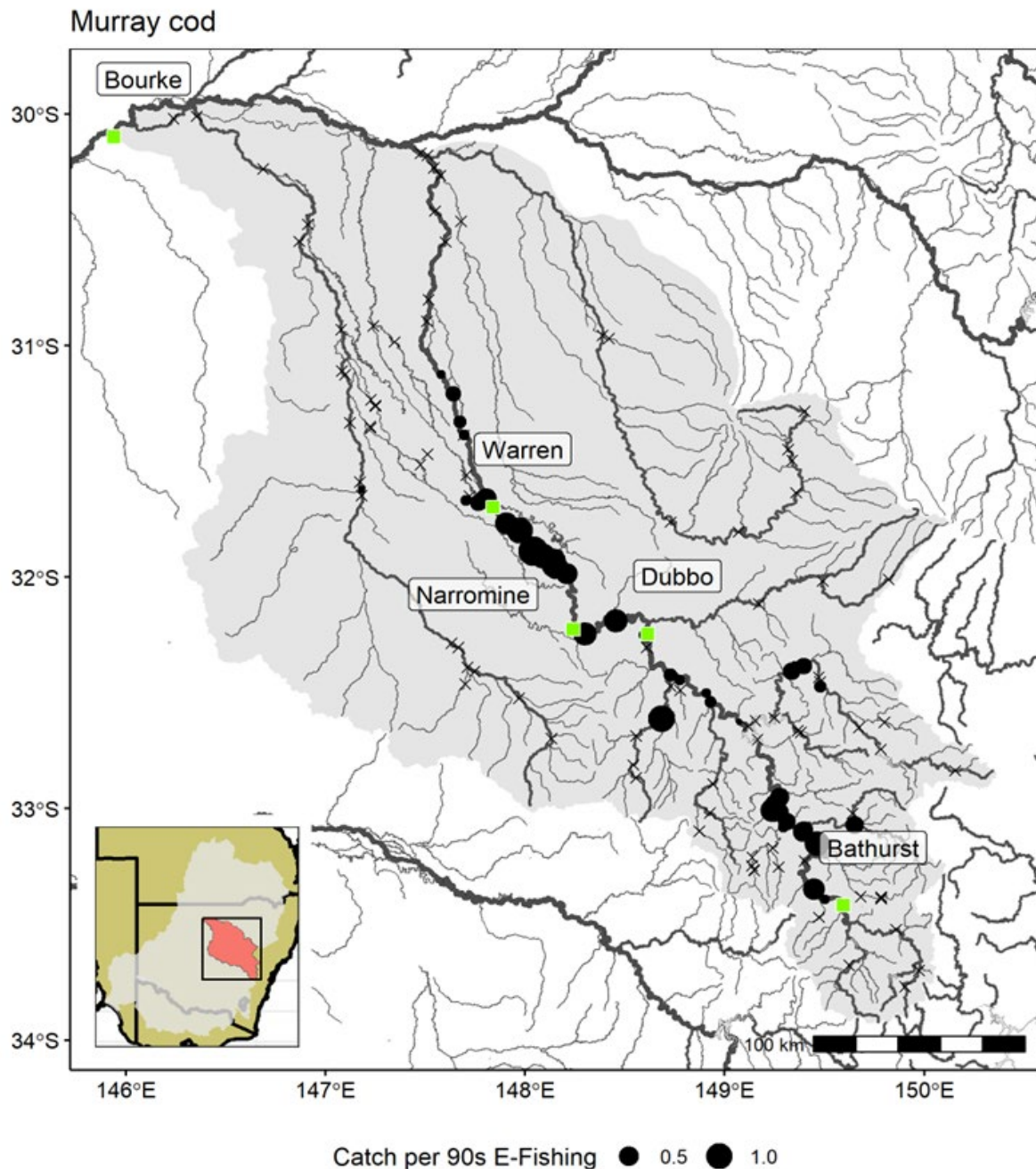


Figure 6.11: Distribution of Murray cod sampled from 2013/14 to 2023/24 in the Macquarie-Castlereagh WRP. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X. Green squares represent key towns.

Golden perch



Population Structure

Figure 6.12 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 72, and 0 % to 31 % of measured fish within a season, with a mean percentage YOY of 6 %.

Overall, during the reporting period, across all the MDB water resource planning areas, the percentage YOY for Golden perch was 8 % (564 out of 7,422).

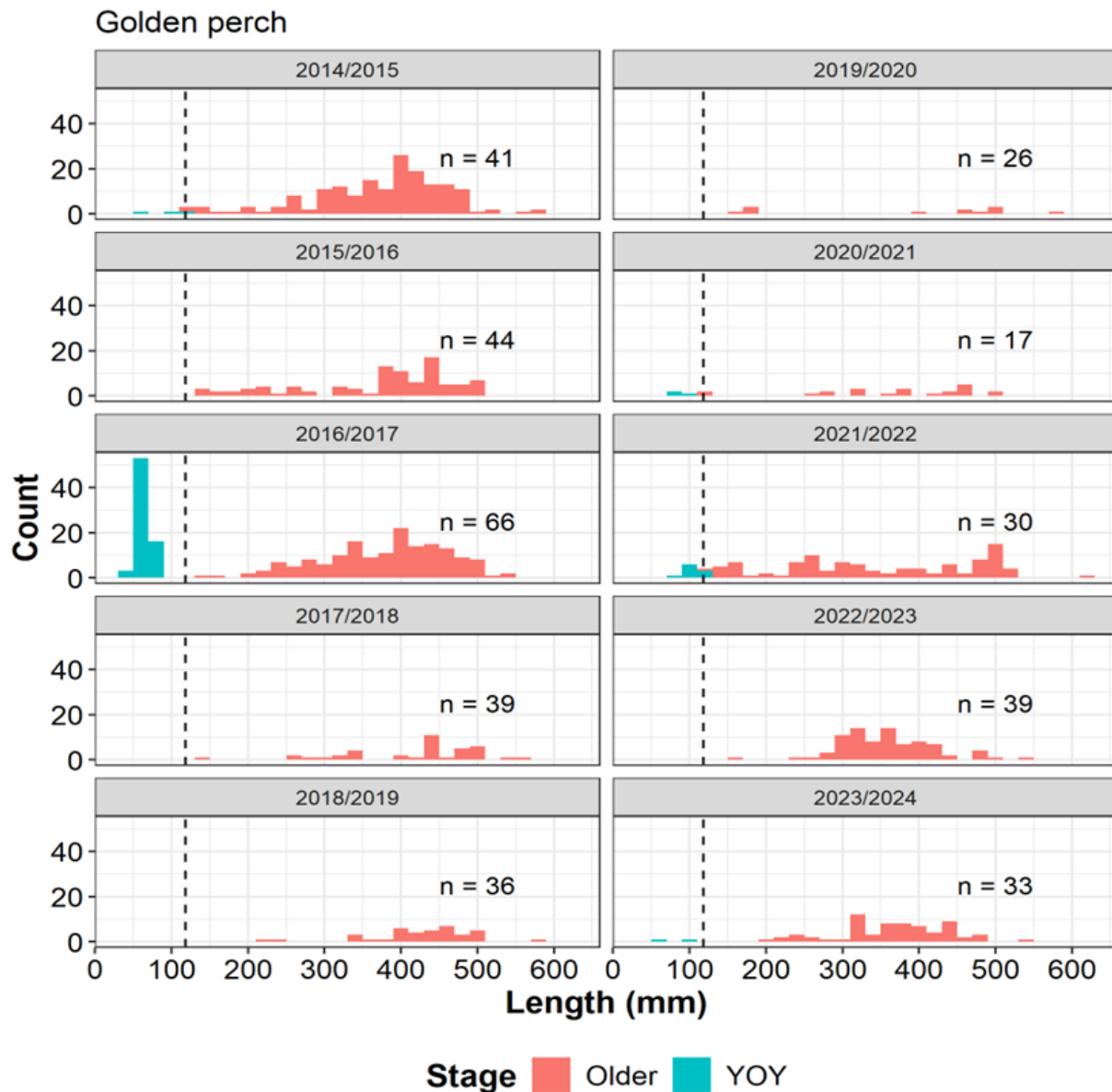


Figure 6.12: Length frequency plots for Golden perch by sampling season in the Macquarie-Castlereagh WRP. YOY represents Young of the Year fish. n shows the number of sites sampled in the WRP in a sampling season.

Summary Statement:

The population consistently showed larger fish but recruitment appears to be sporadic with multiple years of recruitment failure including 2015/16, 2017/18 – 2019-2020 and 2022/23. Very few YOY were observed in 2023/24 suggesting poor recruitment.

Stocking

A total of 1,738,199 Golden perch were stocked into the waterways of the Macquarie-Castlereagh WRPAs during the reporting period. Of these fish, 1,190,921 (68.5 %) were stocked into impoundments while 547,278 (31.5 %) were stocked into rivers or creeks. Table 6.5 shows the detailed breakdown of stocking by season, location and life stage while Figure 6.13 shows the locations of stocking.

Table 6.5: Number and life stage of stocked Golden perch each sampling season in the Macquarie-Castlereagh WRPAs.

Sampling Season	River/Creek or Impoundment	Life Stage	Number Stocked
2014/2015	Impoundment	Fry	162,363
2014/2015	River/Creek	Fry	50,963
2015/2016	Impoundment	Fry	104,058
2015/2016	River/Creek	Fry	64,807
2016/2017	Impoundment	Fry	103,500
2016/2017	River/Creek	Fingerling	26,393
2017/2018	Impoundment	Fry	135,000
2017/2018	River/Creek	Fry	5,000
2018/2019	Impoundment	Fry	91,000
2018/2019	River/Creek	Fry	9,375
2019/2020	River/Creek	Fry	63,666
2020/2021	Impoundment	Fry	180,000
2020/2021	River/Creek	Fry	118,188
2021/2022	Impoundment	Fry	112,000
2021/2022	River/Creek	Fry	64,396
2022/2023	Impoundment	Fry	164,000
2022/2023	River/Creek	Fry	61,682
2023/2024	Impoundment	Fingerling	139,000
2023/2024	River/Creek	Fingerling	82,808

Golden perch stocking

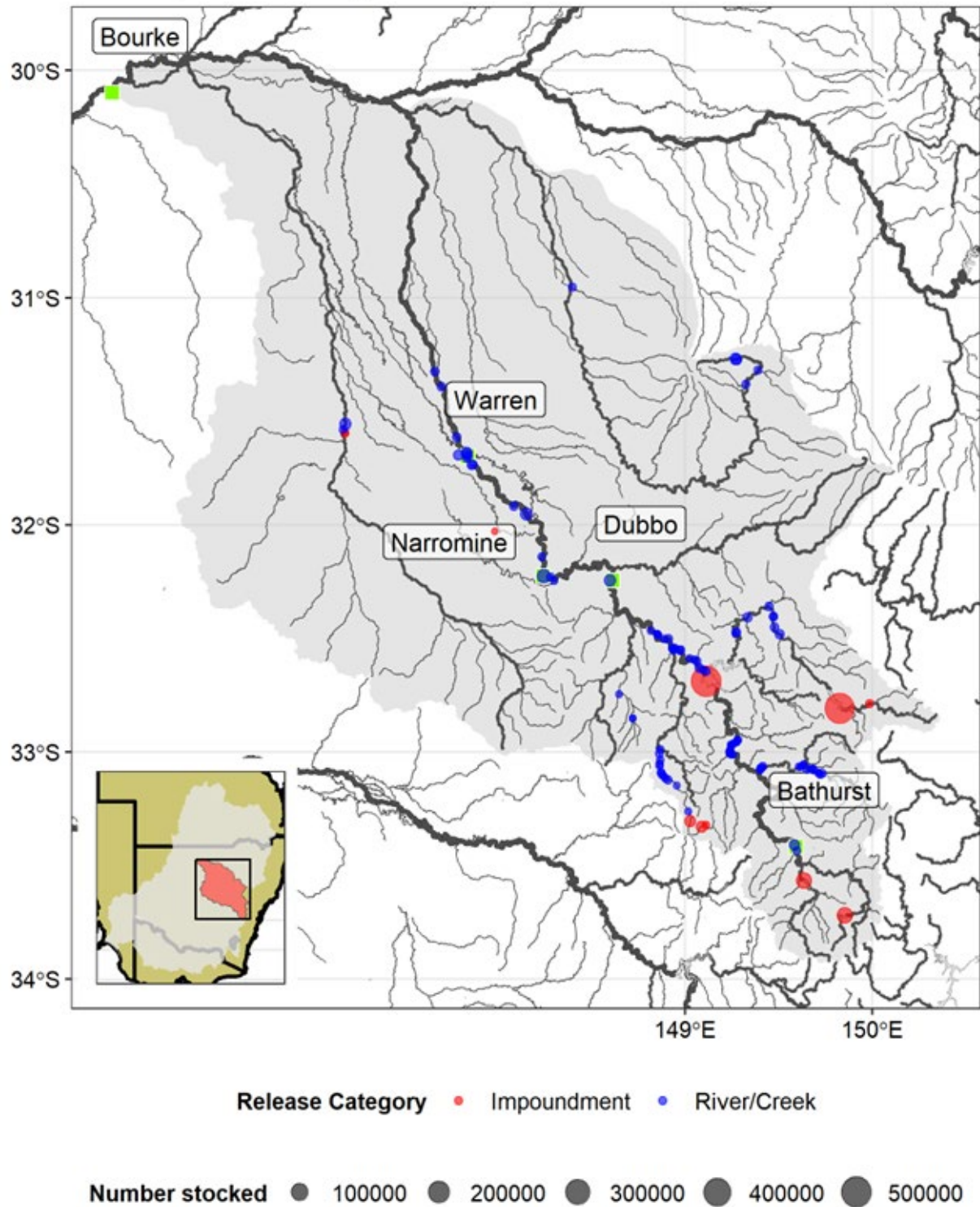


Figure 6.13: Locations of Golden perch stocking in the Macquarie-Castlereagh WRP. Colours show whether a site was a river/creek site or an impoundment, while the size of the point reflects the total number of fish stocked over the reporting period. Green squares represent key towns.

Temporal Trends in Abundance

The relative abundance and biomass of Golden perch since 1994 was modelled based on all suitable boat electrofishing data. The left-hand panels of Figure 6.14 show the abundance and biomass trends for the Macquarie-Castlereagh WRPAs and the right-hand panels show the overall trends across the NSW MDB.

