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Fisheries Victoria
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Gippsland Lakes Black Bream Stock Assessment 2012

No. 42
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Victoria
The Place To Be

Gippsland Lakes Black Bream Stock Assessment 2012

Kemp J, Brown L, Bridge N, Conron S

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Gippsland Lakes fishery

The Gippsland Lakes fishery is a multi-species fishery that has both commercial and recreational sectors.

Habitat and environmental conditions (e.g. abundance of seagrass, freshwater flows, water quality, algal blooms etc.) in the Gippsland Lakes have a significant influence on this species.

Dynamics within the fishery are a reflection of the variable nature of the abundance and availability of this species within the Gippsland Lakes system.

Types of Fisheries

Commercial Fishery

In 2011/12, the majority (87%) of Victoria's commercial catch of bream was harvested from the Gippsland Lakes. The Gippsland Lakes is the only remaining targeted bream commercial fishery in Victoria.

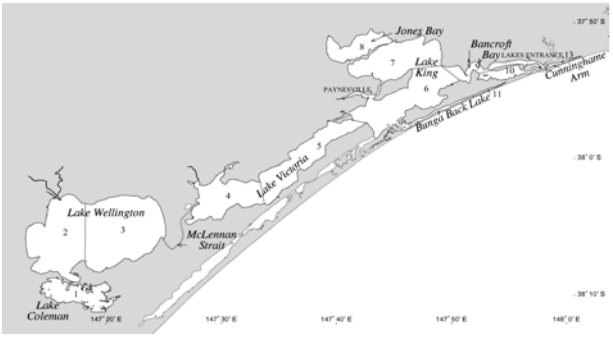
The commercial fishery is restricted to the lakes regions of the Gippsland Lakes system (see map). Total commercial harvest of bream by the Gippsland Lakes commercial fishery in 2011/12 was 96 tonnes.

In 2011/12, mesh nets (also known as gill nets) harvested the majority of the commercial catch of bream (87% by weight) from the Gippsland Lakes, followed by haul seines (13%).

Since the late 1970s, effort has declined significantly for haul seines (~70%) and mesh nets (~40%), but has been stable over the past decade. Voluntary licence buy-backs in 1999/00 and 2005/06 reduced the number of commercial licences in the Gippsland Lakes. There are currently 10 commercial fishery access licences. Reported increases in the abundance of jellyfish and algal 'slub' in the Gippsland Lakes since the mid-2000s has also reduced gear efficiency.

Commercial mesh net operations.

Example of commercial haul seine operations.



Commercial fishing zones 1–13 of the Gippsland Lakes commercial fishery.

Recreational fishery

Recreational anglers targeting bream in the Gippsland Lakes are predominantly in the riverine regions of the system.

The estuarine reaches of the rivers are accessed by both shore- and boat-based anglers. Jones' Bay and Lake King are predominantly accessed by boat-based anglers.

Recreational angling for bream generally involves the use of baited hooks and lures.

The recreational fishery for bream is most active from autumn to spring.

For 2000/01, the estimated total retained recreational catch of bream from Victorian waters was 203 tonnes (National Recreational and Indigenous Fishing Survey, Henry and Lyle 2003). Approximately 50% of this catch came from the Gippsland Lakes, with all other estuaries contributing <10% each.

Stock structure of bream

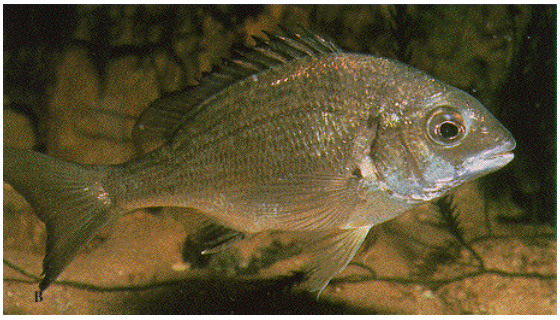
Bream are an estuarine-dependent species completing much of their life-cycle within a single estuary.

The population of bream within the Gippsland Lakes system is assumed to be a discrete stock. The viability of the population is highly dependent on the reproductive capacity of the adult population within the lakes. Therefore, the stock is managed separately from other estuaries in Victoria.

Both commercial and recreational fishers target bream in the Gippsland Lakes.

Management of fisheries

Fisheries Victoria is responsible for managing fisheries and fish resources under the provisions of the *Fisheries Act 1995* and the *Fisheries Regulations 2009*.



Black bream, *Acanthopagrus butcheri*.

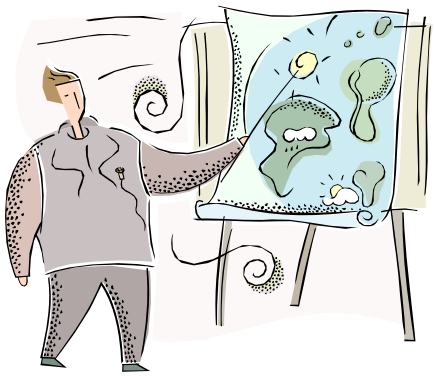
National guidelines for ecologically sustainable development (ESD) of fisheries are used to identify environmental, biological, economic, social and governance dimensions for individual fisheries.

These ESD principles underpin the three key strategic goals of Fisheries Victoria:

- 'Securing' fisheries resources
- 'Sharing' fisheries resources
- 'Growing' or developing the value of the resource for the benefit of the community.

Stock assessments

Stock assessments are designed primarily to provide information on the status of fish stocks in Victoria's bays and inlets to help address biological sustainability and governance objectives.



Assessing information about the condition of fish stocks and the impacts of fishing ensures sustainable fisheries.

Gippsland Lakes bream stock assessment 2012

A formal assessment workshop of the Gippsland Lakes bream stock was conducted at the

Department of Primary Industries, Bairnsdale, Victoria, in September 2012.

Information was provided by:

- representatives of the recreational fishing sector
- fisheries Victoria managers, scientists and compliance officers
- experienced recreational and commercial fishers.

The stock assessment is detailed in this report and a summary presented below.

Healthy bream stocks ensure great fisheries.

Status of the Gippsland Lakes bream fishery

Stock condition

The Gippsland Lakes stock of adult bream has been stable in recent years but at a lower level of productivity compared to the 1970s and 1980s.

Since 2003/04, when there was a 30- and 17-year low in commercial and recreational catch rates, respectively, there has been a gradual increase in catch rates. The increase in catch rates suggests there has been improved abundances of bream throughout the system in recent years.

There has been a change in the age structure of the population. The proportion of older (>8 yrs) bream harvested by commercial and recreational fishers has declined since the late 1990s. The change is consistent with the increase in growth rates in recent years, where faster growing cohorts are entering the fishery at a younger age.

It is difficult to assess whether there has been a change in the age structure of the population or just the harvest; i.e. while older bream may be present in the system, over the past decade faster growing cohorts (that have entered the fishery at a younger age) have dominated catches.

Estimates of total mortality of abundant year-classes (1989, 1995 and 2003) are not considered to be high (0.4–0.7). These estimates equate to an annual survival rate of 50–67% (the proportion of a recruited year-class that survives fishing, predation, disease etc. each year).

Spawning success

The 2008/09 and 2010/11 year classes appear to be moderately abundant and are expected to enter the fishery around 2013 and 2015, respectively. This should result in improved catch rates of bream over the next few years.

The strength of these recent year classes, however, and the spawning success of bream in the Gippsland Lakes in the 1990s and 2000s has been significantly lower relative to levels observed in the 1980s. 1986/87 and 1988/89 were the last exceptionally strong year classes to enter the fishery.

Local knowledge

Recreational fishes reported that, in general, the abundance of undersize bream had increased, the abundance of legal-size bream had decreased or was similar (over the past 12 months compared to the previous 3-4 years), and that the status of bream stocks in the Gippsland Lakes was 'good'.

Feedback from the commercial sector included that 'due to the return of normal rainfall, the abundance of bream in the lakes was high. Juveniles through to large adults were abundant, and bream stocks were reported to be healthy'.

Management arrangement

Fishery and scientific survey data presented to stakeholder and Departmental participants at the September 2012 stock assessment workshop did not indicate the need for a review of Gippsland Lakes bream management arrangements. While the majority of participants supported that the current level of protection should be maintained, not all participants were in agreement. There were requests made to increase protection of bream stocks in the Gippsland Lakes.

Areas of concern

- The change in the age structure of the harvest (decline in the proportion of bream >8 yrs) is consistent with faster growing cohorts entering the fishery at a younger age in recent years. However, if there has been a

decline in the relative abundance of older bream in the population, this may have an impact on the reproductive capacity bream in the Gippsland Lakes; older bream are known to have a higher fecundity (Cashmore, 2002). The consequences of a decline in the relative abundance of older bream in the Gippsland Lakes requires further investigation.

- Fluctuations in black bream productivity in the Gippsland Lakes are being driven primarily by habitat and environmental conditions, which in turn are being driven by a number of factors including climate change (rainfall events becoming more intermittent and intense) and depletion of water quality (increased nutrients, effluent, algal blooms, turbidity, erosion etc.).
- Spawning success of bream is highly dependent on freshwater flows. Increased salinity and changes in freshwater flows are having an impact on the spawning success of bream. It is expected that the productivity of bream will remain relatively low if the salinity of the Gippsland Lakes system remains high and freshwater flows become more intermittent.
- Bream stocks in the Gippsland Lakes are protected from overfishing primarily through LML regulations. This protection is being compromised by anglers retaining undersize fish (estimated at ~10% of the recreational harvest).

Overview of the status of bream in the Gippsland Lakes

Stock Condition - Stable in recent years but at a lower level of productivity compared to the 1970s and 1980s.

Break down by fishery indicators

Pre-recruit monitoring of spawning success, year class strength and recruitment:

- There have been no exceptionally abundant bream year classes in the Gippsland Lakes since the late 1980s
- Fishery –independent pre-recruit surveys and recreational angler diaries suggest the 2008/09 and 2010/11 year-classes are moderately abundant. The 2008/09 year class is expected to enter the fishery in 2013 and the 2010/11 year class is expected to enter the fishery within the next 4-5 years.

Commercial catch rates:

- Catch rates are currently above the 5-year, 10-year and long-term (34-year) averages, however, in recent years (2002–2006, 2009–2010) have been significantly lower than those observed in the late 1970s and 1980s.
- Peaks in 2007/08 and 2011/12 are likely due to increased availability of bream to commercial fishing due to flood events, rather than significant increases in the overall abundance.

Recreational catch rates:

- ↔ Retained and released catch rates are currently marginally below the 5-year, 10-year and long-term (17-year) averages, and have been relatively stable in recent years.
- Angler diary catch rates are currently above the 5-year, 10-year and long-term (15-year) averages.

Stock size- age-structure:

- Size-frequency distributions are within historical ranges. There is no evidence of a change in the size distribution that would suggest over-fishing
- ↓ There has been a decrease in proportion of older (>8 yrs) bream harvested by commercial and recreational fishers over past 10 years that requires further investigation.

Management settings:

- There is no evidence of recent changes in the status of the Gippsland Lakes bream stock that would indicate a need to review existing fishery management settings.

Flagged issues

- There is a lower level of bream productivity in the Gippsland Lakes compared to the 1970s and 1980s.
- A decrease in proportion of older (>8 yrs) bream harvested by commercial and recreational fishers over the past 10 years requires further investigation.
- Black bream productivity in the Gippsland Lakes is currently being limited by habitat and environmental conditions of the system.
- The high proportion (~10%) of under-size fish being harvested by recreational fishers is compromising effectiveness of the current LML which is the principal means of stock protection for bream in the Gippsland Lakes.

Legend

Good condition
↑ Improving
↔ Stable
↓ Decreasing
Poor condition
⚑ Requires close monitoring
Limited data

Assessment process

Fisheries Victoria has developed a process to conduct periodic formal assessments of the status of key marine and estuarine finfish stocks and the fisheries they support. This process involves:

- The synthesis of all relevant fisheries data
- Evaluation of fisheries-independent monitoring and research data, where available
- Convening of a workshop involving scientists, resource users and resource managers to assess the status of the stock/fishery in question
- Production of an assessment report which provides scientific information and advice to facilitate fishery management decision making.