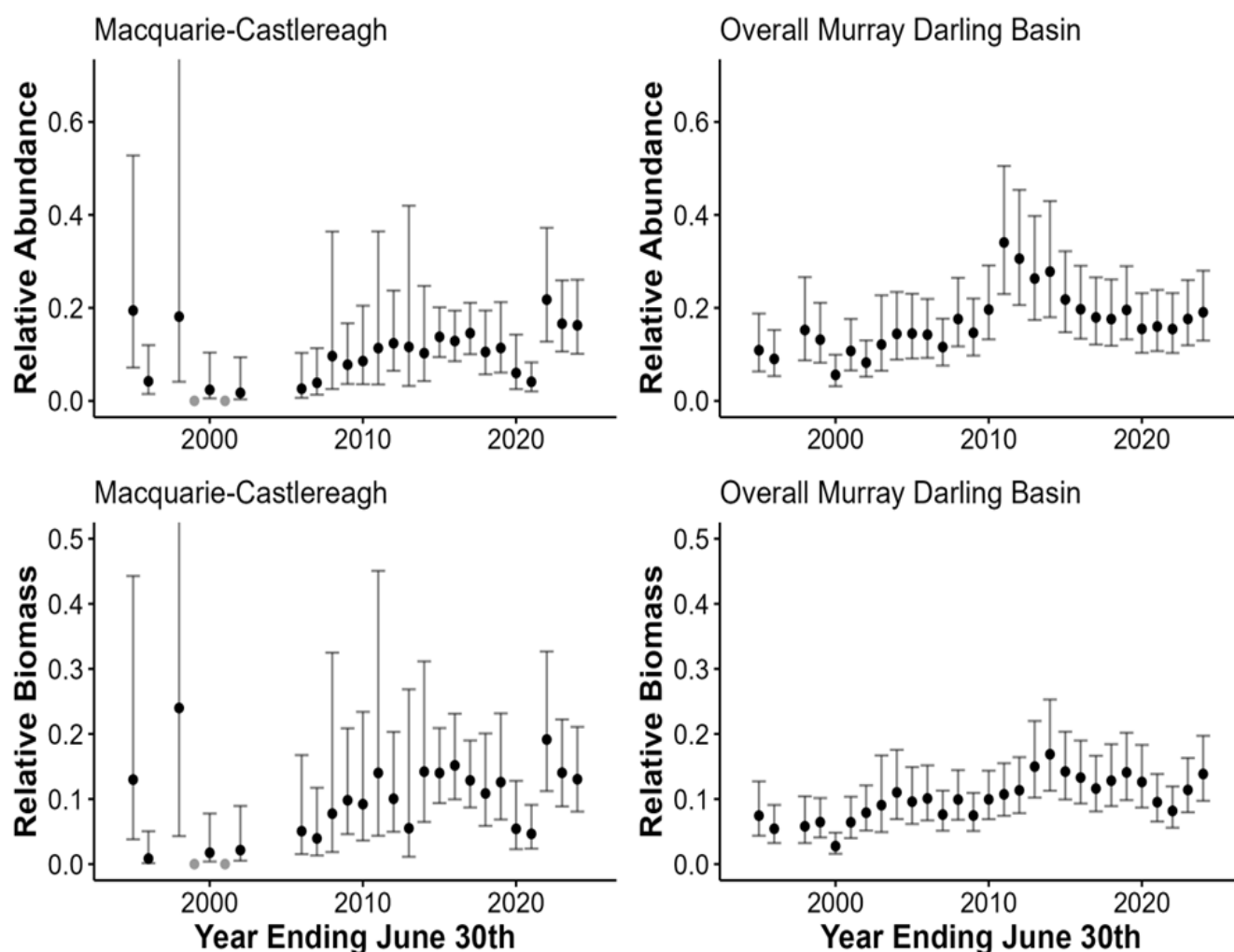


Figure 6.14: Relative abundance and biomass of Golden perch in both this WRPAs and the overall Murray-Darling Basin. These are model estimates based upon all boat electrofishing data within the NSW DPIRD Freshwater ecosystem database and the output of generalised linear mixed models. Error bars show the 95 % confidence intervals around the estimates.

Summary Statement:

For Golden perch in the Macquarie-Castlereagh, there is evidence of an overall increase in abundance and biomass since the early 2000s. Both abundance and biomass increased from low levels since 2021. Relative abundance and biomass are approximately equal to the overall NSW Murray-Darling Basin.

Health

The prevalence of any health issues ranged from 10 % of sampled fish in 2021/2022 to 83 % of sampled fish in 2019/2020 (Figure 6.15). The most common health issue for Golden perch in the Macquarie-Castlereagh water resource planning area was *Lernaea*, which was observed in a total of 181 fish, corresponding to 21 % of all Golden perch measured.

Across the other WRPA's, 25 % of Golden perch (1,823 out of 7,422 Golden perch) showed a health condition (excludes Macquarie-Castlereagh).

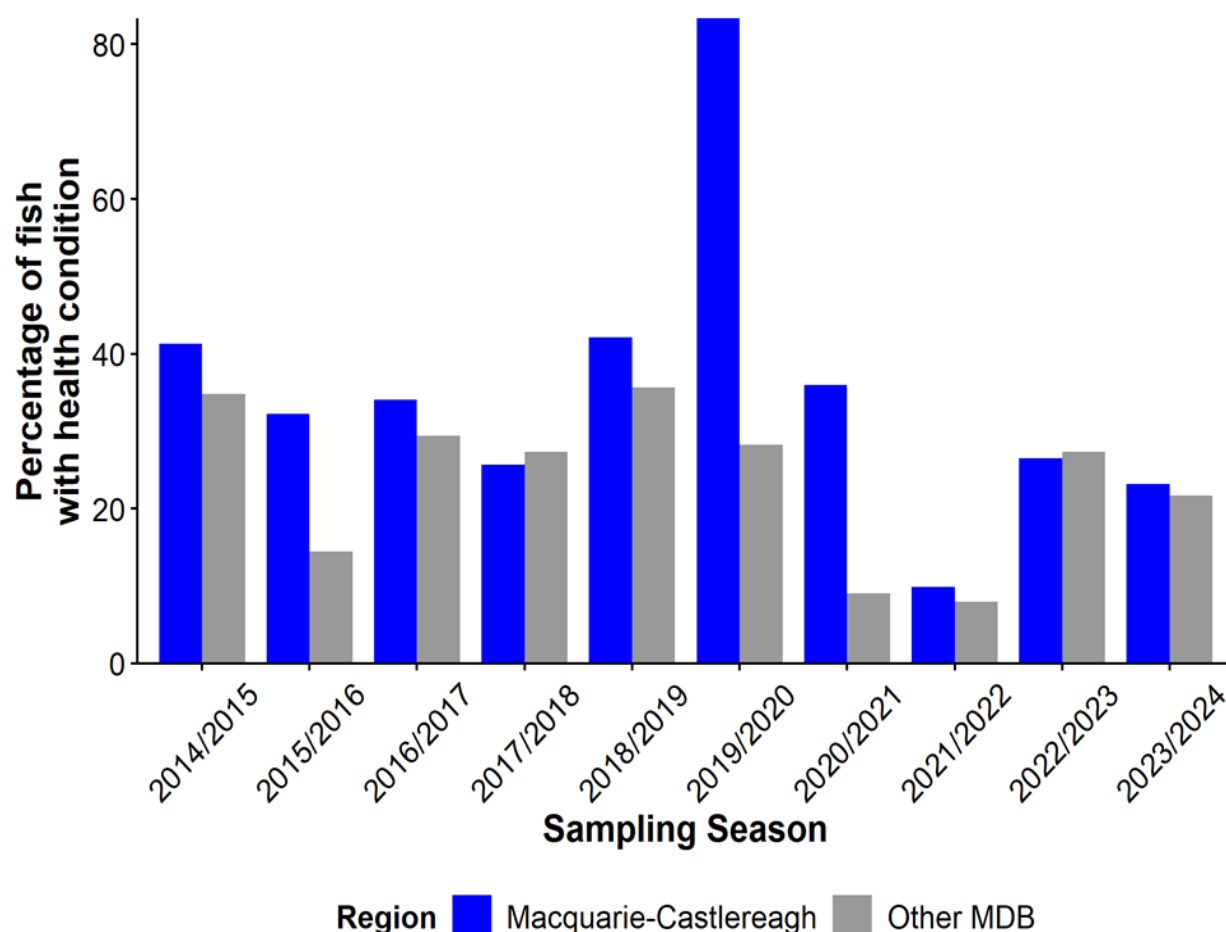


Figure 6.15: Timeseries showing the prevalence of health conditions in Golden perch. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPA's.

Summary Statement:

The presence of observable health conditions for Golden perch in the Macquarie-Castlereagh was moderate to high and generally tracked the average across the rest of the NSW Murray-Darling Basin except for 2019/20 when it was significantly higher.

Distribution

Golden perch were recorded at 64 out of 141 sites in the Macquarie-Castlereagh WRP from 2013/14 to 2023/24. The maximum observed relative abundance at a site was 1.15 fish caught per 90 seconds of electrofishing. Figure 6.16 shows the distribution and relative abundance of Golden perch across the Macquarie-Castlereagh WRP.

Summary Statement:

Golden perch were generally present across the Macquarie-Castlereagh region.

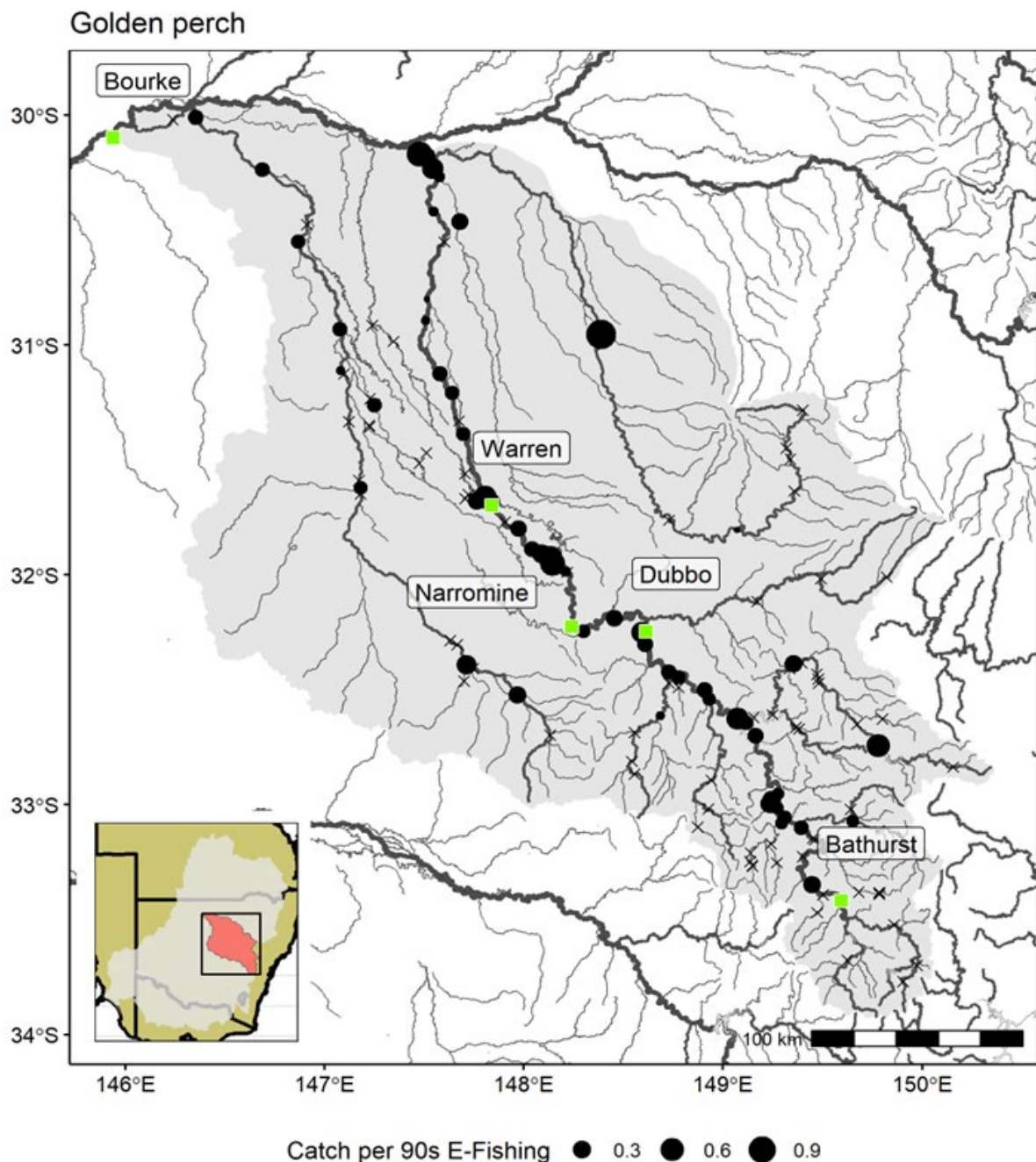


Figure 6.16: Distribution of Golden perch sampled from 2013/14 to 2023/24 in the Macquarie-Castlereagh WRP. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X. Green squares represent key towns.

Freshwater catfish



Population Structure

Figure 6.17 shows the observed length frequency plot for Freshwater catfish for each of the sampling seasons. The observed numbers of Young of the Year (YOY) ranged from 0 to 9, and 0 % to 64 % of measured fish within a season, with a mean percentage YOY of 20 %.

Overall, during the reporting period, across all the MDB water resource planning areas, the percentage YOY for Freshwater catfish was 40 % (390 out of 976).

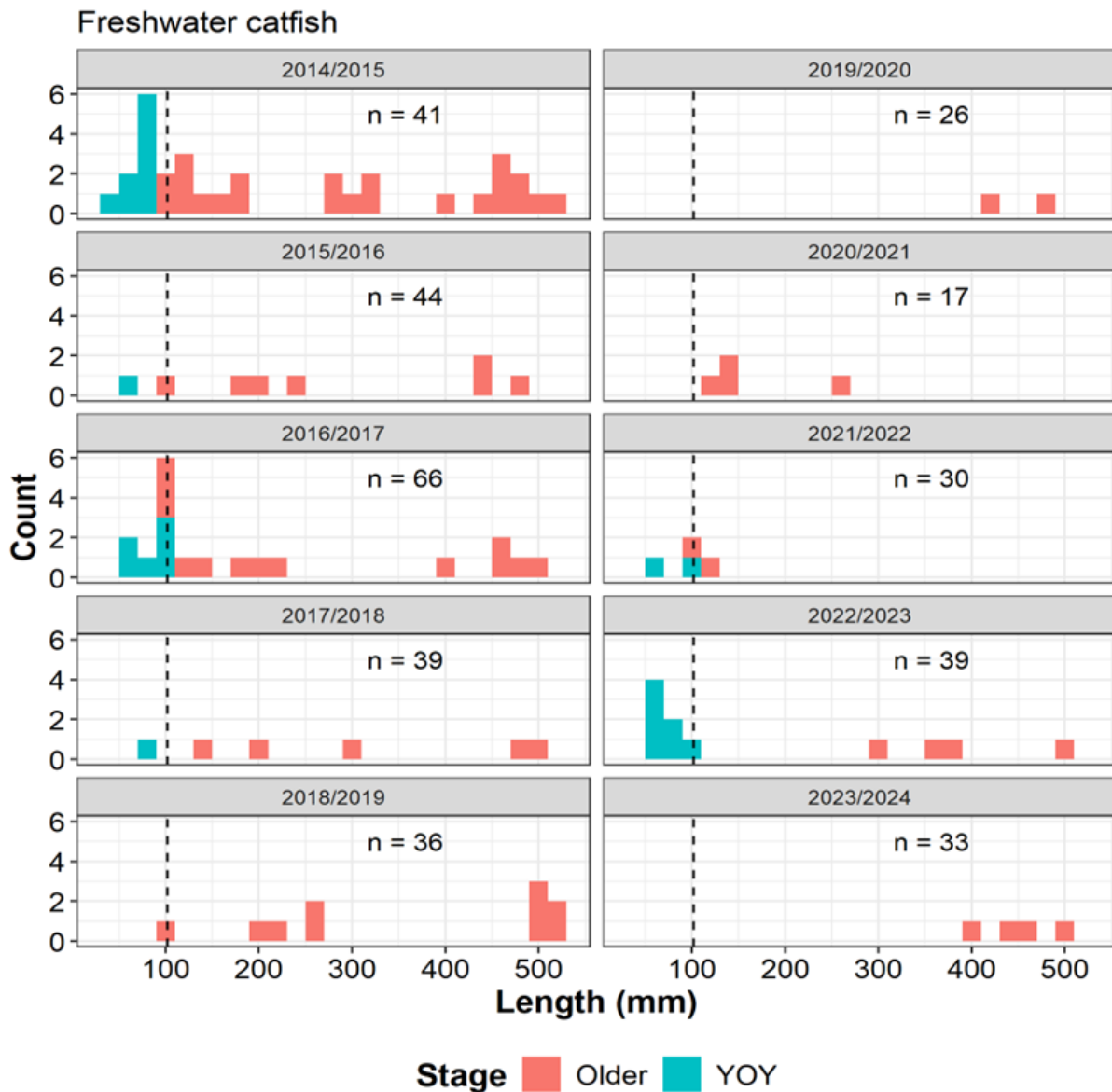


Figure 6.17: Length frequency plots for Freshwater catfish by sampling season in the Macquarie-Castlereagh WRP. YOY represents Young of the Year fish. n shows the number of sites sampled in the WRP in a sampling season.

Summary Statement:

Sporadic recruitment with possible recruitment failure from 2018/19 – 2020/21 and in 2023/24. Despite relatively strong recruitment of YOY in 2022/23, there were very low numbers of Freshwater catfish and no evidence of recruitment in 2023/24.

Temporal Trends in Abundance

The relative abundance and biomass of Freshwater catfish since 1994 was modelled based on all suitable boat electrofishing data. The left-hand panels of Figure 6.18 show the abundance and biomass trends for the Macquarie-Castlereagh WRPA and the right-hand panels show the overall trends across the NSW MDB.