The assessment process:

- Provides scientific evidence on the status of the fish stocks and the environmental factors and harvest pressures that influence stock abundance
- Provides opportunity to draw on the knowledge of stakeholder groups
- Underpins evidence-based decisions in an ecologically sustainable management context
- Complements Victorian fisheries management planning processes
- Ensures the fishery assessment process is accountable and transparent.

Previous assessments of Gippsland Lakes black bream were conducted in 1998 (Cashmore et al. 2000); 2001 (Morison and Conron 2009), 2003, 2004, 2005 (summaries provided in Kemp et al. 2011), and 2009 (Kemp et al. 2011).

A formal assessment of Gippsland Lakes black bream was conducted in Bairnsdale, Victoria in September 2012.

The assessment workshop was attended by representatives of the recreational fishing sector, Fisheries Victoria managers, scientists, and compliance officers, and experienced recreational fishers.

This report

This report assesses the status of black bream in the Gippsland Lakes using commercial and recreational fishery-dependent monitoring and fishery-independent pre-recruit monitoring.

The report is structured as a series of tables which describe:

- The performance indicators for black bream
- The trends in the data for each indicator
- The status matrix for bream in the Gippsland Lakes
- The fisheries that operate in the Gippsland Lakes
- The ecology/biology life-history of bream
- Fisheries management arrangements (past and current) to control fishing effort
- The types of data used in the assessment

These tables are underpinned by a series of 'Figures and Tables' which:

- Detail the data used in the assessment
- Describe the major findings of previous assessments
- Summarise the life history of key species
- Detail data collection methods.

Stock indicators and status key

The following 'traffic light' classification system has been developed to classify the status of individual snapper stocks based on assessment of CPUE data.

Stock status classification	Description	Trend in five-year moving average*	Is the most recent year above the long-term average**
	The indicator suggests that the stock is in good condition. Current management arrangements are considered appropriate.	↑↔	Yes
↑	The indicator suggests that the stock is improving. Current management arrangements are considered appropriate.	↑	No
↔	The indicator suggests that the stock is stable despite being below the long-term average. Current management arrangements may need to be assessed. Where appropriate, management responses to promote stock recovery need to be investigated.	↔	No
↓	The indicator suggests that the stock is decreasing. Current management arrangements may need to be assessed. Where appropriate, management responses to promote stock recovery need to be investigated.	↓	Yes/No
	The status of the stock is considered poor. Current management arrangements need to be assessed. Management responses to promote stock recovery need to be investigated.	↓	No
	A limited amount of information has been collected, or, the available data is inappropriate/insufficient to confidently assess stock status, or, there are inconsistent or contradictory signals in the data that preclude determination of stock status.		

* Trend refers to a significant ($P<0.1$) linear change (ordinary least-squares regression model) in the five-year moving average of an indicator over the past 5 years, non-significant trends were considered stable, analysis of residuals was undertaken to determine whether statistical assumptions were met.

** Long-term refers to the duration of the time-series.

Table 1. Gippsland Lakes black bream status determination using catch rate indicators. The data to support the following classifications are presented in the figures and tables section of this report.

Source	Fishery-independent	Commercial fishery-dependent	Recreational-fishery dependent		
Indicator	Pre-recruit-catch rate time-series (number/shot) (autumn/winter average) (2010–2012) (Figure 24)	Commercial log-book standardised catch rate time-series (kg/shot) (1978–2012) (Figure 7)	Onsite survey standardised retained catch rate time-series (fish/angler hour) (1995–2011) (Figure 8a)	Onsite survey standardised released catch rate time-series (fish/angler hour) (1995–2011) (Figure 8b)	Angler diarist standardised catch rate time-series (fish/angler hour) (1997–2011) (Figure 10)
Minimum	0.80	6.74	0.06	0.13	0.67
Maximum	5.71	82.28	0.36	0.81	3.81
10-year average	N/A	20.02	0.11	0.63	1.82
5-year average	N/A	26.47	0.12	0.60	2.24
Most recent	0.80	34.36	0.10	0.54	2.33
Trend in 5-year moving average in past 5 years	N/A	↑	↔	↔	↑
Above long-term average	N/A	Yes	No	No	Yes
Status	Limited data	Good condition	↔ Stable	↔ Stable	Good condition
Notes	• *The current survey began in 2010 (only 3 years of survey data available).* • *Available data suggests the 2010/11 year-class is moderately abundant. The 2009/10 and 2011/12 year classes were relatively low in abundance.* • *Require 5–10 years of pre-recruit survey data to determine what constitutes a strong year class in the current environment.*	• *Commercial catch rates are currently above the 5-year, 10-year and long-term averages, and have continued to increase in recent years.*	• *Recreational retained and released catch rates are currently only marginally below the 5-year, 10-year and long-term averages, and have been relatively stable in recent years.*		• *Angler diary catch rates are currently above the 5-year, 10-year and long-term averages, and have continued to increase in recent years.*

Table 2. Summary of length indicators of Gippsland Lakes black bream. The data to support the following classifications are presented in the 'Figures and Tables' section of this report.

Source	Commercial fishery		Recreational fishery	
Indicator	Haul seine size (TL)-frequency distribution time-series of retained catch (1994/95–2010/11, no data available for 2003/04–2007/08) (Figure 11)	Mesh net size (TL)-frequency distribution time-series of retained catch (1994/95–2010/11, no data available for 2005/06–2006/07) (Figure 12)	Onsite survey boat/shore-based angler size (TL)-frequency time-series of retained catch (1995–2011) (Figure 13)	Angler diarist boat/shore-based angler size (TL)-frequency time-series of retained catch (1999-2011) (Figure 14)
Maximum Length	44 cm **2010/11: 37 cm**	46 cm **2010/11: 45 cm**	44 cm **2011: 43 cm**	46 cm **2011: 39 cm**
Mean Length (10-year average)	N/A	N/A	30 cm	26 cm
Mean Length (5-year average)	N/A	N/A	30 cm	27 cm
Mean Length (most recent)	**30 cm**	**28 cm**	**31 cm**	**25 cm**
Modal Length (most recent)	**30 cm**	**30 cm**	**31 cm (second mode at 28 cm)**	**16, 19, 24, 28,30-31 cm**
Proportion of retained catch: • ≤29 cm TL (most recent) Trend in time-series: • 30-34 cm TL (most recent) Trend in time-series: • ≥35 cm TL (most recent) Trend in time-series:	**(**Figure 15**)** **50%** Decreasing **48%** Increasing **2%** Stable	**(**Figure 15**)** **39%** Decreasing **58%** Increasing **2%** Increasing	**(**Figure 16**)** **36%** Decreasing **50%** Increasing **14%** Increasing	**(**Figure 16**)** **69%** Decreasing **22%** Increasing **9%** Stable
Proportion of retained catch below size at first maturity (≤24 cm TL) (100% of females are mature at 25 cm TL, Coutin *et al.* 1997)	**2010/11: 0%**	**2010/11: 0%**	**2011: 2%**	**2011: 45%**
Trend in time-series:	**1994/95–1996/97:** Decrease from 24% to 1% **1997/98–2010/11:** Stable	**1994/95–1997/98:** Decrease from 13% to 1% **1998/99–2010/11:** Stable	**1995–1999:** Decrease from 27% to 1% **2000–2011:** Stable	**1999–2011:** Stable
Status	Good condition		Good condition	
Notes	• *Size-frequency distributions are within historical ranges. There is no evidence of a change in the size distribution that would suggest over-exploitation.* • *The decrease in the proportion of bream ≤29 cm TL over the past 15 is at least partially due to increases to the LML.*		• *Size-frequency distributions are within historical ranges. There is no evidence of a change in the size distribution that would suggest over-exploitation.* • *The decrease in the proportion of bream ≤29 cm TL over the past 10 years is at least partially due to increases to the LML.* • *The high proportion of angler diarist catch below size at first maturity (≤24 cm TL) is due to angler diarists reporting catch both above and below the LML.*	

Table 3. Gippsland Lakes black bream status determination using age indicators. The data to support the following classifications are presented in Appendix I.

Source	Commercial fishery		Recreational fishery	
Indicator	Haul seine age-frequency distribution time-series of retained catch (1994/95–2010/11, no data available for 2003/04–2007/08) (Figure 17)	Mesh net age-frequency distribution time-series of retained catch (1994/95–2010/11, no data available for 2005/06–2006/07) (Figure 18)	Onsite survey boat/shore-based angler age-frequency time-series of retained catch (1996–2011) (Figure 19)	Angler diarist shore/boat-based angler age-frequency time-series of retained catch (Figure 20)
Minimum	2 yrs	2 yrs	0 yrs	0 yrs
Maximum	29 yrs **2010/11: 13 yrs**	29 yrs **2010/11: 22 yrs**	32 yrs **2011: 24 yrs**	32 yrs **2011: 23 yrs**
Mean (10-year average)	N/A	N/A	7 yrs	5 yrs
Mean (5-year average)	N/A	N/A	7 yrs	5 yrs
Mean (most recent)	**7 yrs**	**7 yrs**	**7 yrs**	**5yrs**
Mode (most recent)	**7 yrs**	**7 yrs**	**7 yrs**	**4 yrs**
Proportion of retained catch ≥8 years of age	**2010/11: 18%** **(**Figure 22**)**	**2010/11: 18%** **(**Figure 22**)**	**2011: 32%** **(**Figure 22**)**	**2011: 32%** **(**Figure 22**)**
Trend in five-year moving average over the past 10 years:	Decreasing	Decreasing	Decreasing	Decreasing
Trend in five-year moving average over the past 5 years:	N/A	Decreasing	Decreasing	Stable
Status	• ↓ *There has been a decrease in proportion of older bream harvested by commercial fishers over past 10 years.*		• ↓ *There has been a decrease in proportion of older bream harvested by recreational anglers over past 10 years.* • *The lower mean/mode age values for angler diarists is due to the reporting of catch both above and below the LML.*	

* Black bream have an estimated longevity of 37 years.

Table 4. Overall stock status classification matrix for Gippsland Lakes bream.

Source	*Indicator*	*Description of current status*	*Status Classification*
Fishery-independent	Pre-recruit-catch rate time-series (2010–2012) (Figure 24)	• *The current survey began in 2010 (only 3 years of survey data available).* • *Available data suggests the 2010/11 year-class is moderately abundant and is expected to enter the fishery in the next 4 to 5 years.* • *The 2009/10 and 2011/12 year classes were relatively low in abundance.*	Limited data
Commercial fishery-dependent	Commercial logbook standardised catch rate time-series (1978/79–2011/12) (Figure 7)	• *Commercial catch rates are currently above the 5-year, 10-year and long-term averages, and have continued to increase in recent years.*	Good condition
	Haul seine and mesh net size-frequency distribution time-series' of retained catch (haul seine: 1994/95–2011/12, no data available for 2003/04–2007/08; mesh net: 1994/95–2011/12, no data available for 2005/06–2006/07) (Figure 11, Figure 12 and Figure 15)	• *Size-frequency distributions are within historical ranges. There is no evidence of a change in the size distribution that would suggest over-exploitation.*	Good condition
	Haul seine and mesh net age-frequency distribution time-series' of retained catch (haul seine: 1994/95–2011/12, no data available for 2003/04–2007/08; mesh net: 1994/95–2011/12, no data available for 2005/06–2006/07) (Figure 17, Figure 18 and Figure 22)	• *There has been a decrease in proportion of older bream harvested by commercial fishers over past 10 years that* requires *continued monitoring*	↓Decreasing
Recreational Fishery-dependent	Onsite survey standardised retained and released catch rate time-series' (1995–2011) (Figure 8)	• *Recreational retained and released catch rates are currently only marginally below the 5-year, 10-year and long-term averages, and have been relatively stable in recent years.*	↔ Stable
	Angler diarist catch rate time-series (1997-2011) (Figure 10)	• *Angler diary catch rates are currently above the 5-year, 10-year and long-term averages*	Good condition
	Onsite survey boat/shore-based angler and angler diary size -frequency time-series' of retained catch (onsite surveys: 1995–2011; angler diaries: 1999-2011) (Figure 13, Figure 14, and Figure 16)	• *Size-frequency distributions are within historical ranges. There is no evidence of a change in the size distribution that would suggest over-exploitation.*	Good condition
	Onsite survey boat/shore-based angler and angler diary age-frequency time-series' of retained catch (onsite surveys: 1995–2011; angler diaries: 1999-2011) (Figure 19, Figure 20 and Figure 22)	• *There has been a decrease in proportion of older bream harvested by commercial fishers over past 10 years that* requires *continued monitoring*	↓Decreasing

Figures and tables

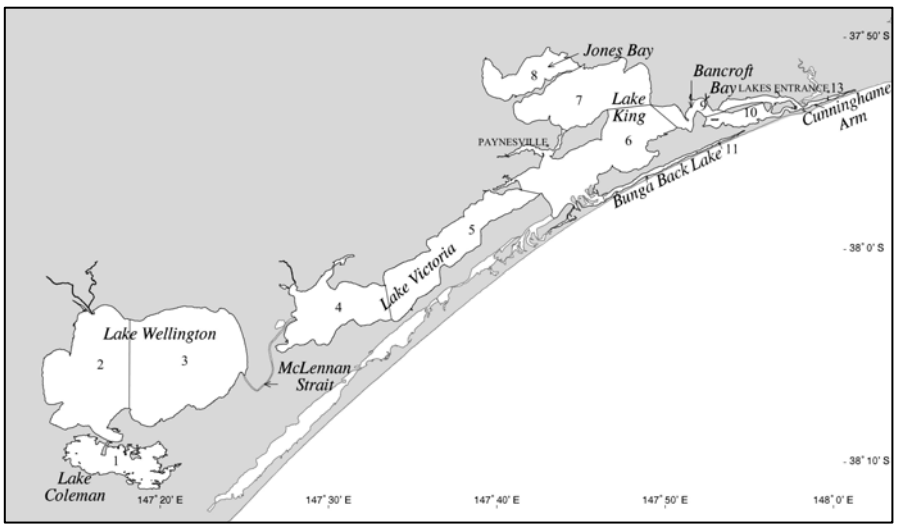


Figure 1: Map of the Gippsland Lakes showing commercial fishing regions numbered 1 to 13 (excluding region 12 Lake Tyers).