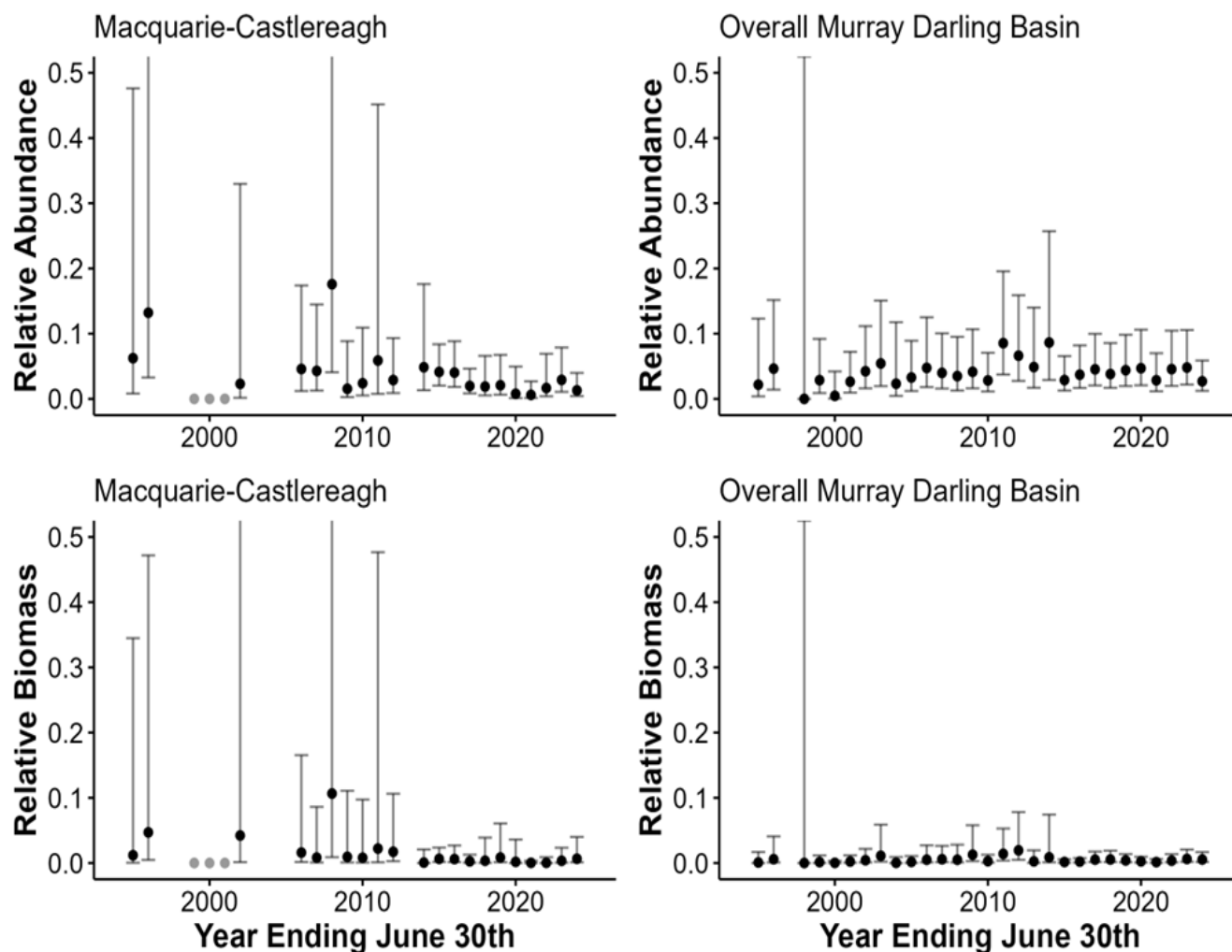


Figure 6.18: Relative abundance and biomass of Freshwater catfish in both this WRPA and the overall Murray-Darling Basin. These are model estimates based upon all boat electrofishing data within the NSW DPIRD Freshwater ecosystem database and the output of generalised linear mixed models. Error bars show the 95 % confidence intervals around the estimates.

Summary Statement:

Abundance and biomass are both low in the Macquarie-Castlereagh WRPA and have likely declined since the 2000s. Abundance and biomass are comparable to the overall NSW MDB.

Health

The prevalence of any health issues ranged from 0 % of sampled fish in multiple years to 17 % of sampled fish in 2017/2018 (Figure 6.19). The most common health issue for Freshwater catfish in the Macquarie-Castlereagh water resource planning area was *Lernaea*, which was observed in a total of 6 fish, corresponding to 6 % of all Freshwater catfish measured.

Across the other WRPA's, 1 % of Freshwater catfish (12 out of 976 Freshwater catfish) showed a health condition (excludes Macquarie-Castlereagh).

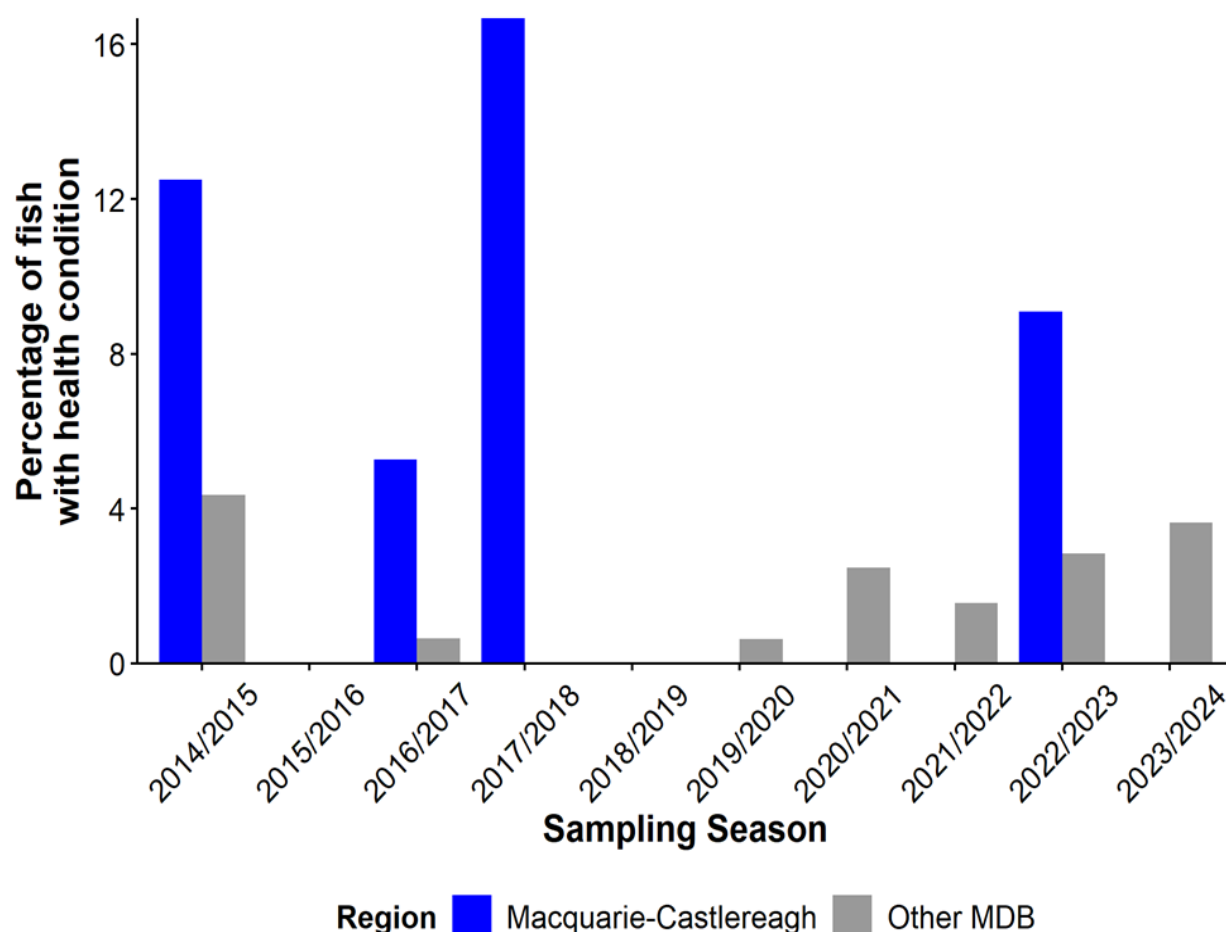


Figure 6.19: Timeseries showing the prevalence of health conditions in Freshwater catfish. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPA's.

Summary Statement:

The presence of observable health conditions for Freshwater catfish in the Macquarie-Castlereagh was overall low – moderate and above the level observed in the other areas of the NSW MDB (when health issues were observed). No health issues were observed in 2023/24 but limited fish were sampled.

Distribution

Freshwater catfish were recorded at 25 out of 141 sites in the Macquarie-Castlereagh WRP from 2013/14 to 2023/24. The maximum observed relative abundance at a site was 0.7 fish caught per 90 seconds of electrofishing. Figure 6.20 shows the distribution and relative abundance of Freshwater catfish across the Macquarie-Castlereagh WRP.

Summary Statement:

Freshwater catfish were generally restricted to the central and upland areas of the Macquarie-Castlereagh WRP.

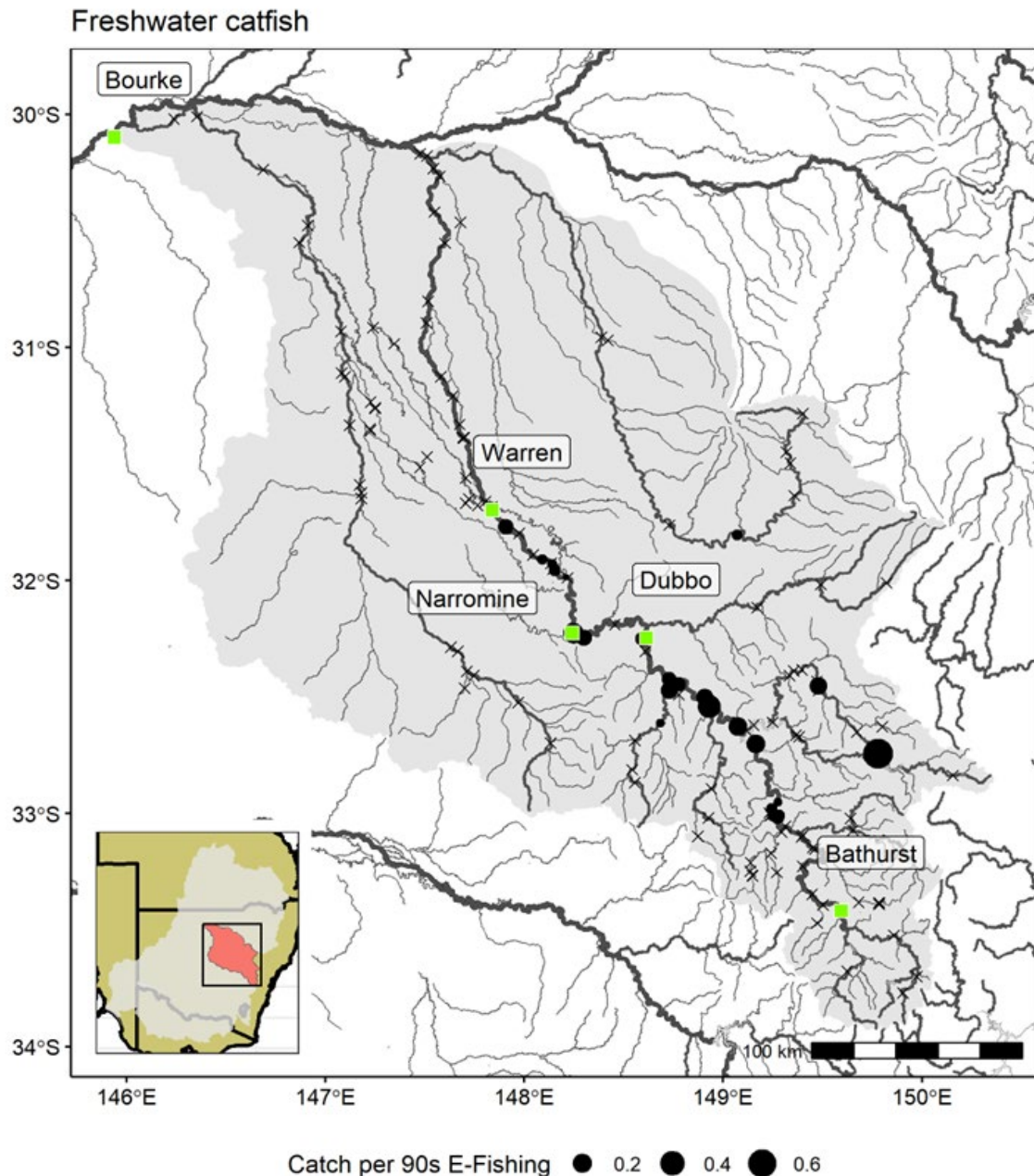


Figure 6.20: Distribution of Freshwater catfish sampled from 2013/14 to 2023/24 in the Macquarie-Castlereagh WRP. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X. Green squares represent key towns.

Bony herring



Population Structure

Figure 6.21 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 11 to 73, and 5 % to 65 % of measured fish within a season, with a mean percentage YOY of 25 %.

Overall, during the reporting period, across all the MDB water resource planning areas, the percentage YOY for Bony herring was 25 % (13,207 out of 52,608). Bony herring are not a stocked species.

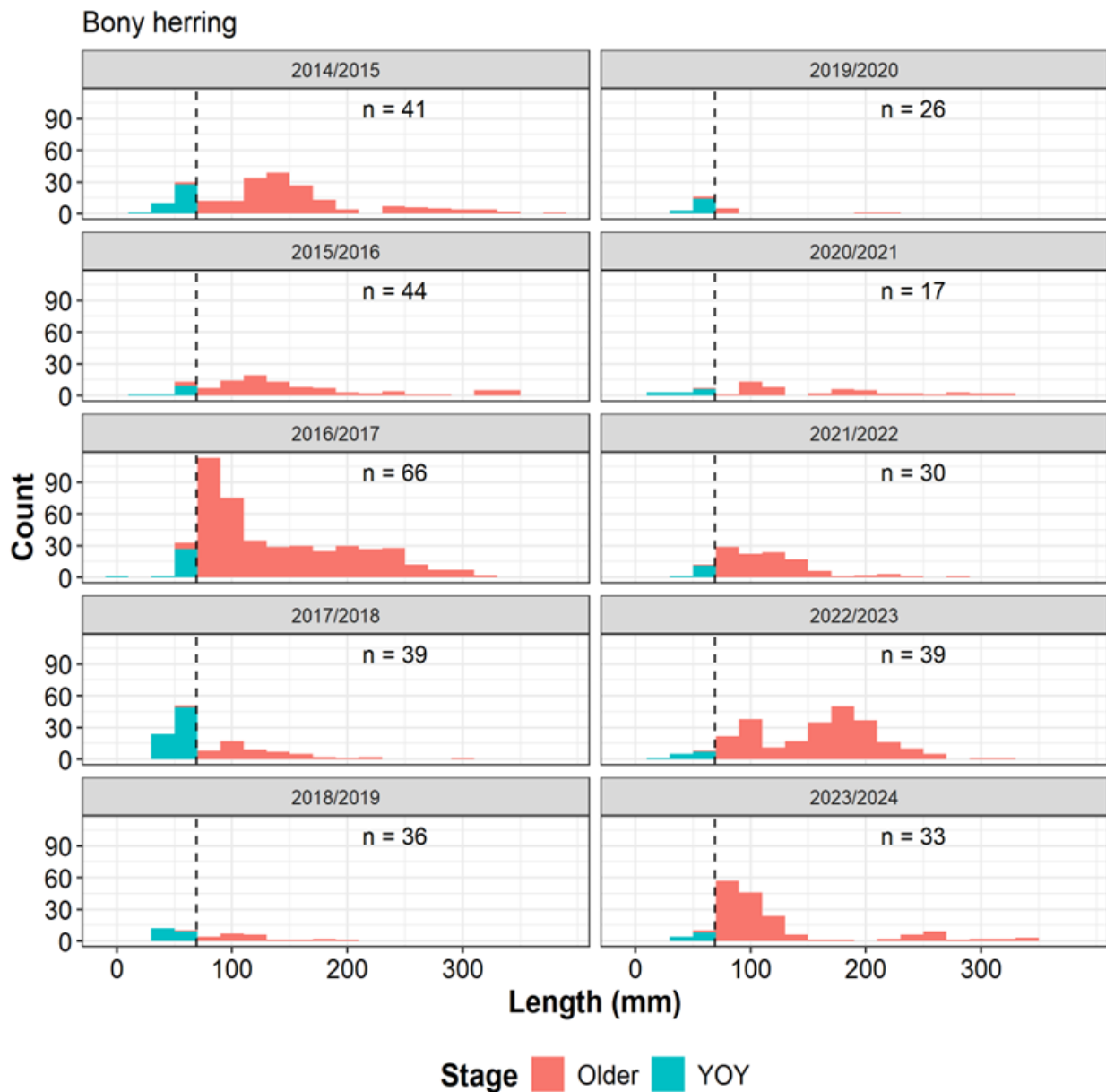


Figure 6.21: Length frequency plots for Bony herring by sampling season in the Macquarie-Castlereagh WRPA. YOY represents Young of the Year fish. n shows the number of sites sampled in the WRPA in a sampling season.