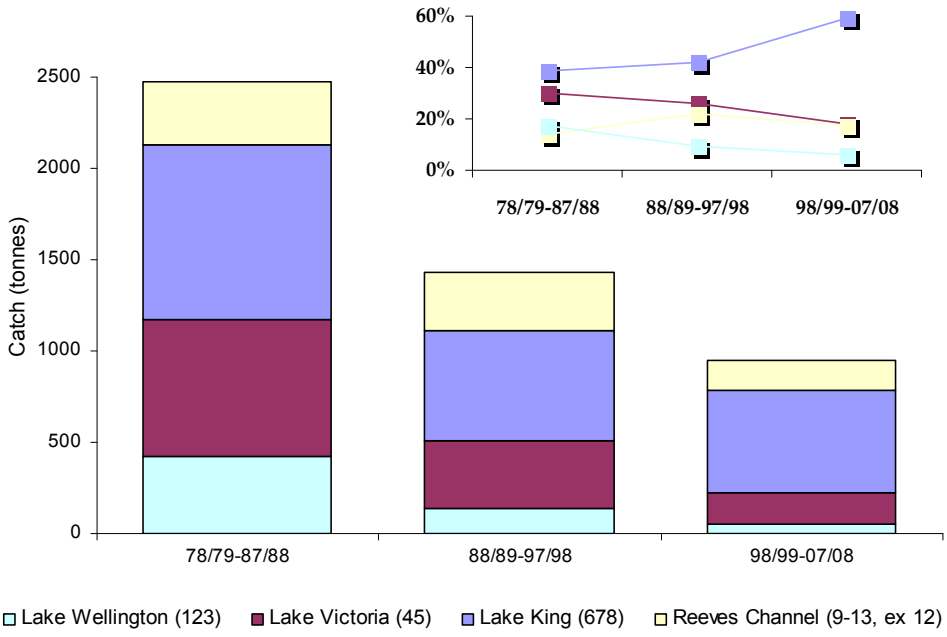


Figure 2: Total commercial harvest of bream from the Gippsland Lakes by decade and fishing region.

Note: In 2011/12, the majority of the commercial mesh net harvest (84%, all species excluding bream) was from fishing zones 6–8 (see map) and the majority of the haul seine harvest (61%, all species excluding bream) was from fishing zones and 9–13. The spatial distribution of commercial fishing effort varies from year to year.

The majority of commercial catch in recent years is harvested from the Lake King area. Historically, large catches were harvested from Lake Wellington and Lake Victoria. It has been suggested that the reduction in bream catches harvested from Lake Wellington partly due to the impact of increased numbers of carp on the efficiency of nets used to target bream (Morison and Conron 2009). Changes in habitat, salinity and water quality have also been suggested as factors contributing to the reduced availability of bream in Lakes Wellington and Lake Victoria.

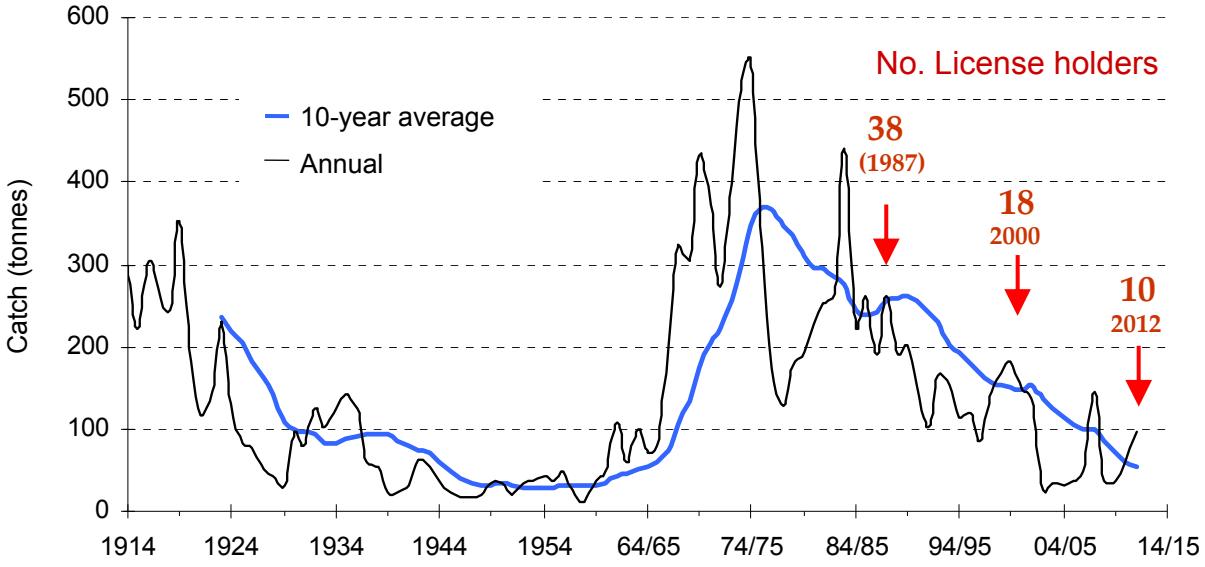


Figure 3: Total commercial harvest of bream from the Gippsland Lakes since 1914.

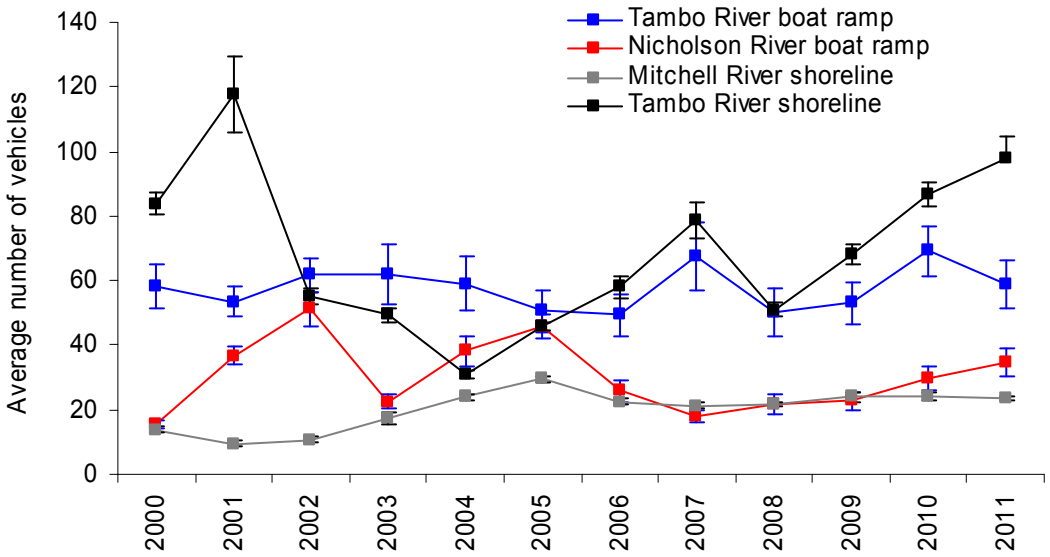


Figure 4: Average number of trailers at the Tambo River (Johnsonville) and Nicholson River boat ramps, and cars at Mitchell River (Bluff East Bank and Two Bells) and Tambo River (lower Tambo Bairnsdale side and Metung side) shoreline locations.

Note: The number of vehicles (trailers at boat ramps/cars at shoreline locations) is used to assess changes in recreational fishing effort. Recreational fishing effort is currently highest in the Tambo River.

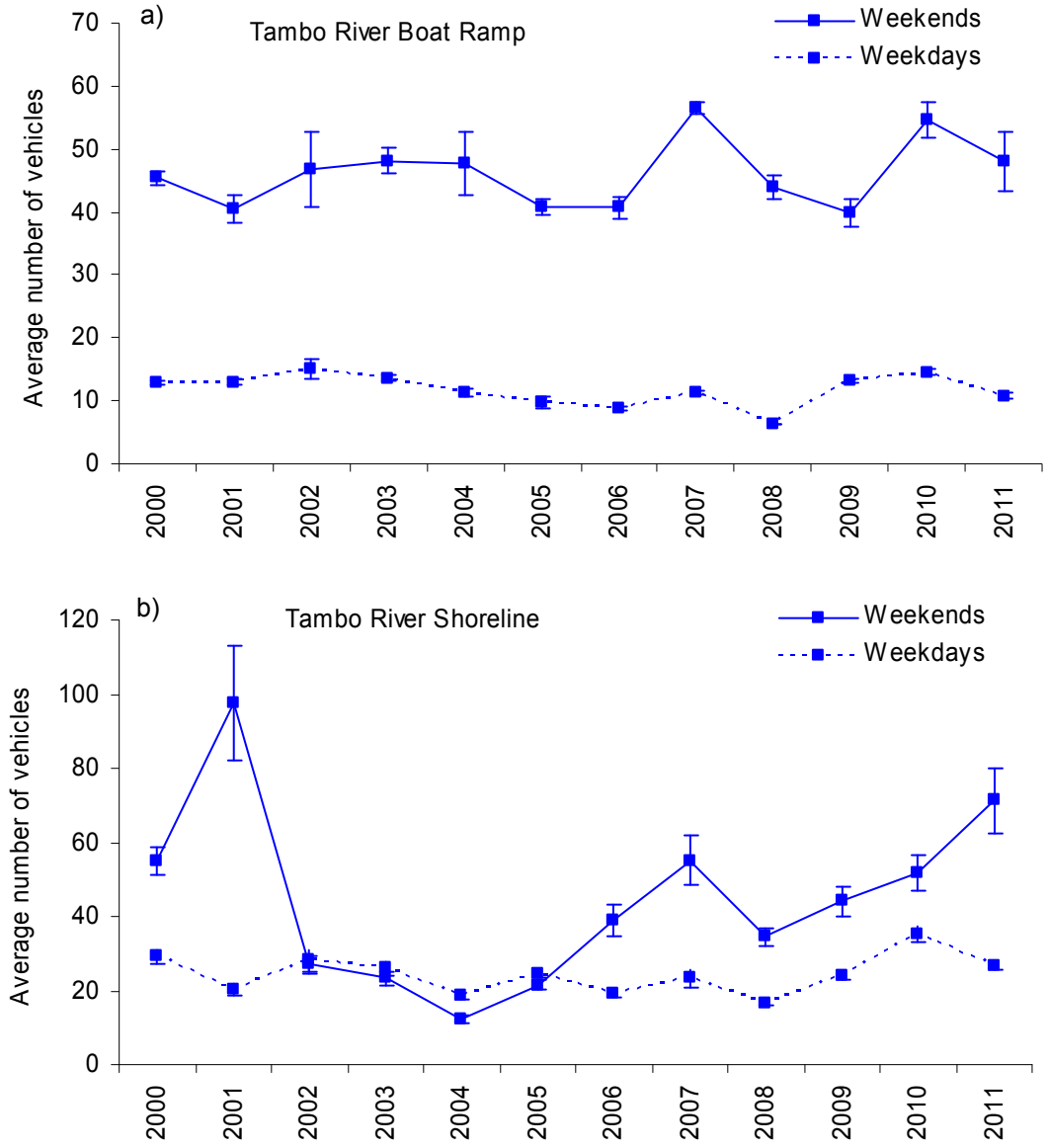


Figure 5: Average number of vehicles along the Tambo River a) trailers at the Tambo river boat ramp Johnsonville and, b) cars at lower Tambo Bairnsdale side and Metung side shoreline locations, on weekends and weekdays between 2000 and 2011. Standard deviation of the mean is presented.