Summary Statement:

Regular recruitment with variable numbers of YOY. Some evidence of recruitment in 2023/24 with multiple size classes evident.

Temporal Trends in Abundance

The relative abundance and biomass of Bony herring since 1994 was modelled based on all suitable boat electrofishing data. The left-hand panels of Figure 6.22 show the abundance and biomass trends for the Macquarie-Castlereagh WRPA and the right-hand panels show the overall trends across the NSW MDB.

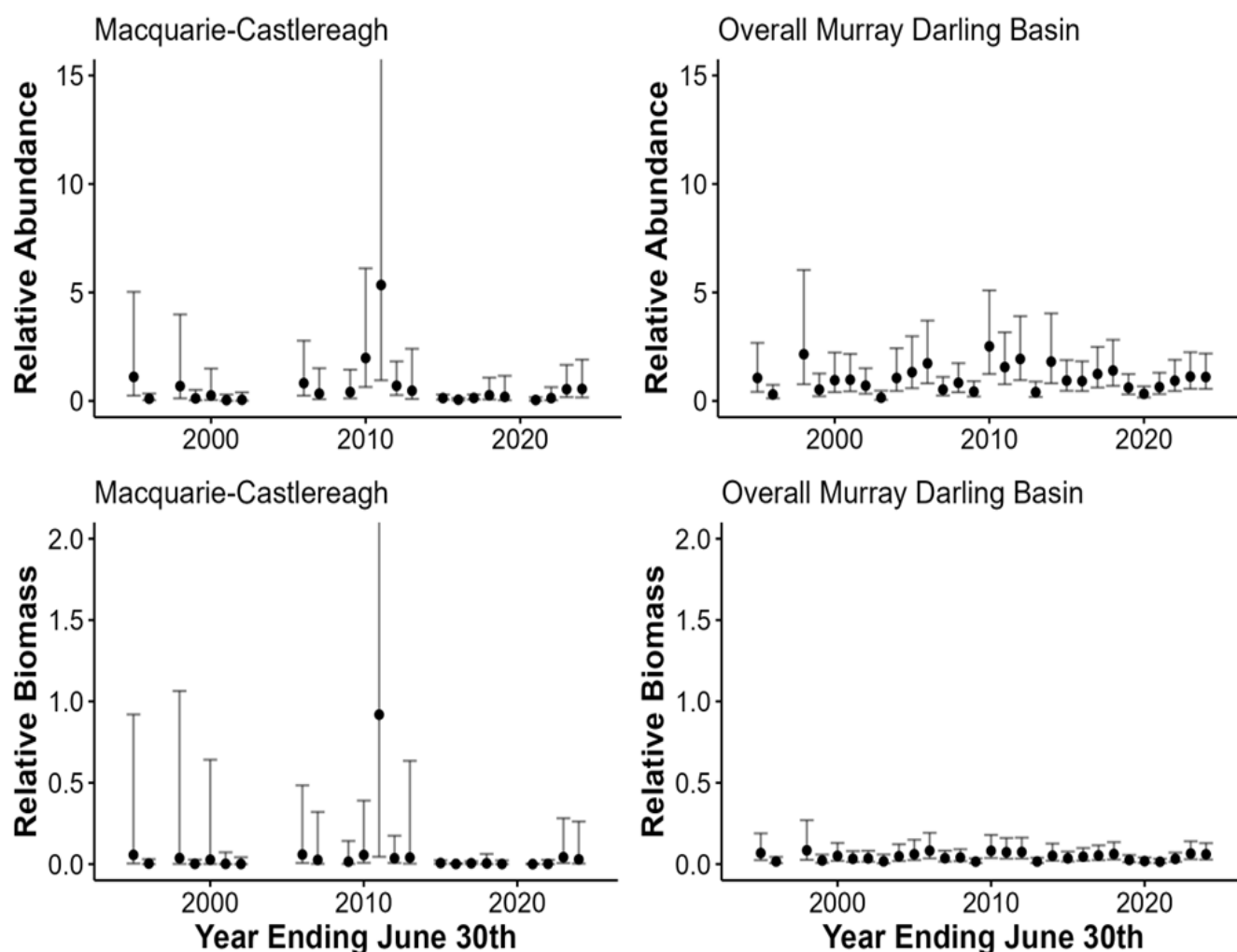


Figure 6.22: Relative abundance and biomass of Bony herring in both this WRPA and the overall NSW MDB. These are model estimates based upon all boat electrofishing data within the NSW DPIRD Freshwater ecosystem database and the output of generalised linear mixed models. Error bars show the 95 % confidence intervals around the estimates. Note some error bars have been truncated for clarity.

Summary Statement:

Variable abundance and biomass but both appear to have increased slightly since 2020 and 2021 and are comparable to the wider NSW MDB.

Health

The prevalence of any health issues ranged from 0 % of sampled fish in multiple years to 6 % of sampled fish in 2016/2017 (Figure 6.23). The most common health issue for Bony herring in the Macquarie-Castlereagh WRPAs was Wounds, which was observed in a total of 11 fish, corresponding to 1 % of all Bony herring measured.

Across the other NSW MDB WRPA, 1 % of Bony herring (526 out of 52,609 Bony herring) showed a health condition (excludes the Macquarie-Castlereagh WRPAs).

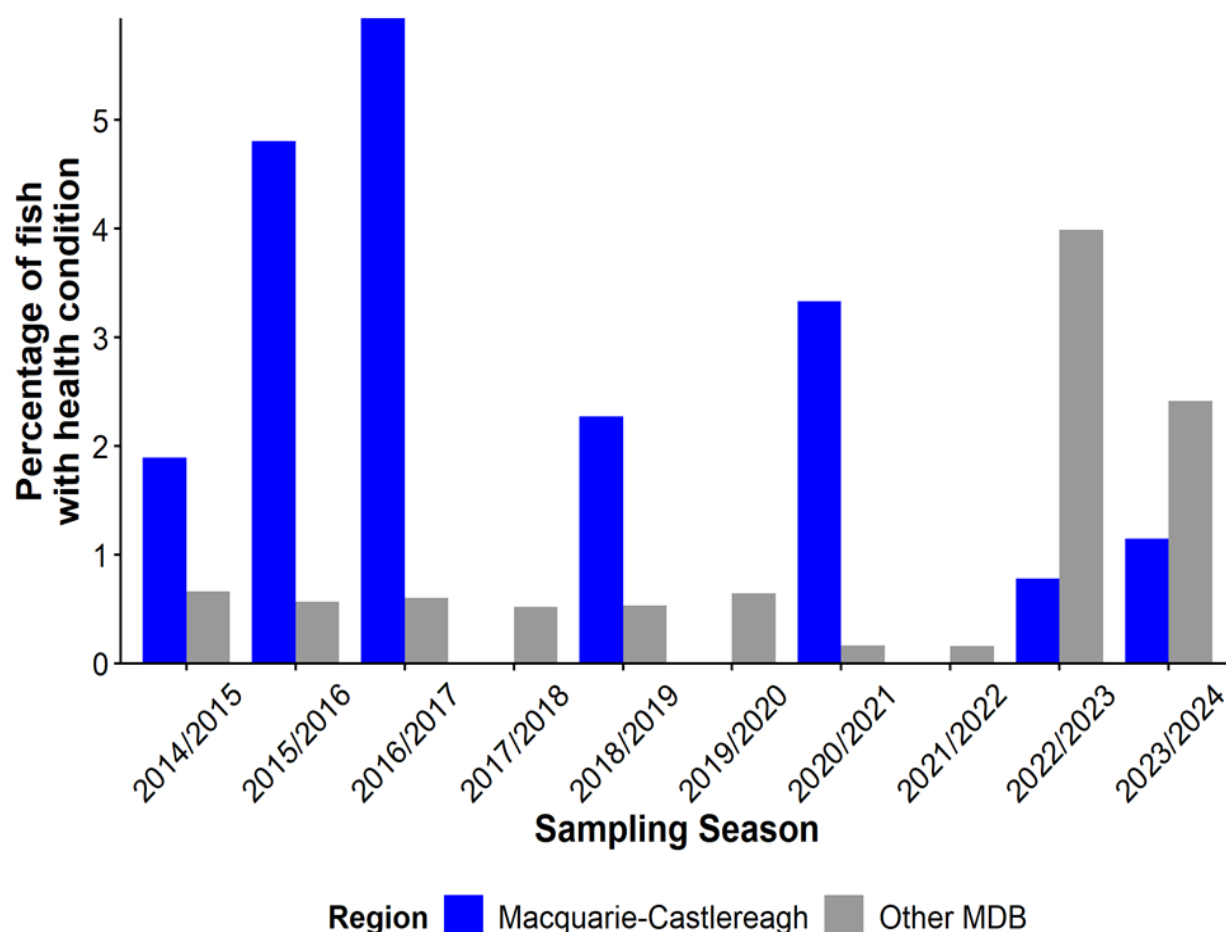


Figure 6.23: Timeseries showing the prevalence of health conditions in Bony herring. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPA.

Summary Statement:

Presence of observable health conditions was generally low but often at higher levels than the rest of the NSW MDB. Low proportion of health issues in 2022/23 compared to the rest of the NSW MDB.

Distribution

Bony herring were recorded at 37 out of 141 sites in the Macquarie-Castlereagh WRP from 2013/14 to 2023/24. The maximum observed relative abundance at a site was 14.1 fish caught per 90 seconds of electrofishing. Figure 6.24 shows the distribution and relative abundance of Bony herring across the Macquarie-Castlereagh WRP.

Summary Statement:

Bony herring appear to be mainly restricted to the northern Macquarie-Castlereagh WRP with very few occurrences south of Dubbo.

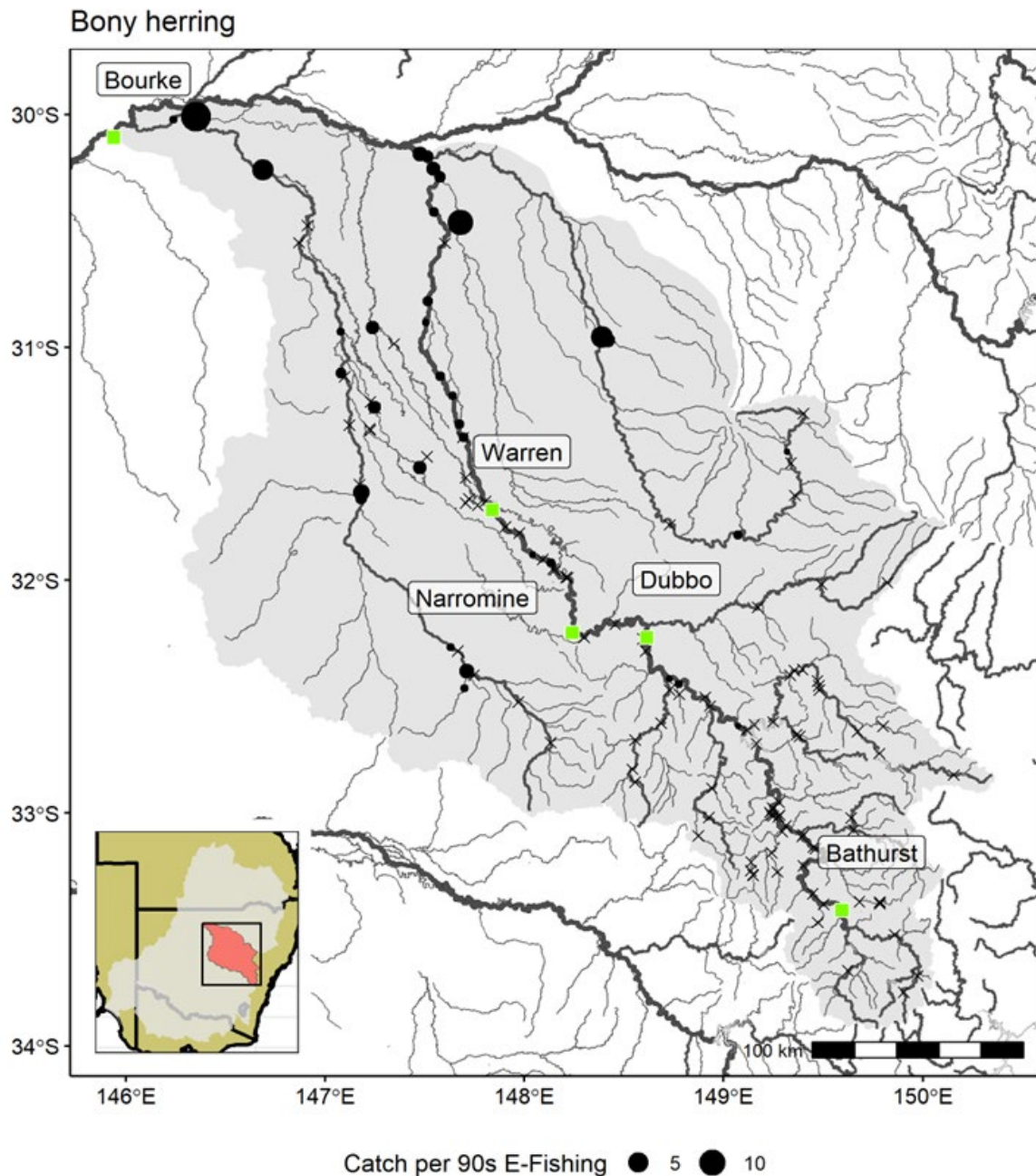


Figure 6.24: Distribution of Bony herring sampled from 2013/14 to 2023/24 in the Macquarie-Castlereagh WRP. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X. Green squares represent key towns.

Australian smelt



Population Structure

Figure 6.25 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 2 to 211, and 4 % to 64 % of measured fish within a season, with a mean percentage YOY of 30 %.

Overall, during the reporting period, across all the MDB water resource planning areas, the percentage YOY for Australian smelt was 42 % (10,896 out of 26,222). Australian smelt are not a stocked species.