Note: Boat-based effort in the Tambo River on weekends and weekdays has been stable for the past 12 years.

Stability in boat-based effort on weekends is likely due to fishing clubs regularly coming down on weekends and fishing regardless of whether there is an abundance of fish or not. Annual fluctuations in shore-based effort on weekends appear to reflect changes the abundance of bream.

Shore-based effort in the Tambo River on weekends was low from 2002 to 2004, which coincided with a decline in the availability/catch rates of bream to/by the commercial and recreational fisheries (see Figure 7, Figure 8 and Figure 10). Since 2004, shore-line effort has been increasing in line with increasing recreational and commercial catch rates.

Shore-based effort in the Tambo on weekdays has been stable for the past 12 years.

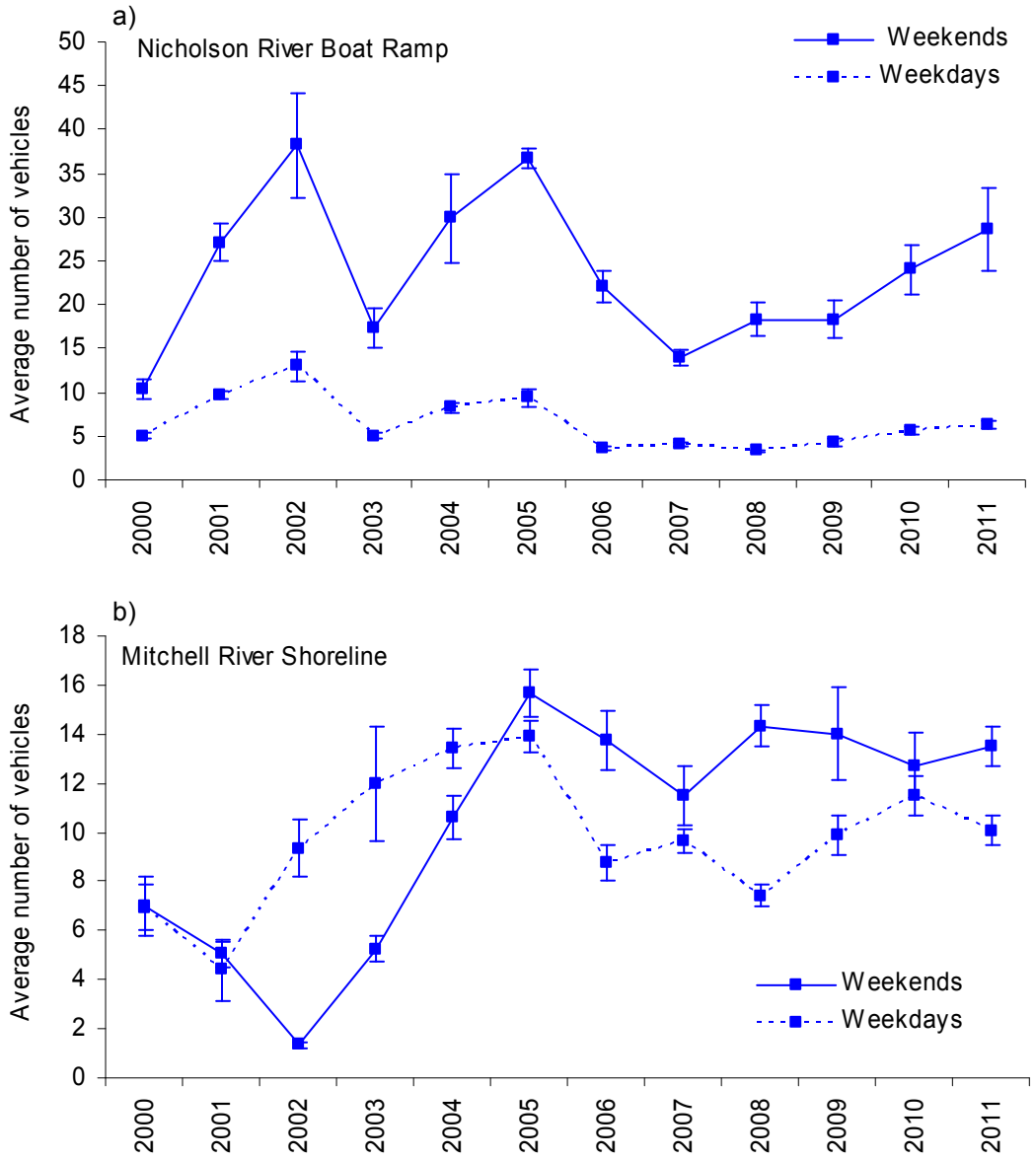


Figure 6: Average number of vehicles along the a) Nicholson River (trailers at the Nicholson River boat ramp), and b) Mitchell River (cars at Bluff East Bank and Two Bells shoreline locations), on weekends and weekdays between 2000 and 2011. Standard deviation of the mean is presented.

Note: Figure 6 a) There was a 12-year low in boat-based effort on weekends in the Nicholson River in 2007. This low coincided with significant flooding of the system in 2007. Since 2007, there has been an increasing trend in boat-based effort in the Nicholson River on weekends to average levels observed between 2001 and 2006.
Fluctuations in boat-based effort in the Nicholson River are similar to those observed on weekends but at a lower level.
There was a 12-year low in shore-based fishing effort on weekdays and weekends in 2001 and 2002, respectively. A subsequent increase in shore-based fishing effort on weekends and weekdays was observed from 2001/02 and 2005. Since 2006, shore-based fishing effort has remained relatively stable.

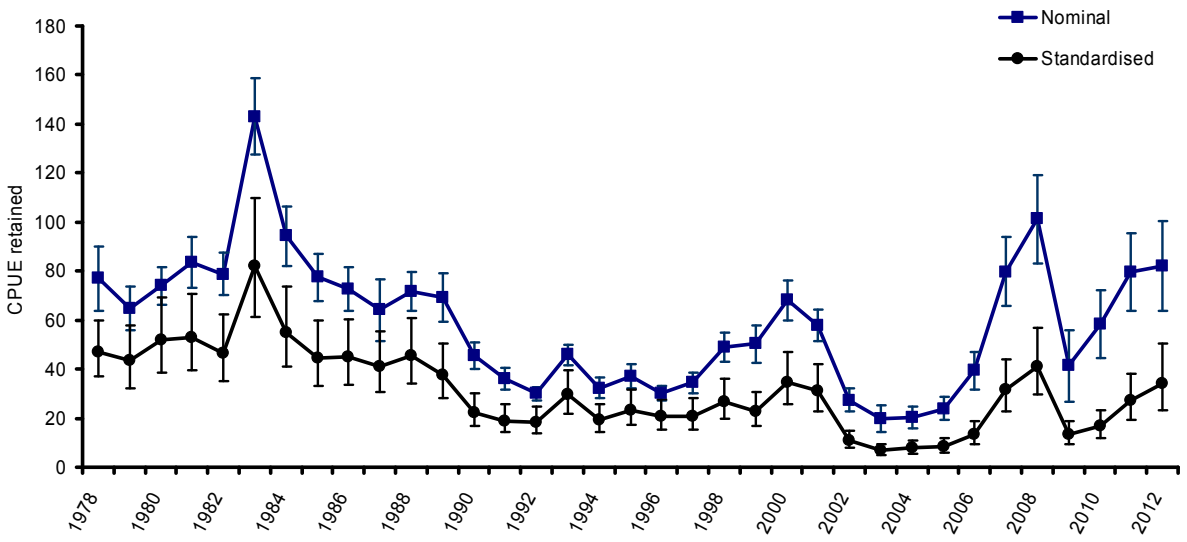


Figure 7: Nominal and standardised catch per unit effort (kg/shot with 95% confidence intervals) of black bream harvested by commercial fishers in the Gippsland Lakes from 1978–2012.

Note: Catch rates were standardised for the effects of fishing area (2-11), month, gear type (estuary and bait small mesh <30 mm seines, haul medium mesh 30-59 mm seines, haul large mesh 60-100 mm seines, multifilament mesh 60-74 mm nets, multifilament mesh 75-94 mm nets and multifilament mesh 95-124 mm nets), fisherman (47), and river flow (Tambo River flow; there was no effect of Mitchell River flow).

Fluctuations in commercial catch rates reflect the availability of bream in commercial fishing areas (lakes) rather than indicate the overall abundance of bream in the estuary. The 2007/08 and 2011/12 catch rates are elevated above LTA due to high river flows during flood events where bream move down the rivers into the lakes region where commercial fishing occurs.

Commercial catch rates are currently above the 5-year, 10-year and long-term averages, and have continued to increase in recent years.

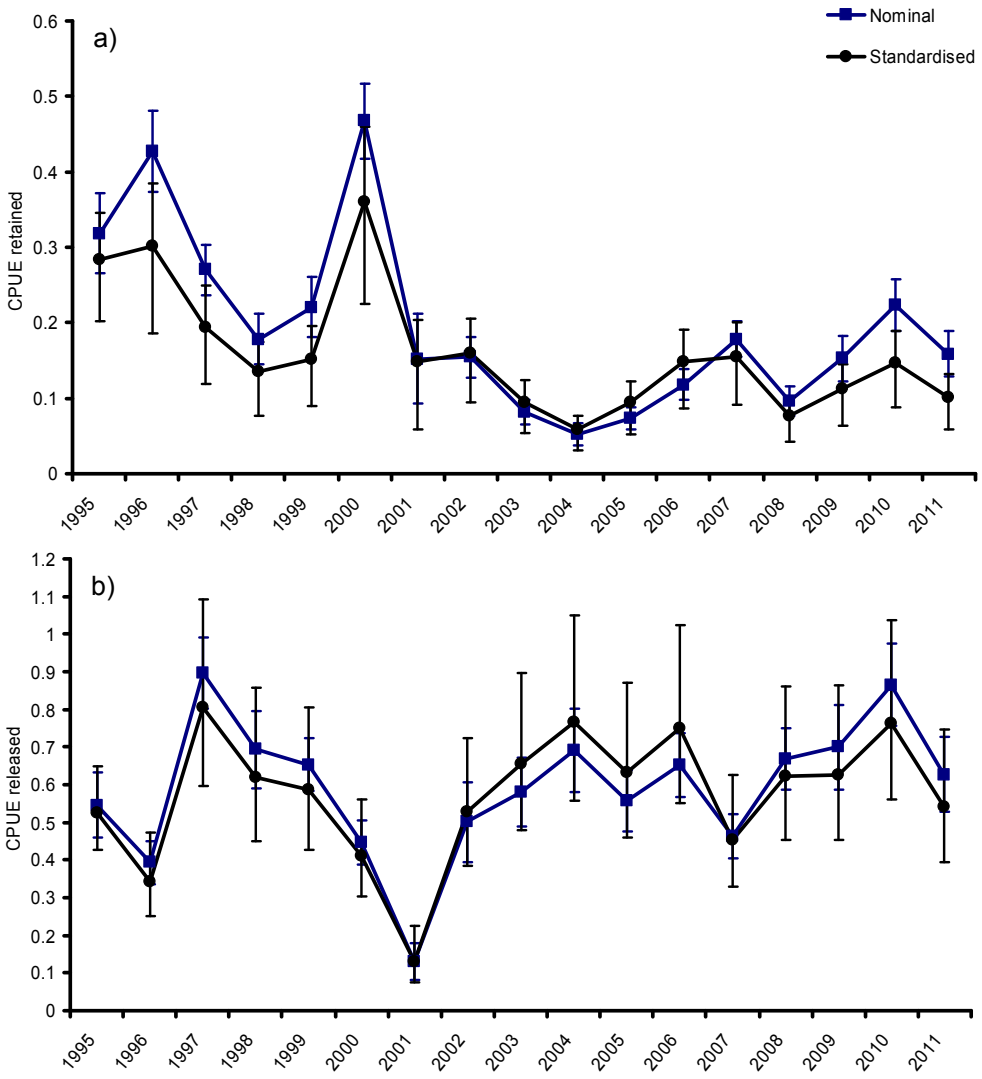


Figure 8: Nominal and standardised catch per unit effort (fish/angler hour with 95% confidence intervals) of black bream a) retained, and b) released, by shore and boat-based avid anglers interviewed during onsite access point surveys in the Gippsland Lakes from 1995–2011.