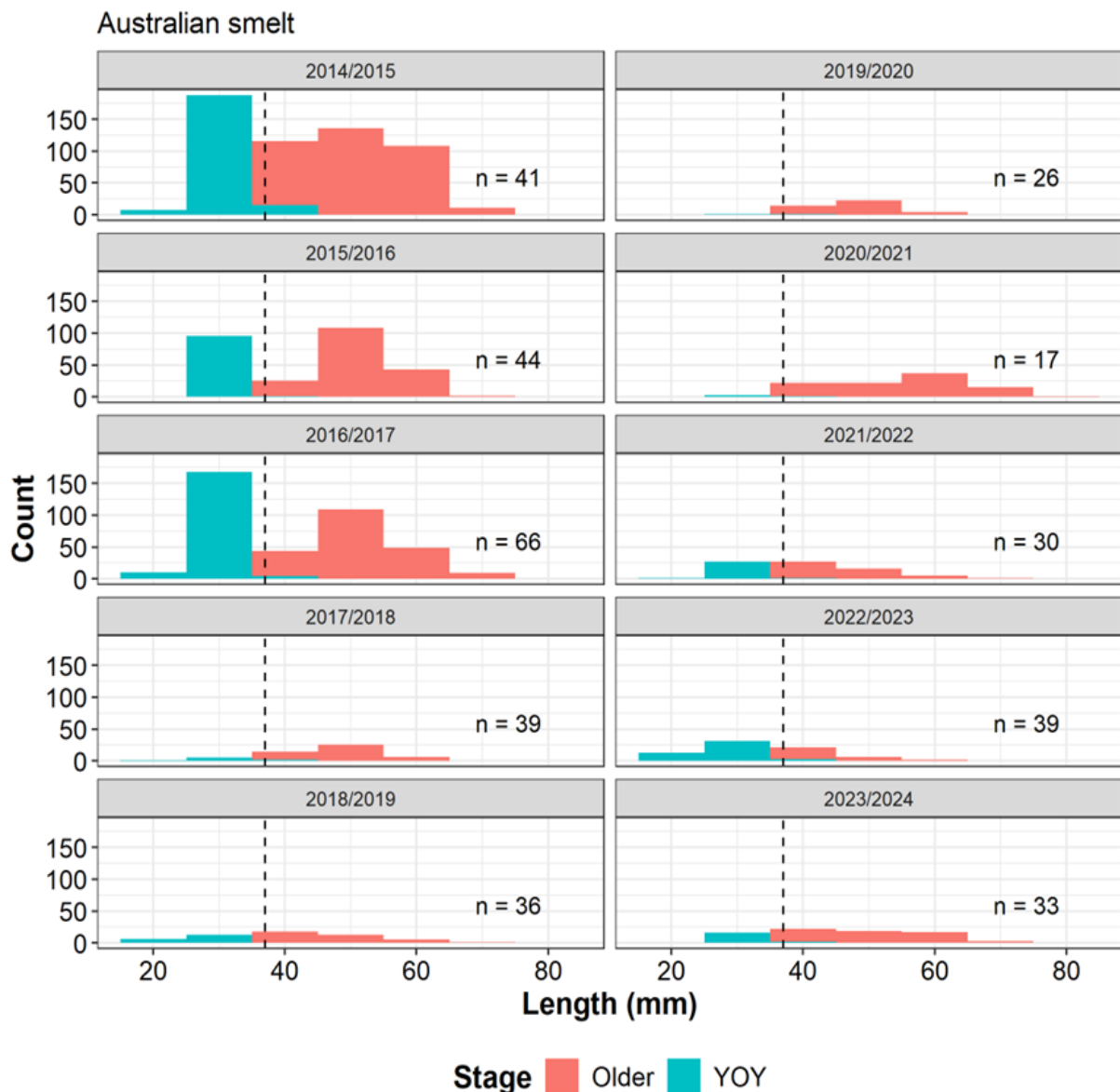


Figure 6.25: Length frequency plots for Australian smelt by sampling season in the Macquarie-Castlereagh WRPA. YOY represents Young of the Year fish. n shows the number of sites sampled in the WRPA in a sampling season.

Summary Statement:

Regular recruitment but evidence of large recruitment events from 2014/15 – 2016/17. Lower recruitment in following years including 2023/24.

Temporal Trends in Abundance

The relative abundance of Australian smelt since 1994 was modelled based on all suitable boat electrofishing data. The left-hand panel of Figure 6.26 show the abundance trends for the Macquarie-Castlereagh WRPAs and the right-hand panel show the overall trend across the NSW MDB.

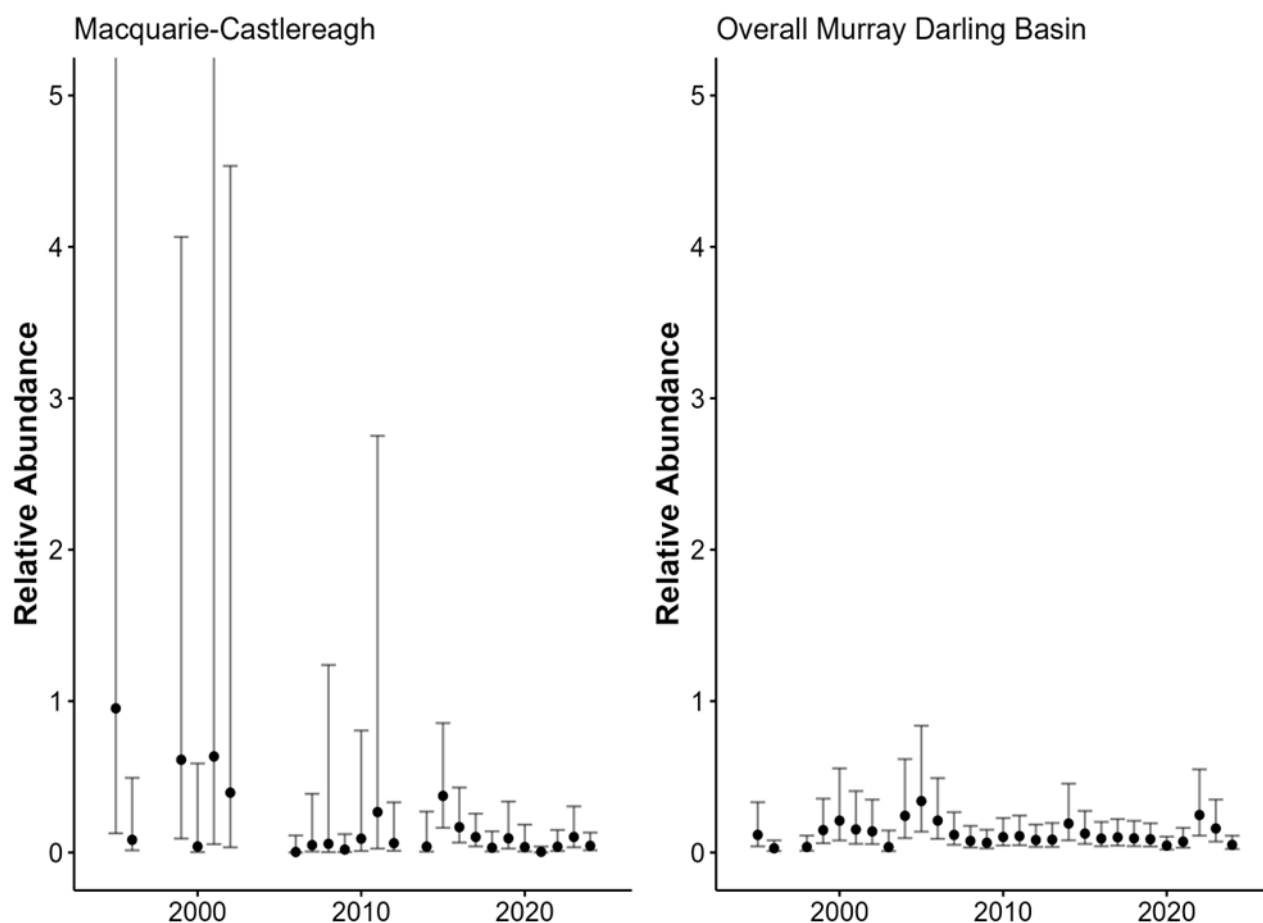


Figure 6.26: Relative abundance of Australian smelt in both this WRPAs and the overall NSW MDB. These are model estimates based upon all boat electrofishing data within the NSW DPIRD Freshwater ecosystem database and the output of generalised linear mixed models. Error bars show the 95 % confidence intervals around the estimates. No modelling of biomass was done for Australian smelt.

Summary Statement:

Highly variable abundance but there is some evidence that abundance has declined since 2015. Abundance is similar to the overall NSW MDB.

Health

The prevalence of any health issues ranged from 0 % of sampled fish in all years since 2016/17 to 1 % of sampled fish to 2016/2017 (Figure 6.27). The most common health issue for Australian smelt in the Macquarie-Castlereagh WRPAs was Lesions, which was observed in a total of 3 fish, corresponding to <1 % of all Australian smelt measured.

Across the other NSW MDB WRPA, 1 % of Australian smelt (168 out of 26,224 Australian smelt) showed a health condition (excludes the Macquarie-Castlereagh WRPAs).

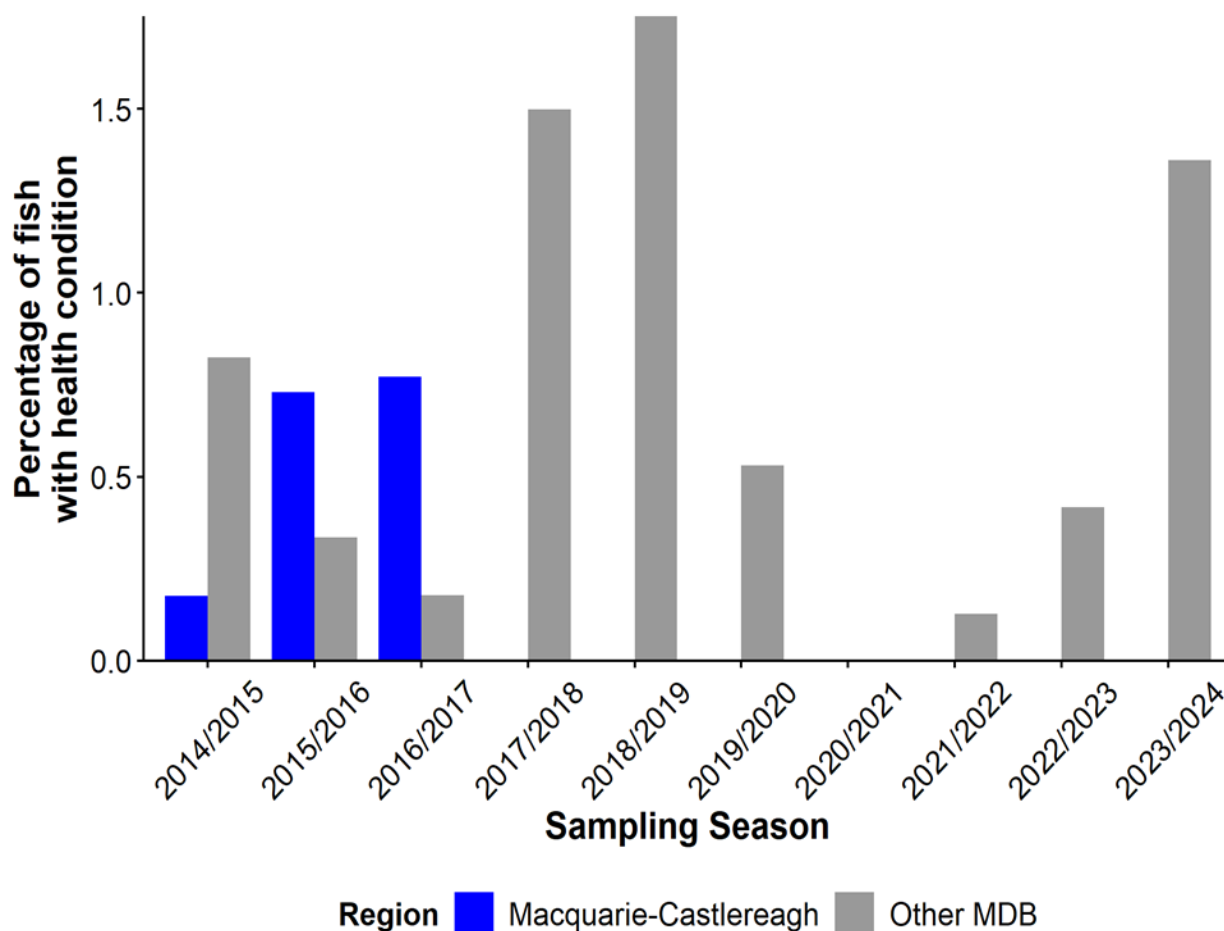


Figure 6.27: Timeseries showing the prevalence of health conditions in Australian smelt. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPA.

Summary Statement:

Very few health issues were recorded in Australian smelt in the Macquarie-Castlereagh and none in recent years.

Distribution

Australian smelt were recorded at 51 out of 141 sites in the Macquarie-Castlereagh WRP from 2013/14 to 2023/24. The maximum observed relative abundance at a site was 8.3 fish caught per 90 seconds of electrofishing. Figure 6.28 shows the distribution and relative abundance of Australian smelt across the Macquarie-Castlereagh WRP.

Summary Statement:

Australian smelt were mostly observed across the southern half of the Macquarie-Castlereagh WRP with very few observations in the northern region.

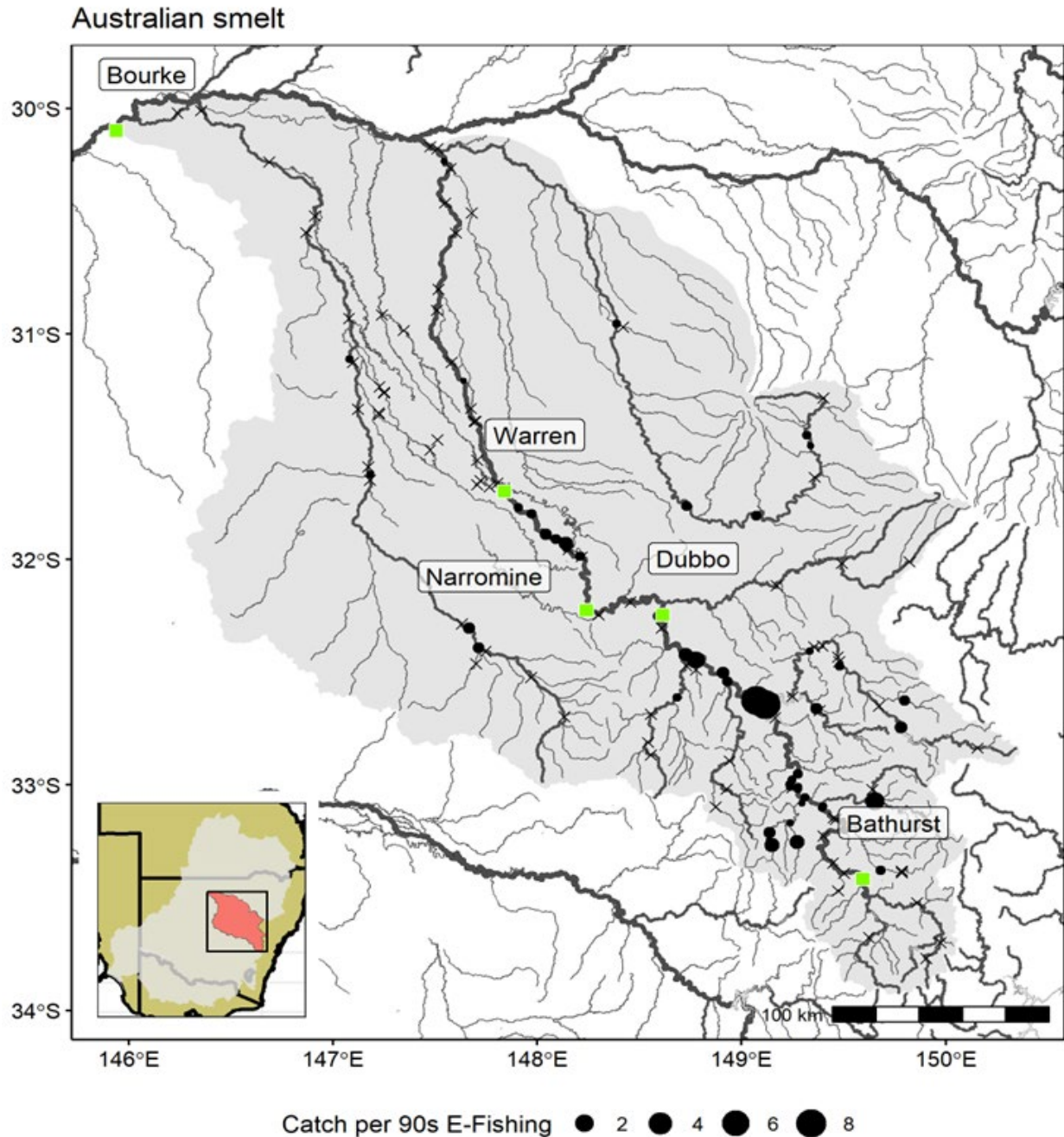


Figure 6.28: Distribution of Australian smelt sampled from 2013/14 to 2023/24 in the Macquarie-Castlereagh WRP. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X. Green squares represent key towns.

Common carp



Population Structure

Figure 6.29 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 54 to 1925, and 9 % to 74 % of measured fish within a season, with a mean percentage YOY of 36 %.

Overall, during the reporting period, across all the MDB water resource planning areas, the percentage YOY for Common carp was 57 % (31,755 out of 55,973).