Note: a) Retained catch rates were standardised for the effects of season (autumn, winter, spring), angler type (experienced ≥15 days/year, 5-14 days/year, <5days), target (1st target species bream, 2nd target species bream, other target species), and platform (shore-based, boat-based). There was no effect of fishing zone (Tambo/Nicholson, Mitchell).

b) Released catch rates were standardised for the effects of angler type, target, and fishing zone. There was no effect of season and platform. There was an effect of fishing zone on released catch rates due to the Mitchell typically having more undersized bream.

Fluctuations in recreational catch rates reflect the availability of bream in recreational fishing areas (rivers) rather than indicate the overall abundance of bream in the estuary. The decrease in retained catch rates in 2008 and 2011 are due to high river flows during flood events where bream have moved down the rivers into the lakes region away from where the majority of recreational fishing occurs.

Released catch rates are consistent with several more abundant pre-recruit bream year classes moving through the stock in the last decade.

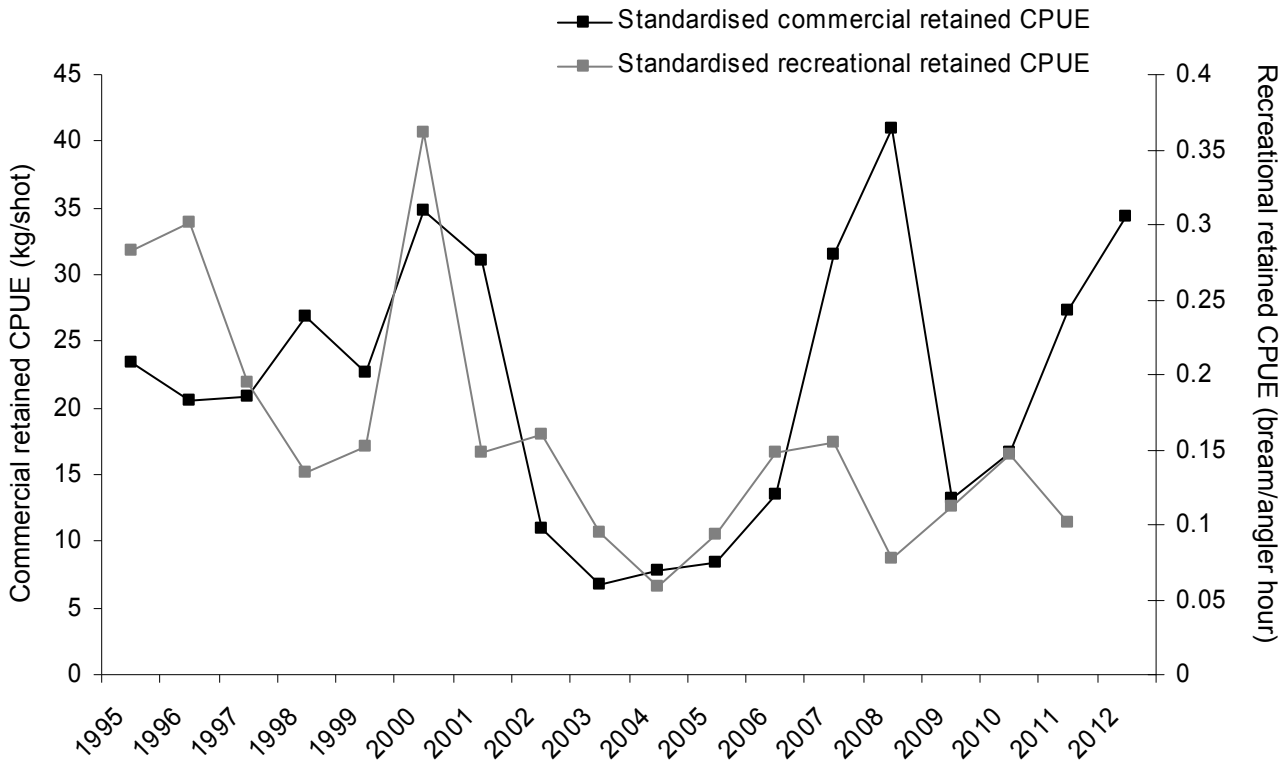


Figure 9: Standardised retained catch rates of black bream by commercial and recreational fishers from 1995–2012.

Note: Fluctuations in commercial and recreational catch rates reflect the availability of bream in commercial (lakes) and recreational (rivers) fishing areas, respectively. The increase in commercial catch rates in 2007/08 and 2011/12 and the subsequent decrease in recreational catch rates in 2008 and 2011 are due to high river flows during flood events where bream have moved down the rivers into the lakes regions where commercial fishing occurs and away from areas where the majority of recreational fishing occurs in the rivers.

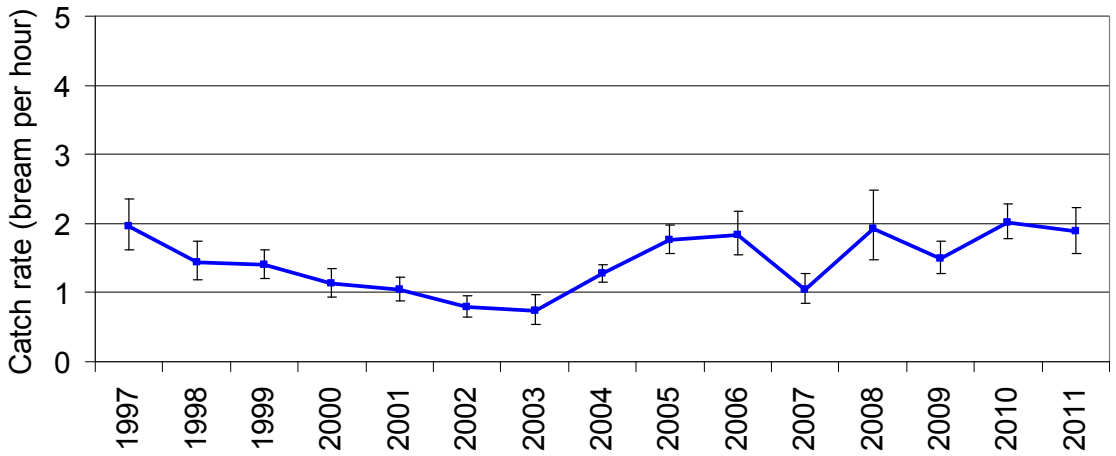


Figure 10: Average annual catch rate of black bream reported by general angler diarists in the Gippsland Lakes from 1997 to 2011.

Note: The catch rate of recreational angler diarist is, in general, significantly higher than that of recreational anglers interviewed during onsite surveys due to angler diarists reporting catch both above and below the LML. Further, angler diarists are often more experienced than a significant proportion of the anglers interviewed during onsite surveys.

Angler diary catch rates are currently above the 5-year, 10-year and long-term averages, and have continued to increase in recent years.

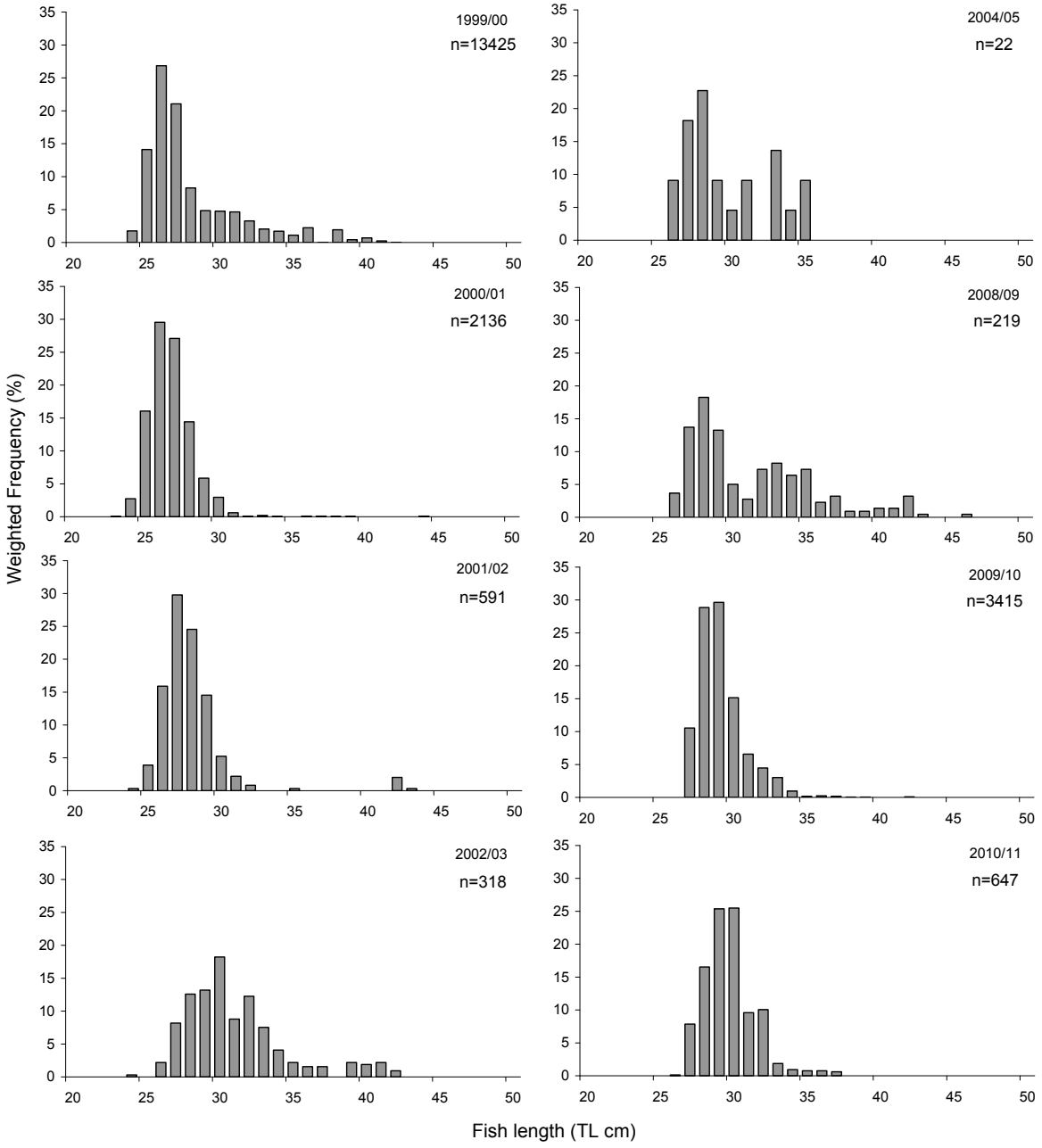


Figure 11: Length-frequency distribution of black bream harvested using haul seines in the Gippsland Lakes from 1999/00 to 2010/11, presented by financial year. Data are available from 1994/95 to 2010/11, excluding 2003/04 to 2007/08. Note that the LML from 2001/02 to December 2003 was 26 cm TL, and from 2004 to current has been at 28 cm TL.

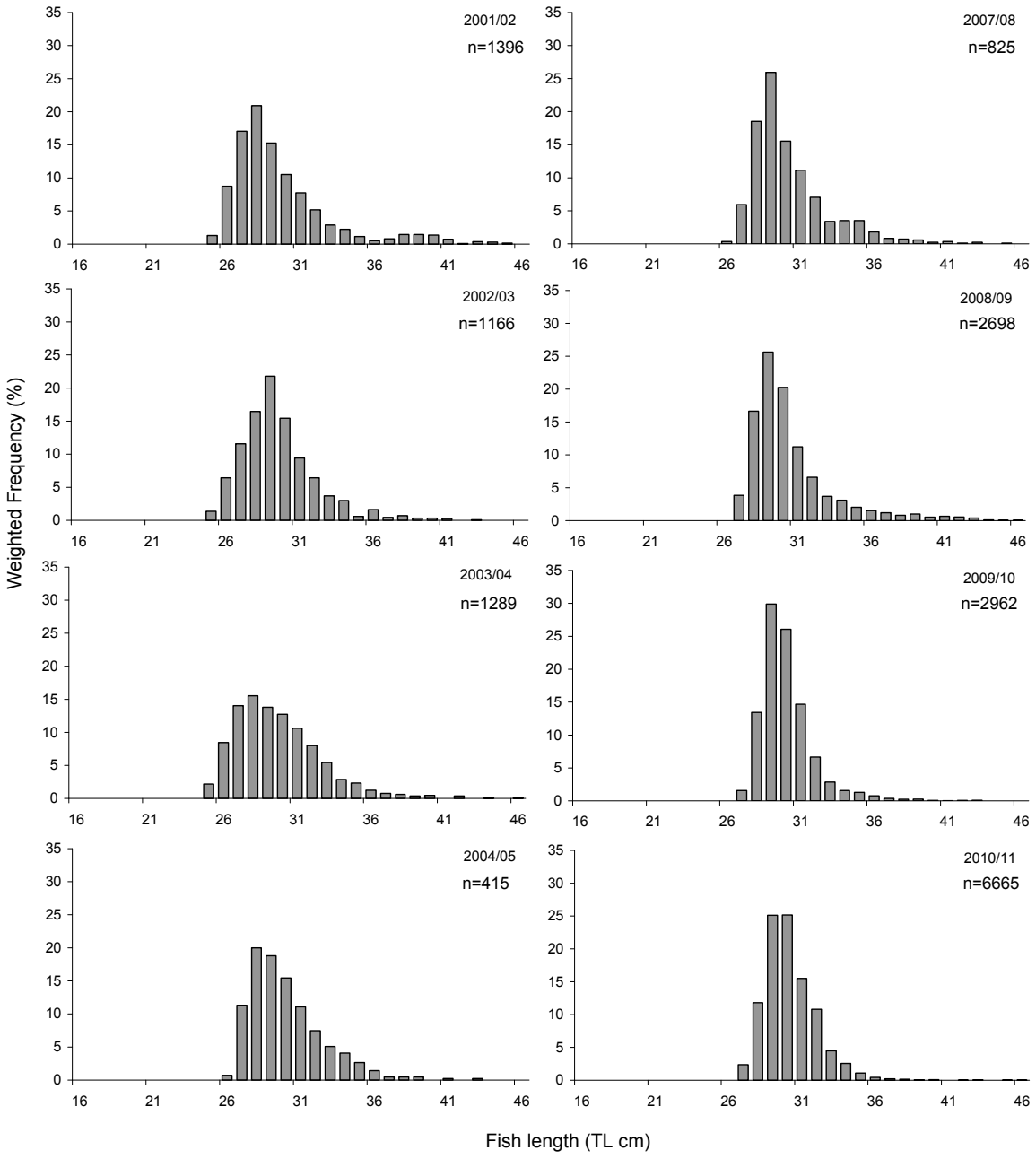


Figure 12: Length-frequency distribution of black bream harvested by mesh nets in the Gippsland Lakes from 2001/02 to 2010/11, presented by financial year. Data are available from 1994/95 to 2010/11, excluding 2005/06 and 2006/07. Note that the LML from 2001/02 to December 2003 was 26 cm TL, and from 2004 to current has been at 28 cm TL.

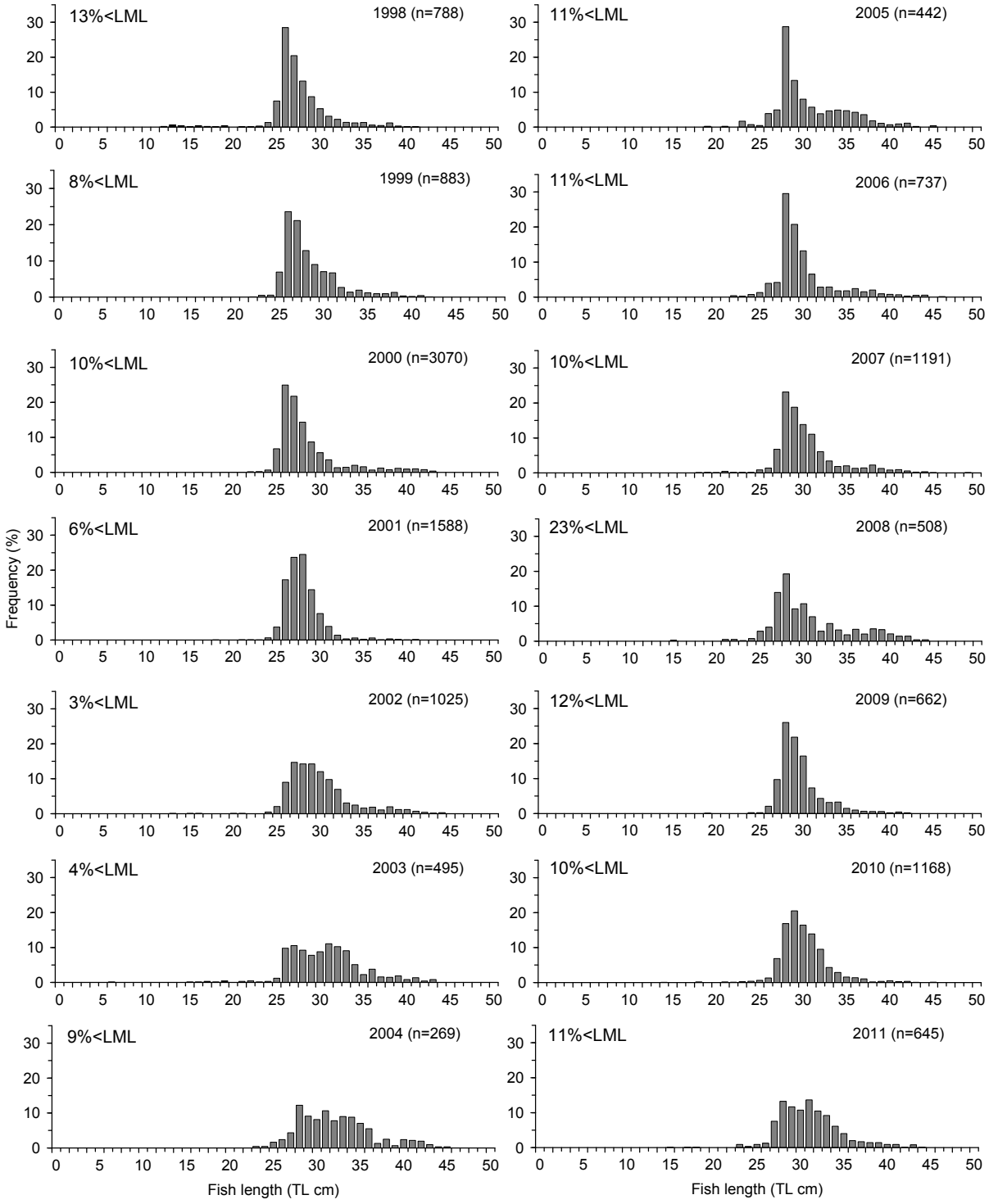


Figure 13: Length-frequency distributions of black bream retained by shore- and boat-based recreational anglers interviewed during onsite surveys in the Gippsland Lakes from 2005 to 2011, presented by calendar year. Data is available from 1995 to 2011. LML from 2004 to 2011 was 28 cm TL. The % of fish below the legal minimum length (LML) is reported. Note that the LML from 1999 to 2003 was 26 cm TL, and from 2004 to current has been at 28 cm TL.

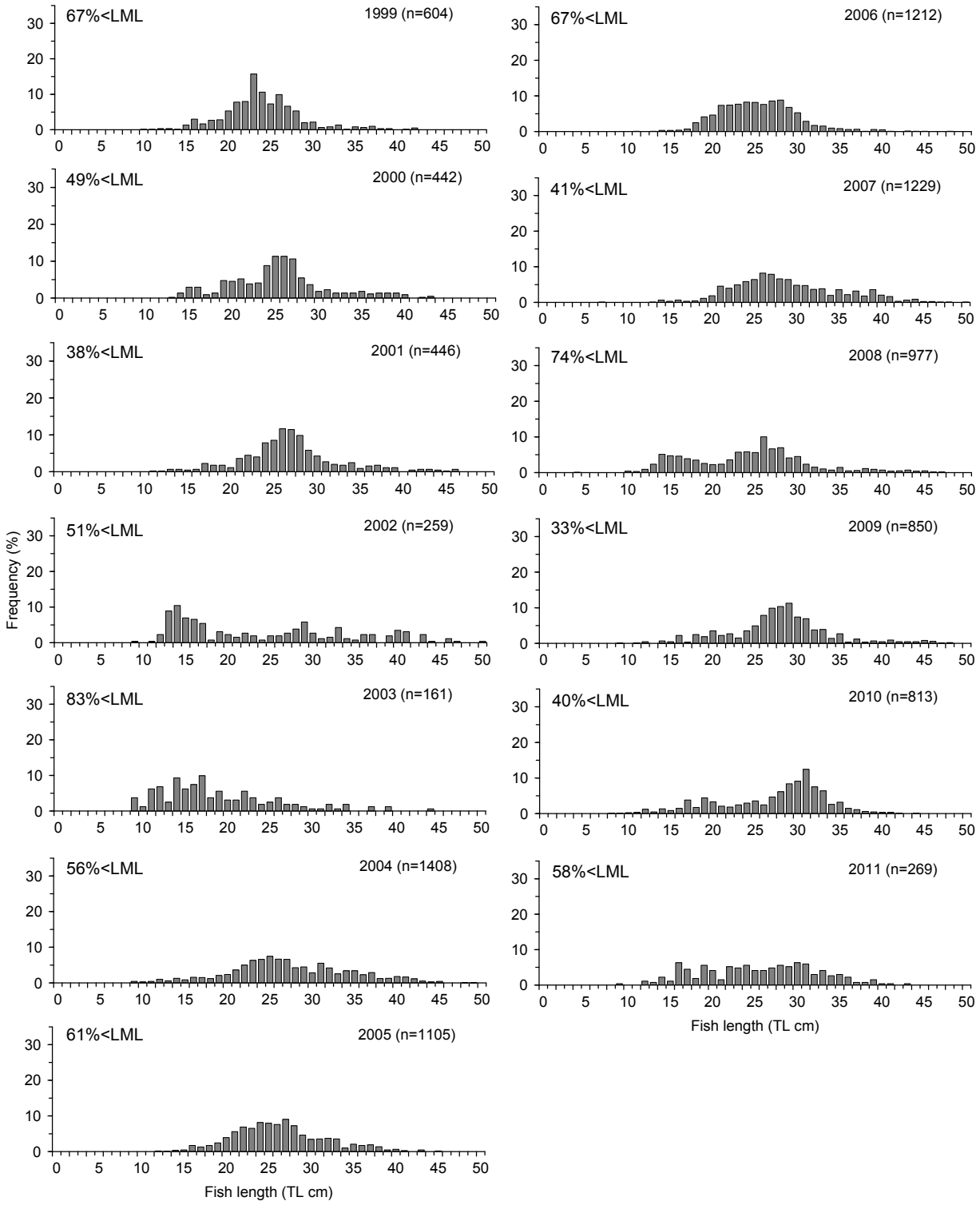


Figure 14: Length-frequency distributions of black bream caught by angler diarists in the Gippsland Lakes from 1999 to 2011. Data is available from 1997. The % of fish below the legal minimum length (LML) is reported. Note that the LML from 1999 to 2003 was 26 cm TL, and from 2004 to current has been at 28 cm TL.

Note: Angler diarists are reporting the length of bream harvested above and below the LML. The length-frequency distribution of bream harvested in 2011 provides evidence for the presence of pre-recruit (<28 cm TL) year classes that will enter the fishery over the coming years.