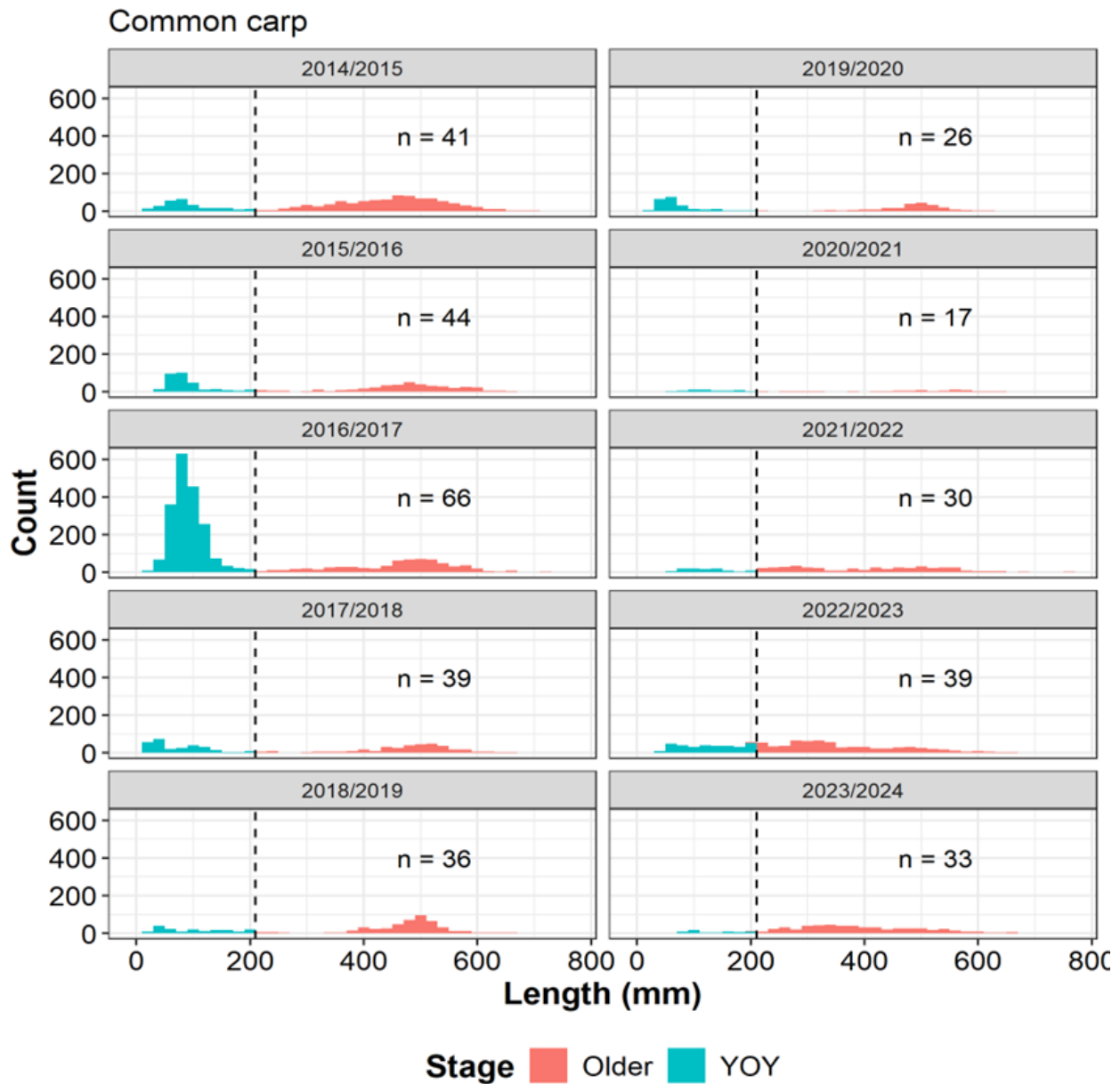


Figure 6.29: Length frequency plots for common carp by sampling season in the Macquarie-Castlereagh WRPA. YOY represents Young of the Year fish. n shows the number of sites sampled in the WRPA in a sampling season.

Summary Statement:

Variable recruitment with a very strong peak in 2016/17. Large fish (>500 mm) present in all years. Low recruitment in 2023/24 with evidence of multiple year classes in the population.

Temporal Trends in Abundance

The relative abundance and biomass of Common carp since 1994 was modelled based on all suitable boat electrofishing data. The left-hand panels of Figure 6.30 show the abundance and biomass trends for the Macquarie-Castlereagh WRPA and the right-hand panels show the overall trends across the NSW MDB.

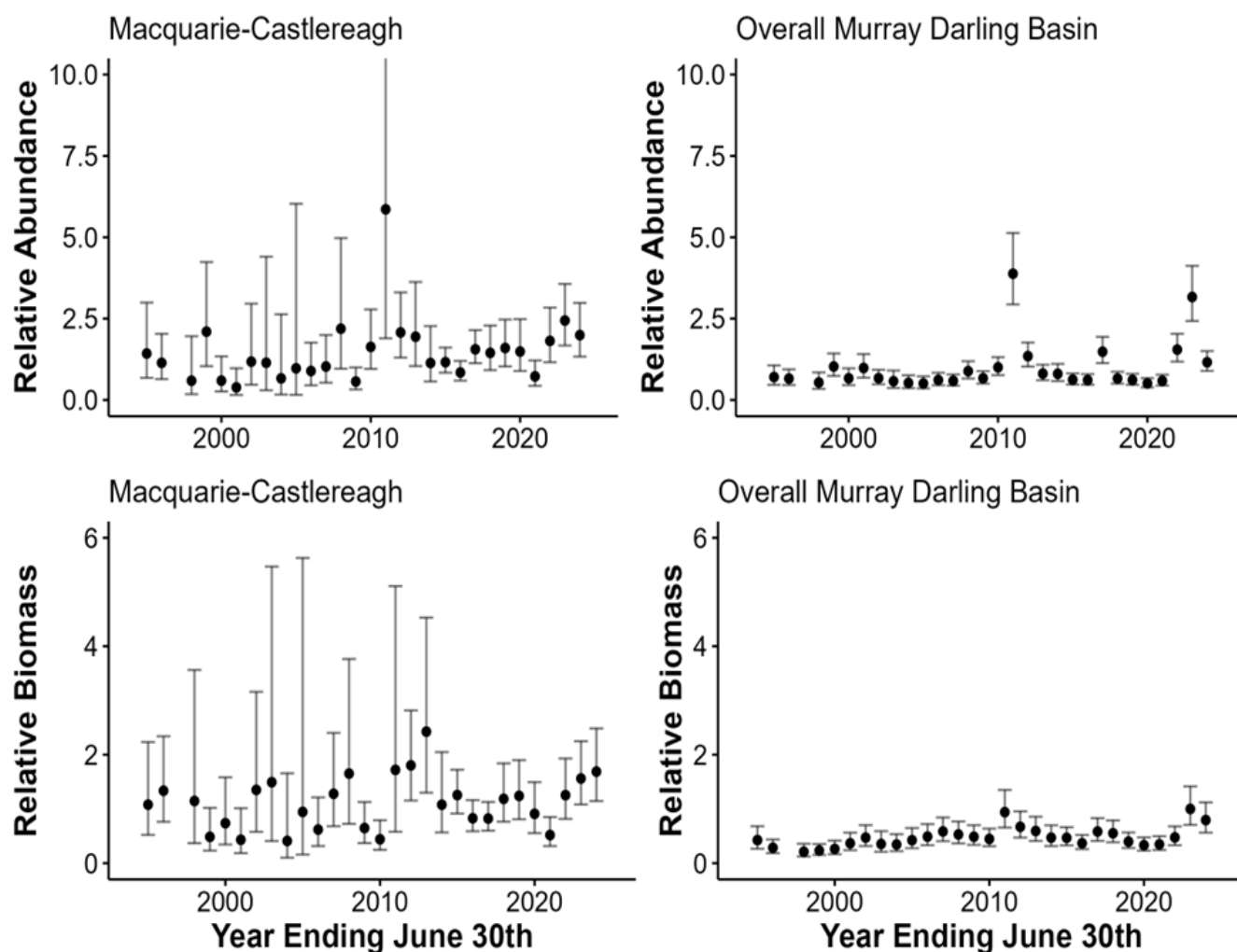


Figure 6.30: Relative abundance and biomass of Common carp in both this valley and the overall Murray-Darling Basin. These are model estimates based upon all electrofishing data within the NSW DPIRD Freshwater ecosystem database and the output of generalised linear mixed models. Error bars show the 95 % confidence intervals around the estimates.

Summary Statement:

Abundance and biomass are likely both slightly higher than the 1990s following strong recruitment in recent years. Recent abundance similar to, or slightly higher, than overall NSW MDB. Recent biomass higher than overall NSW MDB and trending upwards.

Health

The prevalence of any health issues ranged from 3 % of sampled fish in 2017/2018 to 18 % of sampled fish in 2018/2019 (Figure 6.31). The most common health issue for Common carp in the Macquarie-Castlereagh water resource planning area was *Lernaea*, which was observed in a total of 480 fish, corresponding to 6 % of all Common carp measured.

Across the other WRPA's, 3 % of Common carp (1,680 out of 55,975 Common carp) showed a health condition (excludes Macquarie-Castlereagh).

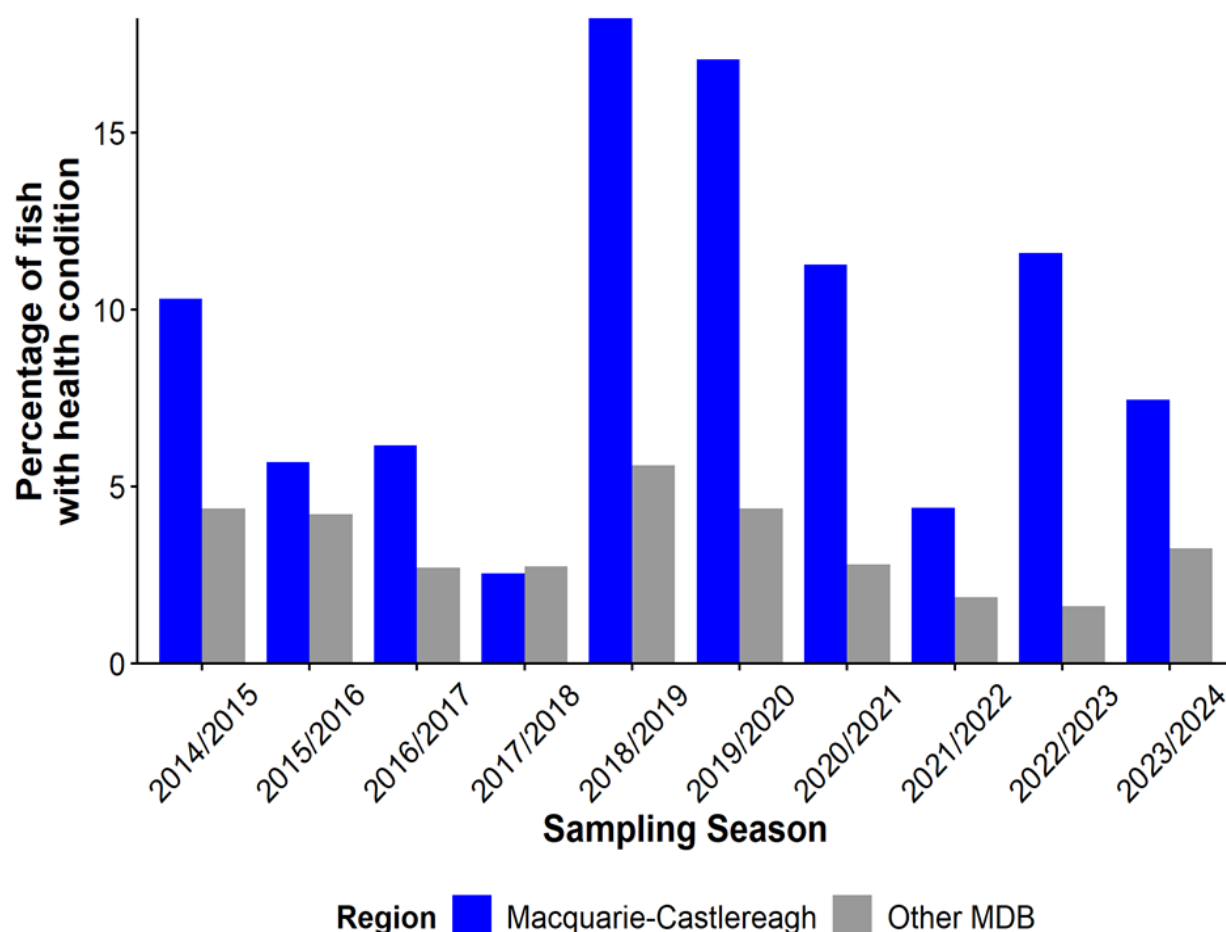


Figure 6.31: Timeseries showing the prevalence of health conditions in Common carp. Blue shows the region-specific data while the grey shows the average across the other NSW MDB WRPA's.

Summary Statement:

The presence of observable health conditions for Common carp in the Macquarie-Castlereagh was low to moderate and but consistently higher than the wider NSW MDB. 2023/24 showed a moderate level of health issues.

Distribution

Common carp were recorded at 121 out of 141 sites in the Macquarie-Castlereagh WRP from 2013/14 to 2023/24. The maximum observed relative abundance at a site was 26.8 fish caught per 90 seconds of electrofishing. Figure 6.32 shows the distribution and relative abundance of Common carp across the Macquarie-Castlereagh WRP.

Summary Statement:

Common carp were found in relatively high abundance across the Macquarie-Castlereagh region.

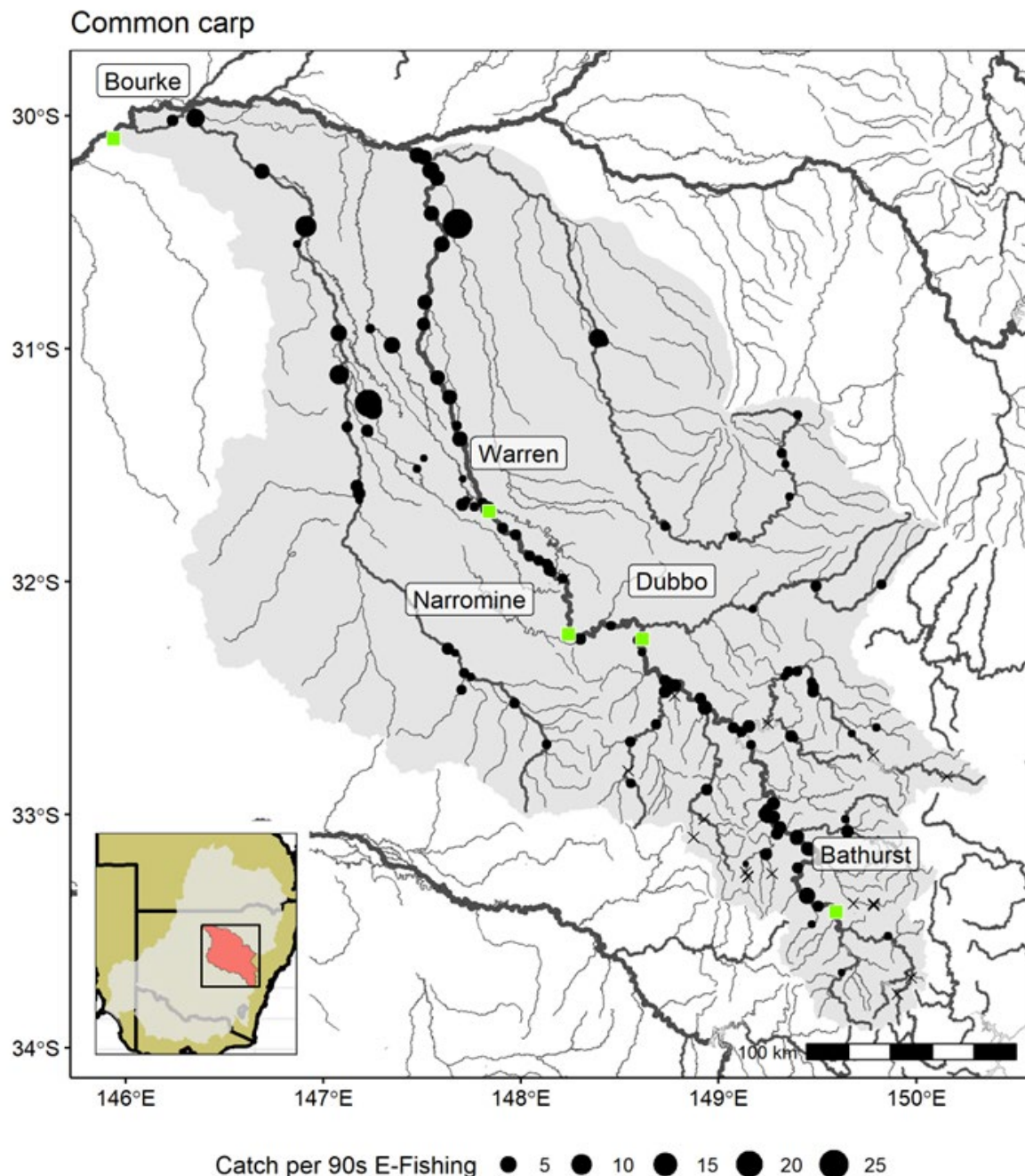


Figure 6.32: Distribution of Common carp sampled from 2013/14 to 2023/24 in the Macquarie-Castlereagh WRP. Filled circles show sites where the species was present, and the size of the circle represents relative abundance. Sites that were sampled with electrofishing but did not contain the species are shown with an X. Green squares represent key towns.