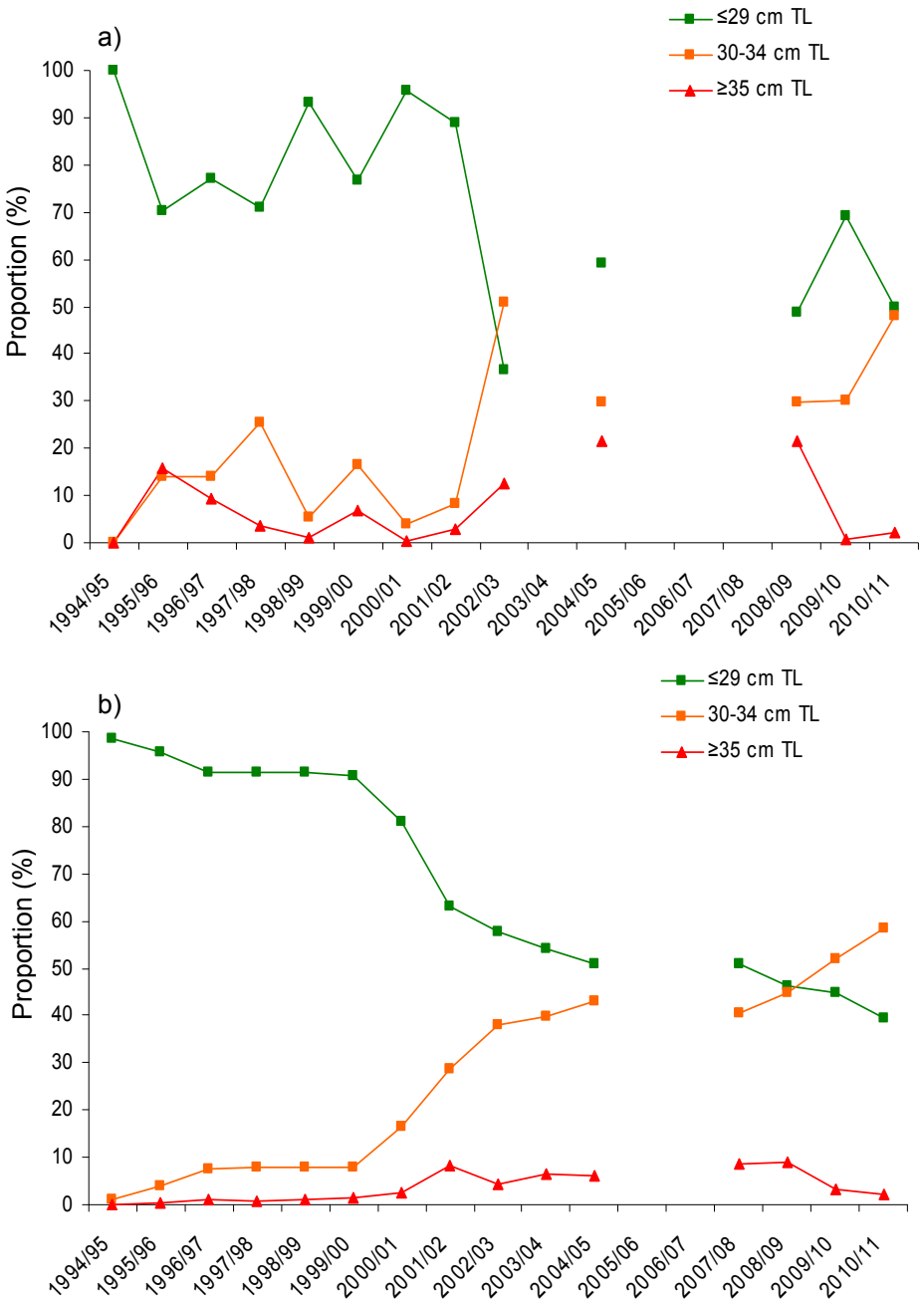


Figure 15: Annual proportion bream harvested by a) haul seines and, b) mesh nets that are ≤29 cm TL, 30–34 cm TL and ≥35 cm TL. No data were available for 2003/04 and 2005/06 to 2007/08 for haul seines and from 2005/06 to 2006/07 for mesh nets.

Note: There has been a decline in the proportion of bream ≤29 cm TL and an increase in the proportion of bream 30–34 cm TL harvested by haul seines (since 2002/03) and mesh nets (since 1994/95). These changes are at least partially due to increases to the LML: From 1994/95 to December 1996 the LML was 24 cm TL; from 1997 to 2003 the LML was 26 cm TL, and from 2003 the LML has been 28 cm TL.

Larger mesh sizes were also introduced by mesh net operators to accommodate for the increase in LML in December 2003 to minimize catches of undersize bream and optimize catches of bream at sizes just above the LML.

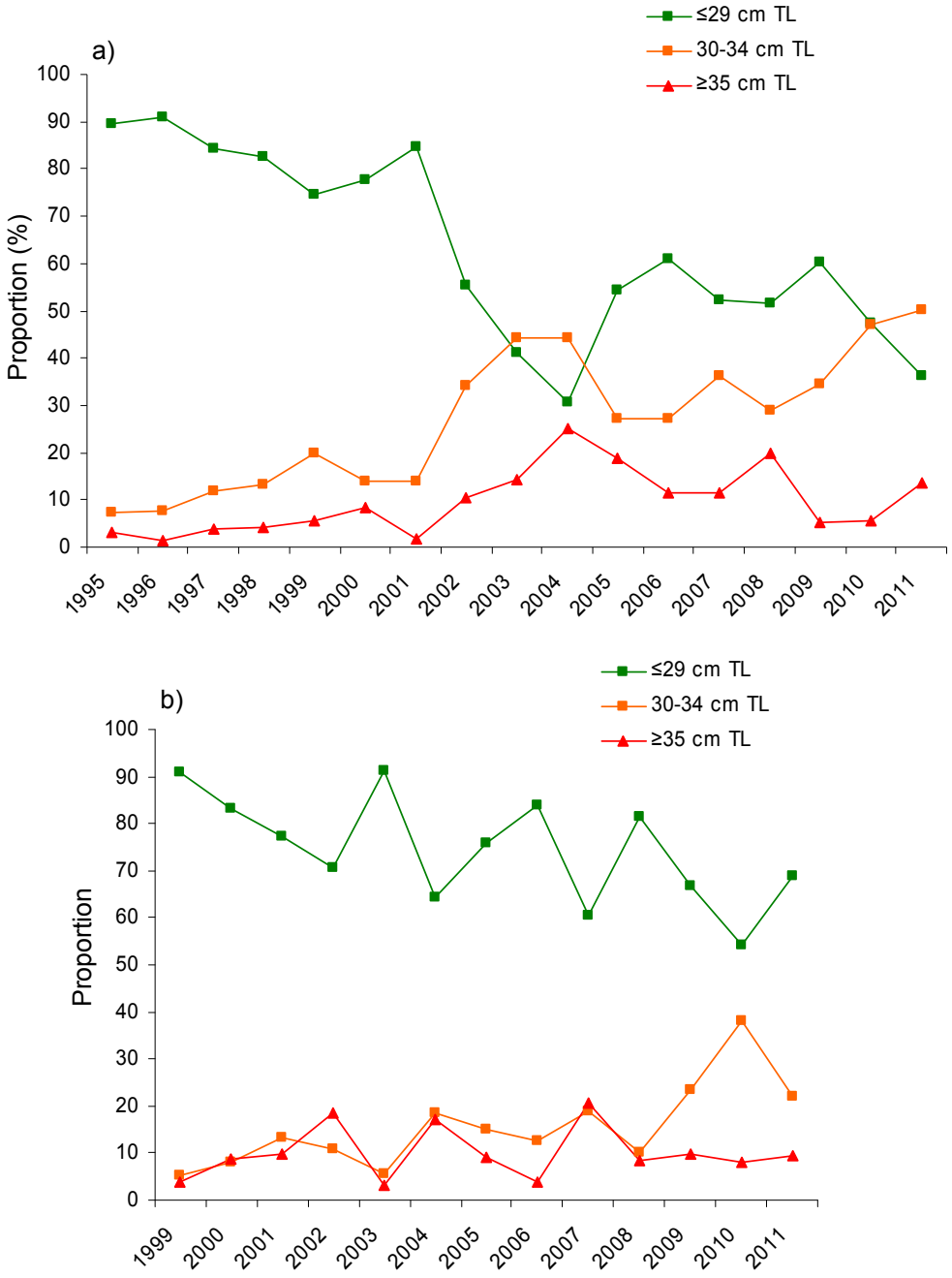


Figure 16: Annual proportion of bream harvested by recreational boat-based anglers interviewed during onsite access point surveys and angler diarists that are ≤29 cm TL, 30–34 cm TL, 35–39 cm TL and 40–44 cm TL.

Note: There is evidence of a decline in the proportion of bream ≤29 cm TL and an increase in the proportion of 30–34 cm TL bream harvested by recreational shore- and boat-based a) anglers (since 1995) (creel surveys) and, b) angler diarists (since 1999). These changes are at least partially due to increases to the LML: From 1994/95 to December 1996 the LML was 24 cm TL, from 1997 to 2003 the LML was 26 cm TL; and from 2003 the LML has been 28 cm TL.

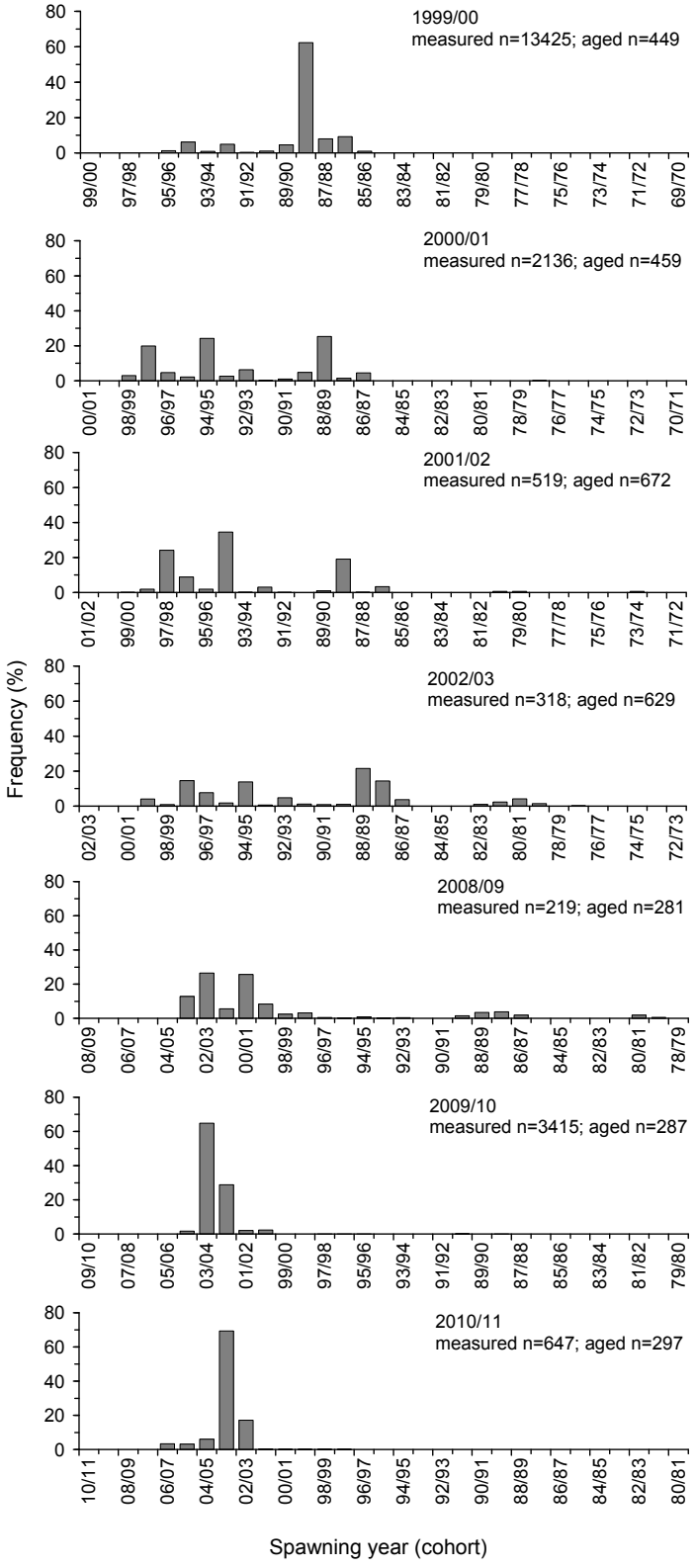


Figure 17: Cohort-frequency distribution of black bream harvested by haul seines in Gippsland Lakes from 1999/00 to 2010/11, presented by financial year. Data is available from 1994/95 to 2010/11 excluding 2003/04 to 2007/08.