Threatened Species

The following table (Table 6.6) 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 during standardised electrofishing surveys in the Macquarie-Castlereagh Water Resource Planning Area during the reporting period. A list of all threatened fish species observed by NSW DPIRD Fisheries (as part of any sampling program in any area) is provided in Table 6.10.

Table 6.6: Listed species which were observed in this region during the sampling period. (* = FMA, # = EPBC)

Species	Common name	Total caught (observed)
<i>Ambassis agassizii</i>	Olive perchlet*	41 (3)
<i>Bidyanus bidyanus</i>	Silver perch*#	14 (6)
<i>Maccullochella macquariensis</i>	Trout cod*#	7 (0)
<i>Maccullochella peelii</i>	Murray cod#	1,453 (481)
<i>Macquaria australasica</i>	Macquarie perch*#	3 (0)
<i>Tandanus tandanus</i>	Freshwater catfish*	120 (16)

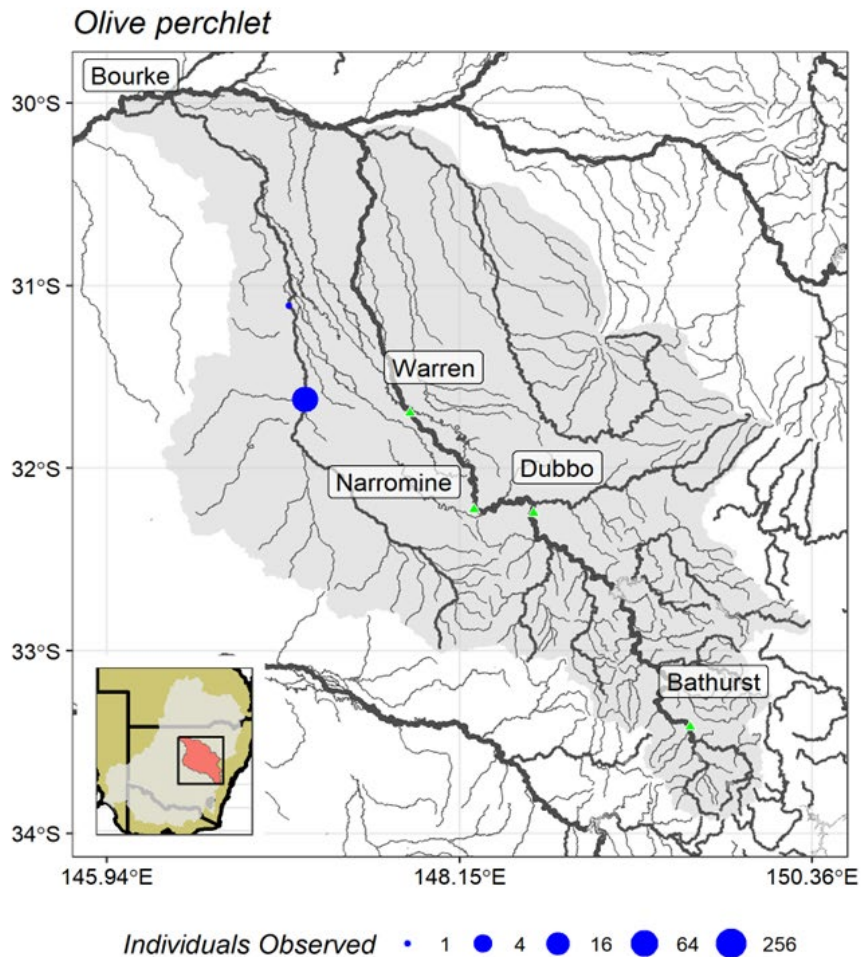


Figure 6.33: Distribution of the observed threatened species sampled from 2013/14 to 2023/24 in the Macquarie-Castlereagh WRP. Filled circles show sites where the species was present, and the size of the circle represents number of observed individuals abundance.

Summary Statement:

A total of 41 Olive perchlet were caught across two sites in the Bogan River. Individuals were observed in all sampling years except 2021/22. Olive perchlet were stocked in the Macquarie-Castlereagh WRP in 2020/21 and 2021/22 (n= 35,000).

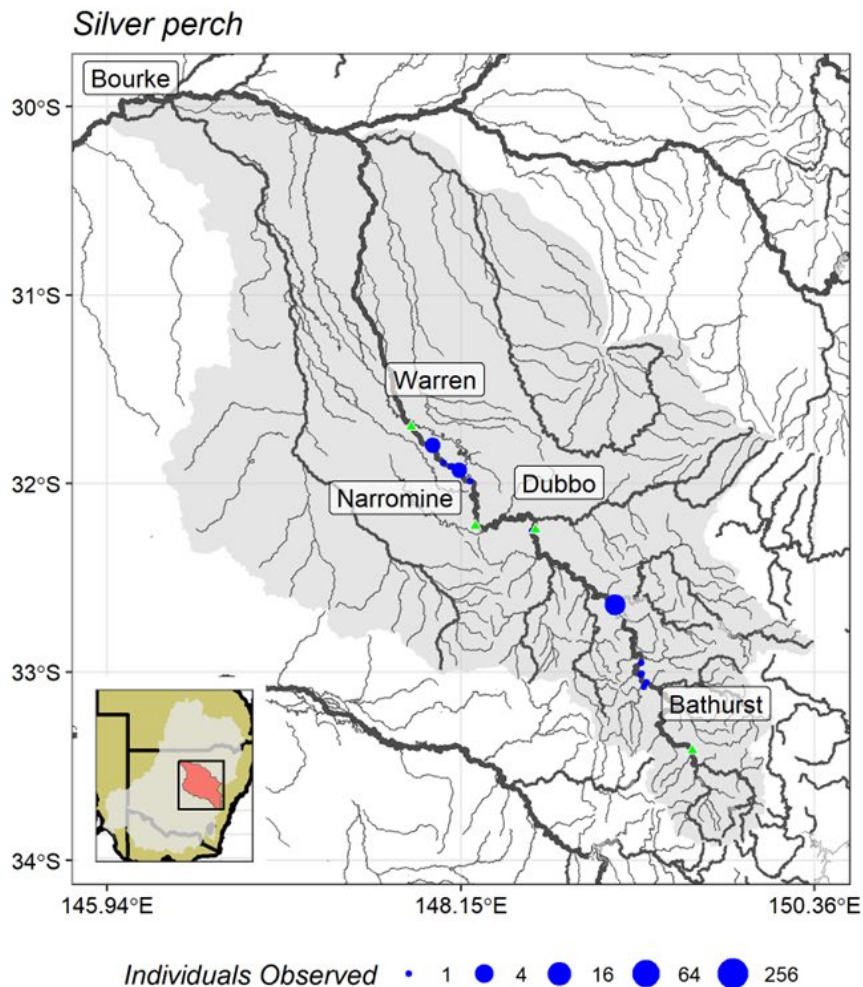


Figure 6.34: Distribution of the observed threatened species sampled from 2013/14 to 2023/24 in the Macquarie-Castlereagh WRPA. Filled circles show sites where the species was present, and the size of the circle represents number of observed individuals abundance.

Summary Statement:

14 Silver perch were caught across the reporting period across 10 sites in the Macquarie River and Little Bald Creek. Individuals were observed in all years except 2019/2020 and 2023/24.

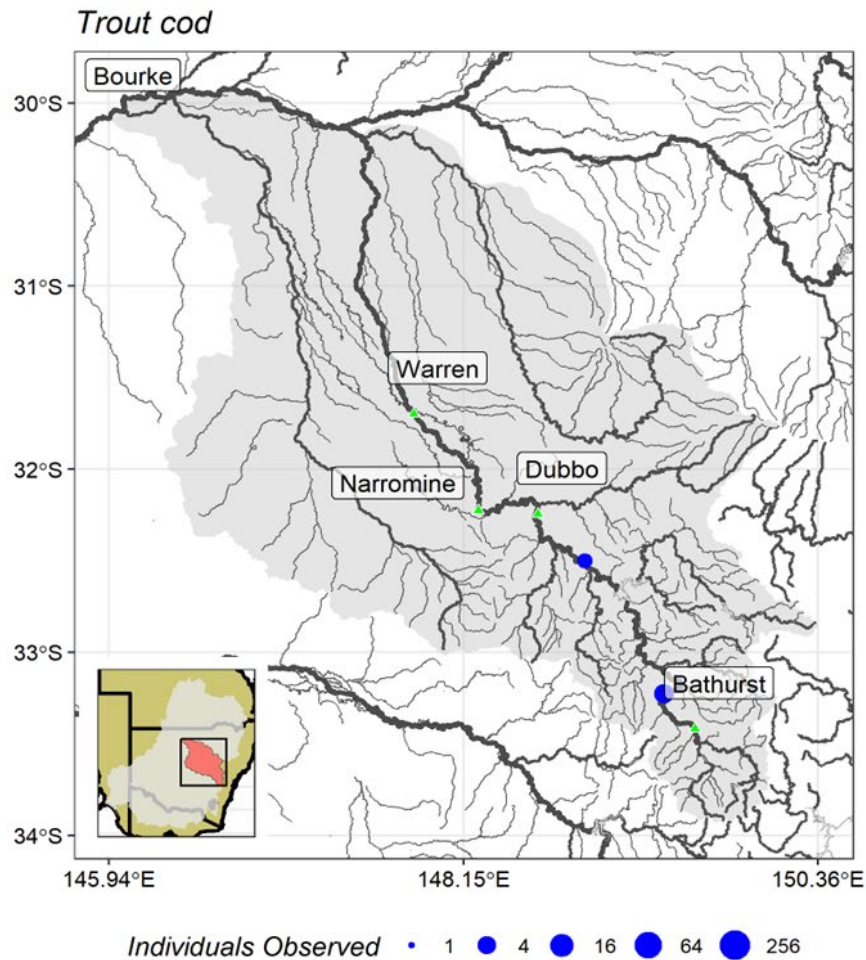


Figure 6.35: Distribution of the observed threatened species sampled from 2013/14 to 2023/24 in the Macquarie-Castlereagh WRPA. Filled circles show sites where the species was present, and the size of the circle represents number of observed individuals abundance.

Summary Statement:

Trout cod were observed in 2014/15 ($n=2$) and 2015/16 ($n=5$) in the Macquarie River. Trout cod have been stocked in this WRPA since 1992, most recently in 2018. Trout cod have not been recorded in this WRPA since 2016.

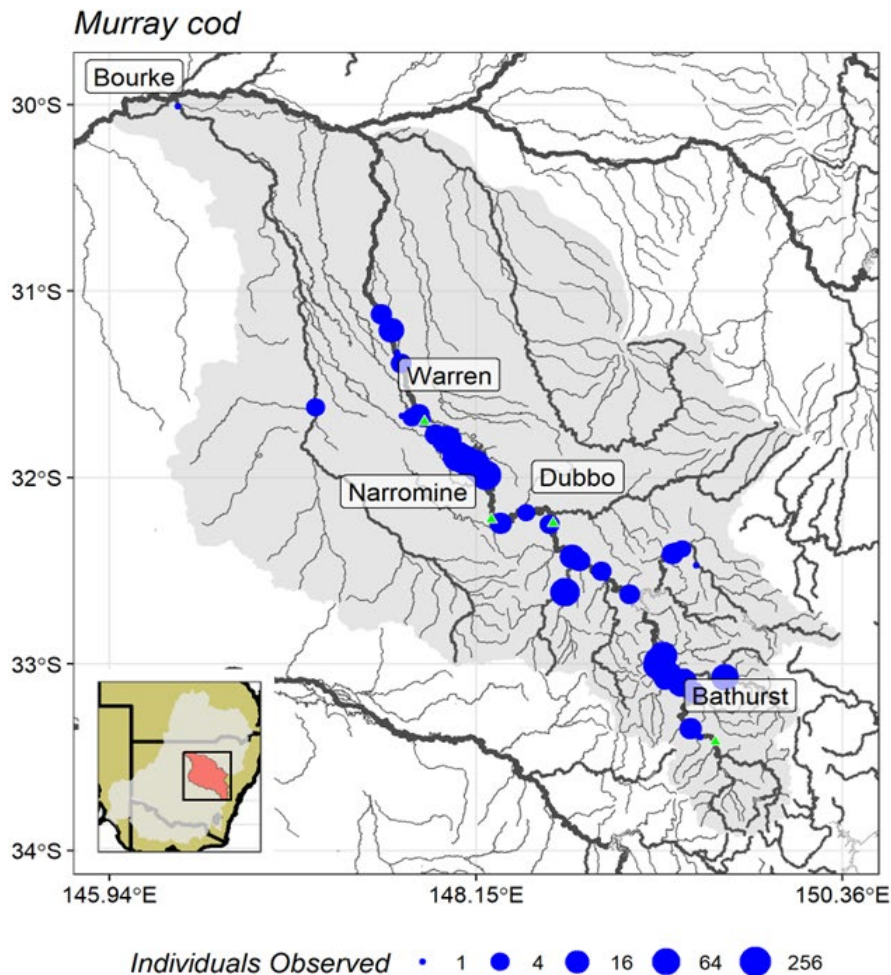


Figure 6.36: Distribution of the observed threatened species sampled from 2013/14 to 2023/24 in the Macquarie-Castlereagh WRP. Filled circles show sites where the species was present, and the size of the circle represents number of observed individuals abundance. Note the lower image shows a juvenile Murray cod.

Summary Statement:

Murray cod were widespread across the Macquarie-Castlereagh WRP, and were particularly common in the Macquarie River. A total of 1,453 individuals were caught over the reporting period with individuals observed in each sampling season.

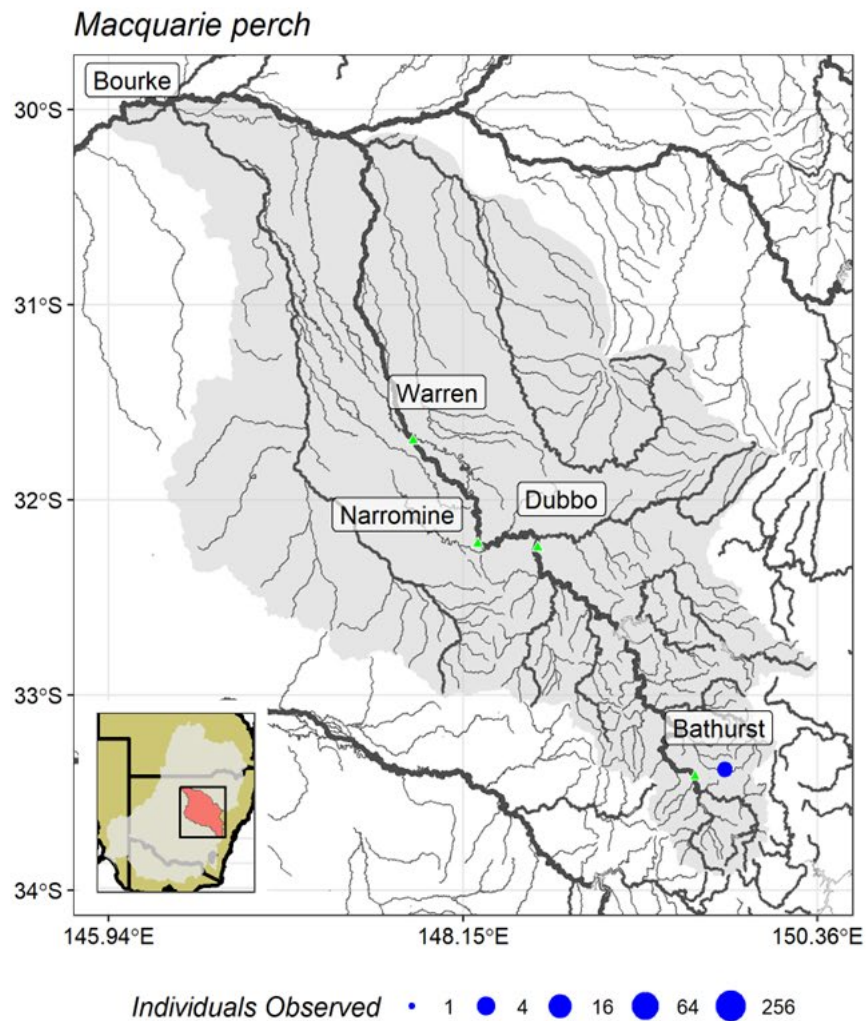


Figure 6.37: Distribution of the observed threatened species sampled from 2013/14 to 2023/24 in the Macquarie-Castlereagh WRPA. Filled circles show sites where the species was present, and the size of the circle represents number of observed individuals abundance.

Summary Statement:

One Macquarie perch was caught in 2020/21 and two Macquarie perch were caught in 2021/22.

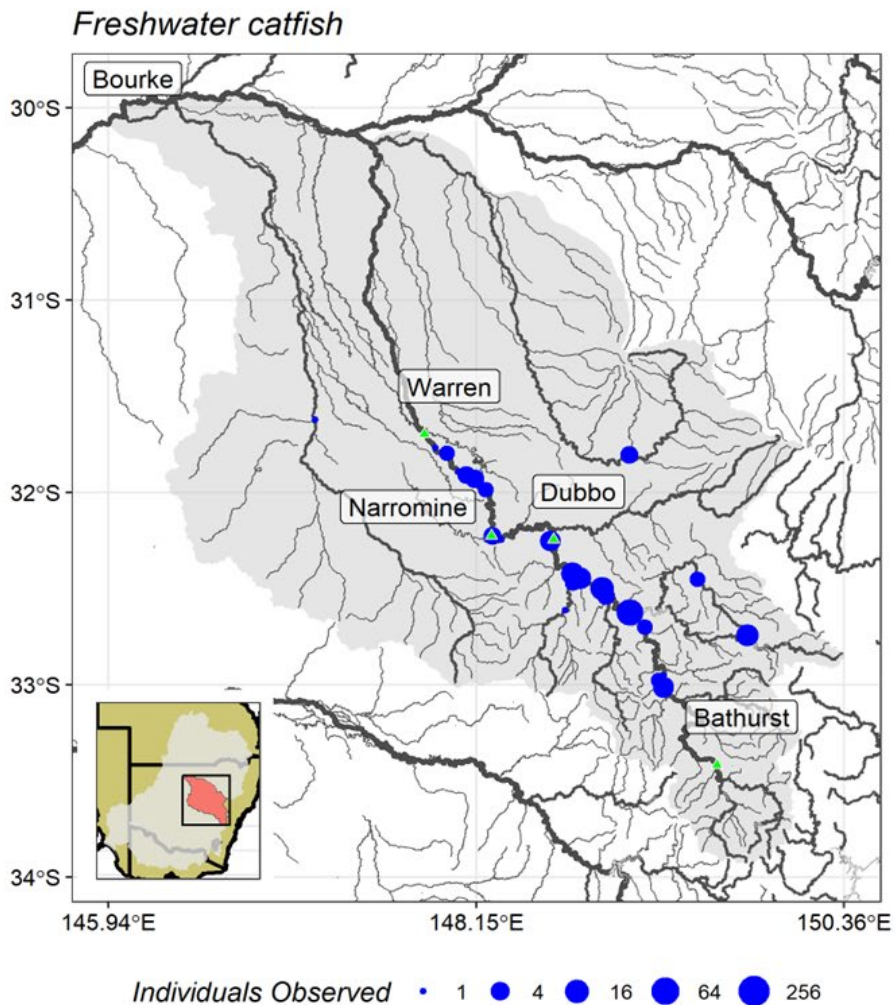


Figure 6.38: Distribution of the observed threatened species sampled from 2013/14 to 2023/24 in the Macquarie-Castlereagh WRP. Filled circles show sites where the species was present, and the size of the circle represents number of observed individuals abundance.

Summary Statement:

Freshwater catfish were caught in all sampling years (total= 120) across the central and southern half of the Macquarie-Castlereagh WRP. Most individuals were in the Macquarie River.

Appendix

This report contains data from the projects listed in Table 6.7.

Table 6.7: Projects included in this report. Sampling Events show the total number of sampling events included from each project. Sampling Seasons shows which sampling seasons each project contributed data to.

Project Name	Sampling Seasons	Sampling Events
Basin Plan Environmental Outcomes Monitoring	2014/2015, 2015/2016, 2016/2017, 2017/2018, 2018/2019, 2019/2020, 2020/2021	259
Basin Plan Environmental Outcomes Monitoring 2	2022/2023, 2023/2024	37
Carp Biomass Project (NCCP)	2017/2018	1
Carp herpes virus investigation	2015/2016, 2016/2017	11
Golden perch Macquarie migration pathways	2022/2023	4
Macquarie River eflow response monitoring	2020/2021, 2021/2022, 2022/2023, 2023/2024	33
Macquarie perch surveys	2020/2021, 2021/2022, 2022/2023	5
Monitoring, Evaluating and Reporting - Inland	2014/2015, 2015/2016, 2016/2017	17
Murray-Darling Basin Fish Surveys	2014/2015, 2015/2016, 2016/2017, 2017/2018, 2018/2019, 2019/2020, 2020/2021, 2021/2022, 2022/2023, 2023/2024	84
Orange Pipeline assessment	2014/2015, 2016/2017, 2017/2018, 2018/2019, 2019/2020, 2021/2022, 2022/2023, 2023/2024	97

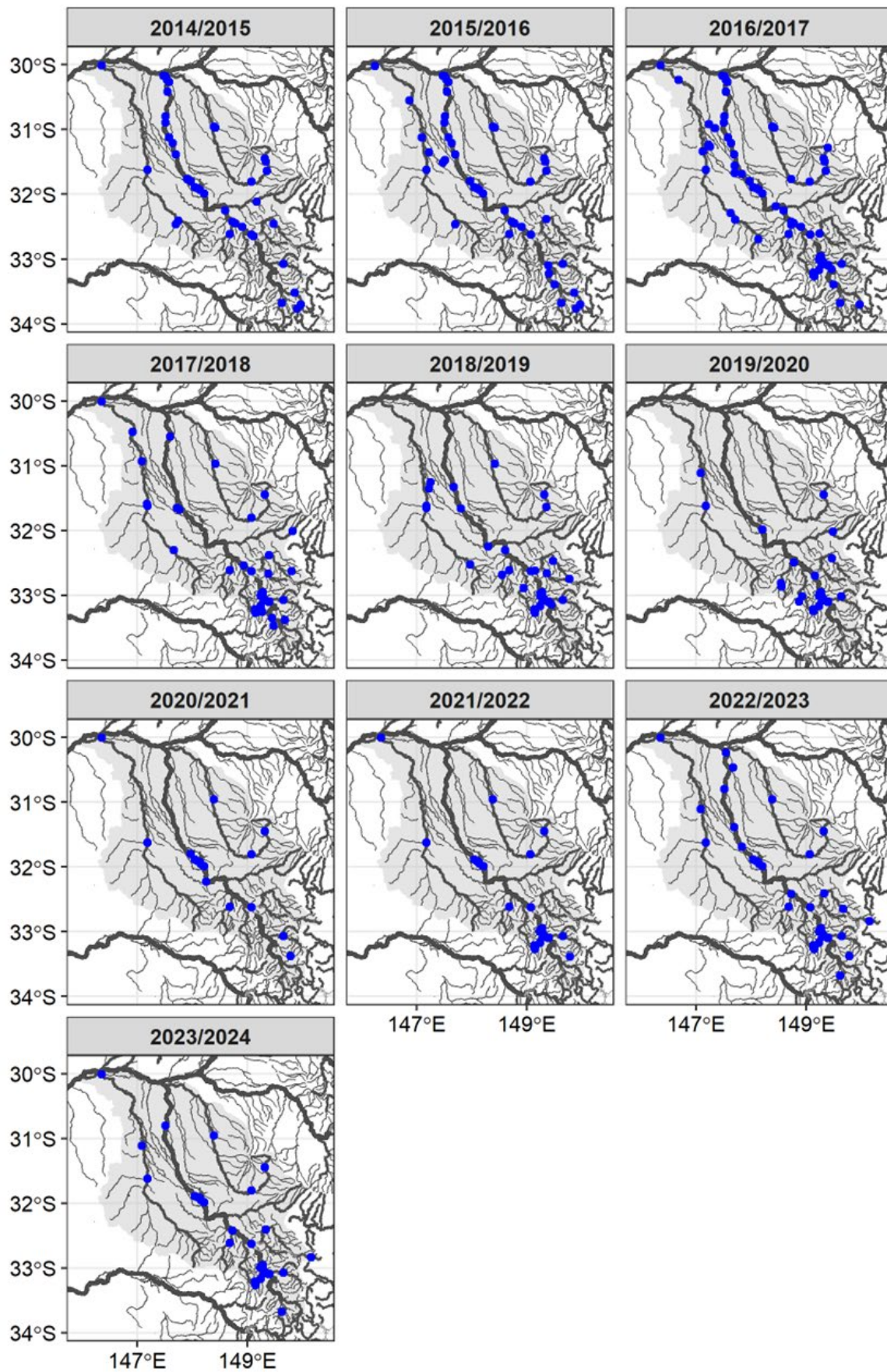


Figure 6.39: Sites sampled and included in this report by sampling season in the Macquarie-Castlereagh WRP. Dry sites are not shown.

Table 6.8 shows all species detected during this survey period as part of standardised monitoring projects (see Table 6.7). Note there are variations in effort between sampling seasons so this information should be considered in conjunction with Table 6.1. 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 standardised sampling in the Macquarie-Castlereagh WRPAs were: Darling hardyhead, Flat-headed galaxias, Southern purple-spotted gudgeon, Southern pygmy perch and Hyrtl's catfish. It should be noted that the MaxENT modelling 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 the standardised monitoring protocols and sampling methods is presented in Table 6.11.

Table 6.8: Total number caught of each species by sampling season in the Macquarie-Castlereagh WRPAs.

Common name	Expected from modelling	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24
Australian smelt	YES	1,017	370	985	51	56	42	101	84	153	79
Bony herring	YES	240	103	1,179	153	44	26	60	155	483	375
Brown trout	YES	4	3	12	0	0	0	18	102	55	0
Carp-gudgeon species complex	YES	2,502	1,222	1,295	1,061	1,020	389	1,198	66	78	109
Common carp	NA	1,412	722	3,638	712	638	634	149	594	1,746	803
Common carp - Goldfish hybrid	NA	2	1	2	3	7	0	0	3	4	13
Dwarf flathead gudgeon	YES	0	1	0	2	0	0	0	0	0	0
Eastern gambusia	NA	2,445	2,777	4,758	1,518	1,322	696	247	59	699	383
Flathead gudgeon	YES	784	116	244	192	120	87	4	3	10	53
Freshwater catfish	YES	54	8	19	6	10	2	4	4	11	4
Golden perch	YES	185	90	229	39	37	12	24	109	81	67
Goldfish	NA	130	147	4,391	239	61	72	13	80	446	138
Macquarie perch	YES	0	0	0	0	0	0	1	2	0	0
Mountain galaxias	YES	93	114	39	130	16	7	64	148	85	44
Murray cod	YES	432	188	198	101	97	39	329	114	128	114
Murray-Darling rainbowfish	YES	738	169	135	3	1	0	10	4	0	13
River blackfish	NA	0	0	0	0	0	5	2	0	5	3
Olive perchlet	YES	0	7	2	1	1	15	13	0	2	0
Rainbow trout	YES	4	27	13	4	0	7	0	40	64	4

Common name	Expected from modelling	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24
Redfin	YES	222	18	840	67	110	47	0	346	89	55
Silver perch	YES	6	2	2	2	0	0	1	1	0	1
Spangled perch	YES	35	21	80	9	2	0	14	54	78	10
Trout cod	YES	3	5	0	0	0	0	0	0	0	0
Unspecked hardyhead	YES	192	112	228	16	15	53	28	32	105	44

The following table summarises the sampling methods for each species caught (Table 6.9).

Table 6.9: Total catch of each species by sampling method in the Macquarie-Castlereagh WRPA.

Common name	Backpack Electrofishing	Bait Trap	Boat Electrofishing
Australian smelt	276	1	2,542
Bony herring	112	11	2,695
Brown trout	129	0	65
Carp gudgeon species complex	2,239	4,525	852
Common carp	1,022	723	9,110
Common carp - Goldfish hybrid	0	0	34
Dwarf flathead gudgeon	2	0	1
Eastern gambusia	8,882	4,061	1,686
Flathead gudgeon	179	145	1,216
Freshwater catfish	19	0	101
Golden perch	10	3	845
Goldfish	411	53	5,253
Macquarie perch	3	0	0
Mountain galaxias	679	12	13
Murray cod	18	1	1,434
Murray-Darling rainbowfish	19	1	1,049
River blackfish	12	0	3
Olive perchlet	0	8	33
Rainbow trout	140	0	23
Redfin	182	106	1,287
Silver perch	1	0	13
Spangled perch	64	26	213
Trout cod	5	0	2
Unspecked hardyhead	29	5	789

Table 6.10: Listed threatened species recorded in the Murray-Darling Basin (from the NSW DPIRD 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	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 6.11 shows all 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 standardised sampling in the Macquarie-Castlereagh WRPAs were: Darling hardyhead, Flat-headed galaxias, Southern purple-spotted gudgeon and Southern pygmy perch. 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 standardised monitoring during this period is in Table 6.8.

Table 6.11: Total catch of each species by all sampling programs and all methods in the Macquarie-Castlereagh WRPAs. Note these include projects with sampling not representative of the community and the data should be used with caution.

Common name	Expected from modelling	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24
Australian smelt	YES	1,017	511	995	51	56	42	110	84	396	82
Bony herring	YES	240	103	1,349	153	44	26	194	155	510	375
Brown trout	YES	4	3	12	0	14	32	60	132	102	0
Carp gudgeon species complex	YES	2,502	1,511	1,660	1,061	1,021	389	2,710	66	82	112
Common carp	NA	1,564	914	3,689	712	639	636	331	649	2,498	1,063
Common carp - Goldfish hybrid	NA	2	5	2	3	7	0	0	3	4	13
Dwarf flathead gudgeon	YES	0	1	0	2	0	0	0	0	0	0
Eastern gambusia	NA	2,445	3,169	5,273	1,518	1,335	701	2,535	59	729	384
Flathead gudgeon	YES	784	228	260	192	127	90	33	4	218	53
Freshwater catfish	YES	57	27	26	6	10	2	241	20	15	5
Golden perch	YES	185	129	245	39	37	12	29	115	229	147
Goldfish	NA	130	147	4,760	239	61	72	327	80	469	146
Hyrtl's catfish	YES	0	0	1	0	0	0	0	0	3	0
Macquarie perch	YES	0	0	0	0	0	0	1	2	0	0
Mountain galaxias	YES	93	126	40	130	148	348	151	234	181	44
Murray cod	YES	432	286	199	101	97	39	1,051	148	157	132
Murray-Darling rainbowfish	YES	758	176	136	3	1	0	48	4	0	13

Common name	Expected from modelling	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24
River blackfish	NA	0	0	0	0	0	5	2	0	5	3
Olive perchlet	YES	0	7	2	1	1	15	13	0	2	0
Rainbow trout	YES	4	27	13	4	117	67	121	138	181	4
Redfin	YES	222	156	840	67	111	49	2	355	163	62
Silver perch	YES	6	4	2	2	0	0	1	1	7	1
Spangled perch	YES	35	21	119	9	2	0	14	54	256	10
Trout cod	YES	3	5	0	0	0	0	0	0	0	0
Unspecked hardyhead	YES	212	230	234	16	15	53	280	32	4	0

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