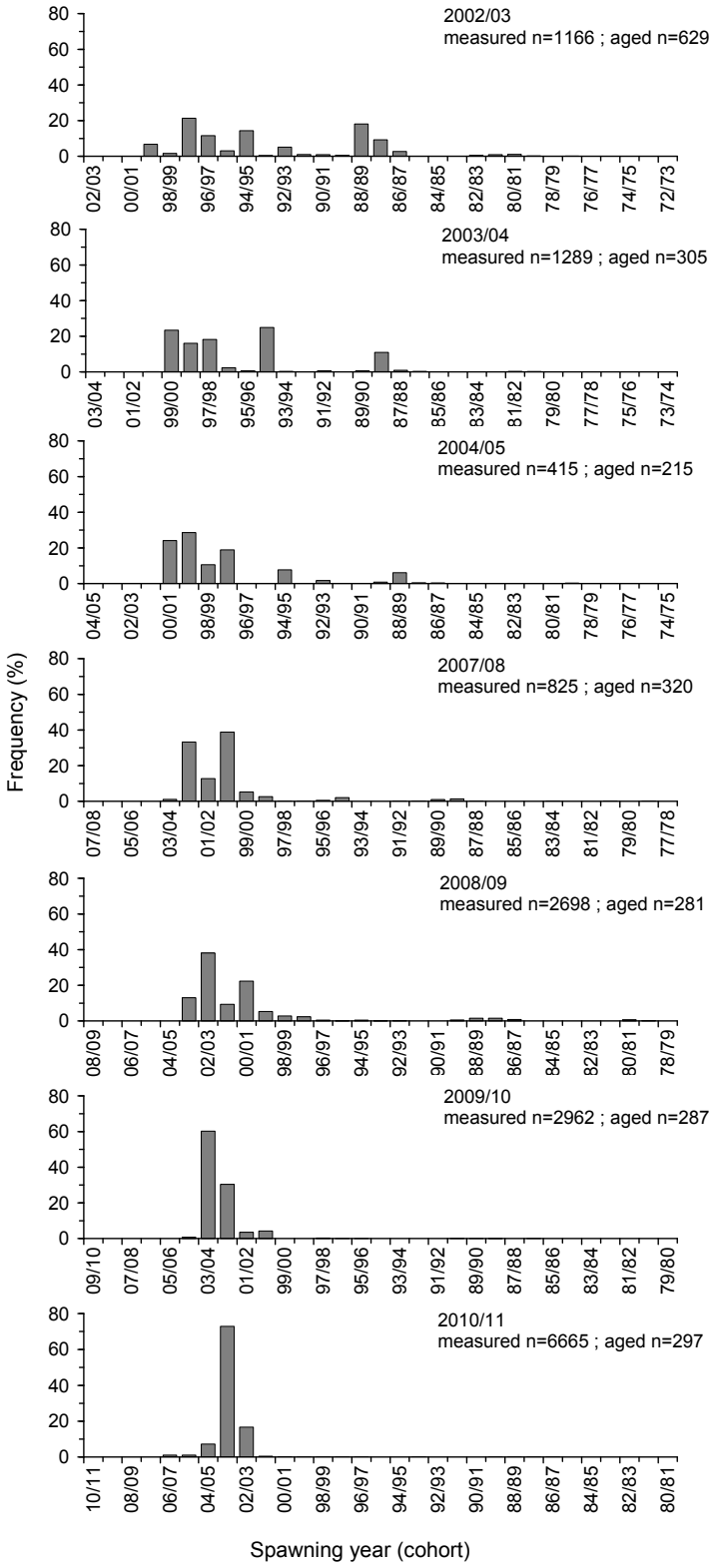


Figure 18: Cohort-frequency distributions of black bream cohort strengths harvested by mesh nets in Gippsland Lakes from 1999/00 to 2010/11, presented by financial year. Data is available from 1994/95 to 2010/11 excluding 2005/06 to 2006/07.

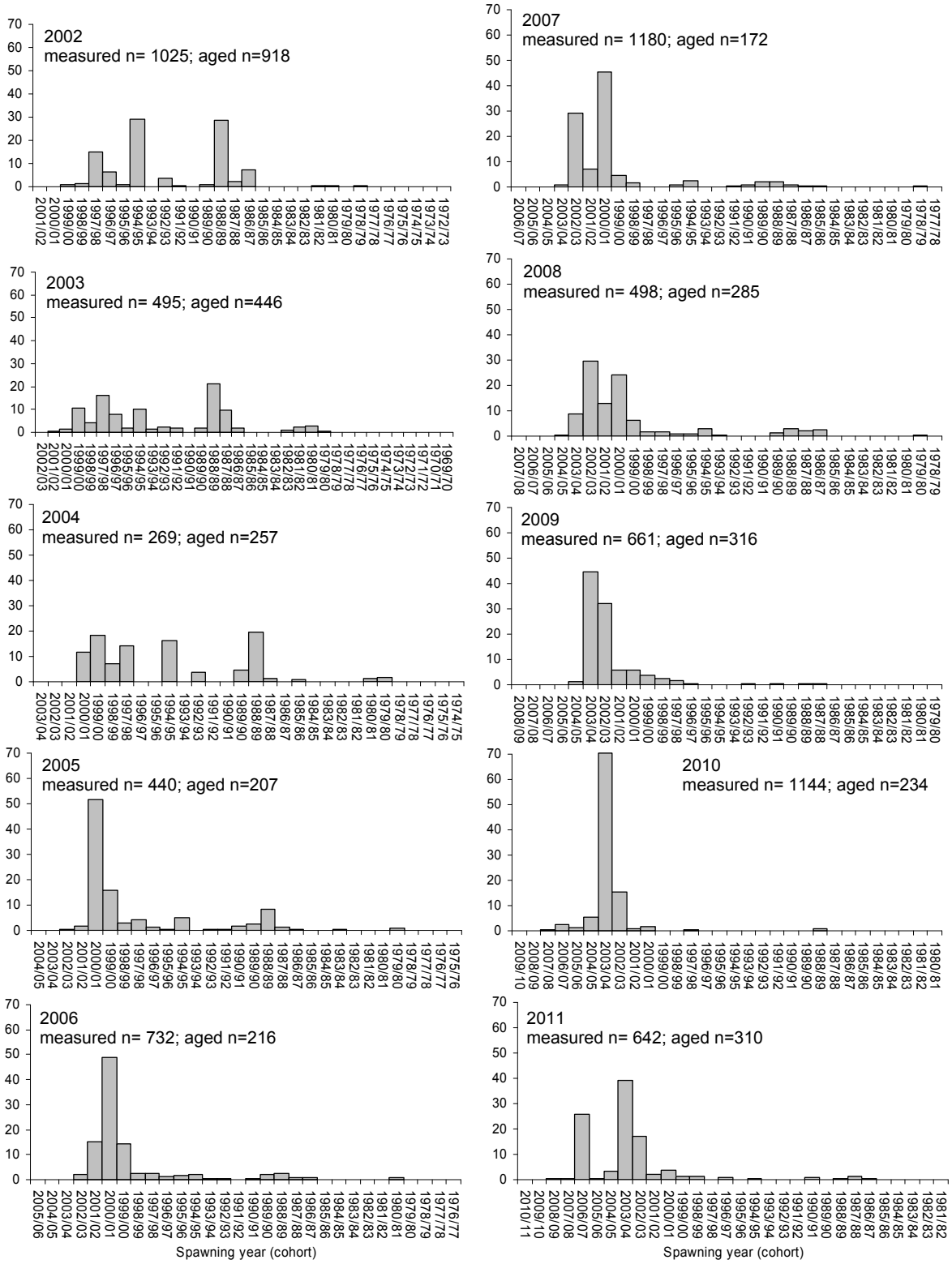


Figure 19: Cohort-frequency distributions of black bream retained by shore- and boat-based recreational anglers interviewed during onsite surveys in the Gippsland Lakes from 2002 to 2011. Data is available from 1996 to 2011.

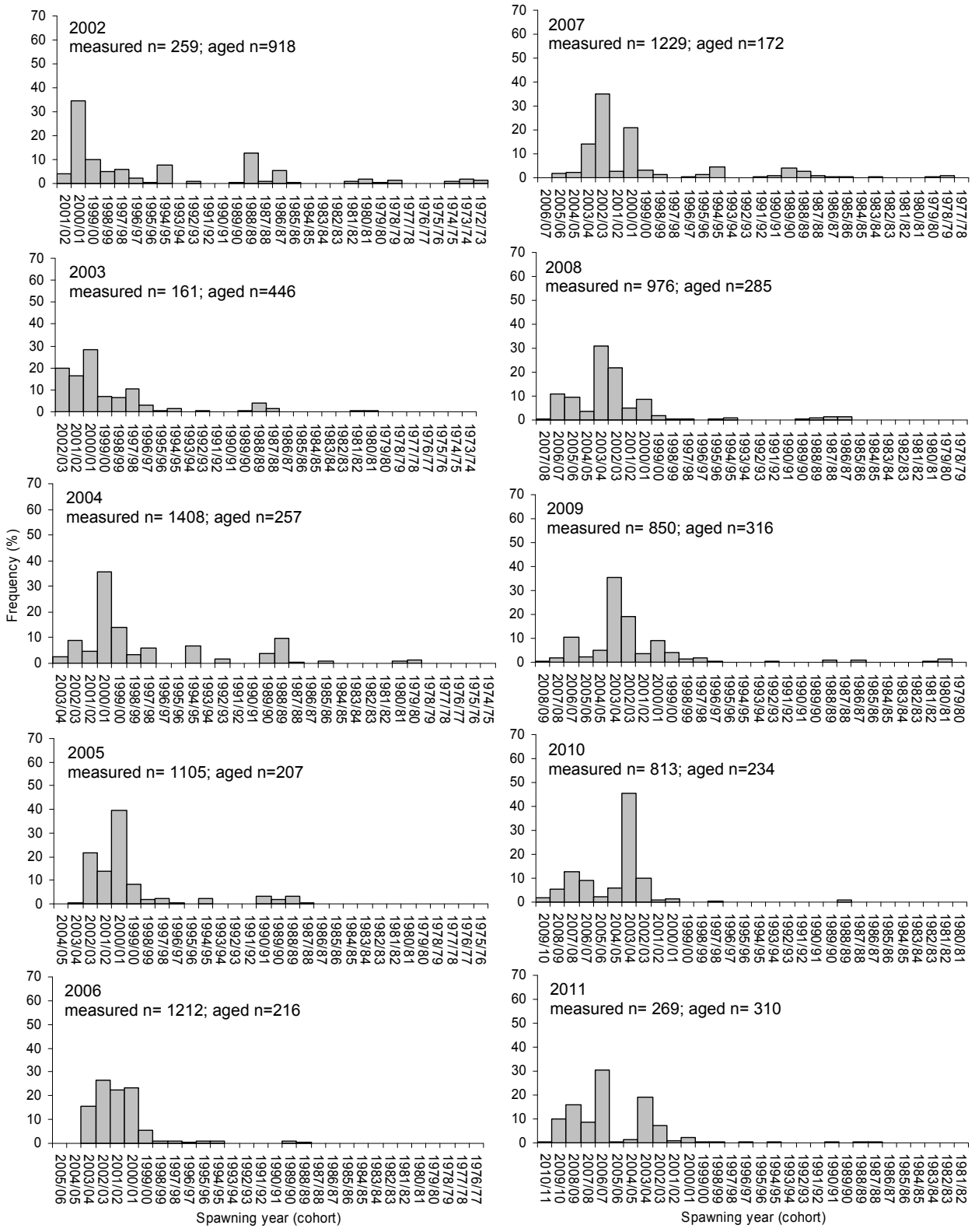


Figure 20: Cohort-frequency distributions of black bream harvested by shore- and boat-based angler diarists in the Gippsland Lakes from 2002–2011. Data is available from 1997.

Note: The age-frequency distribution of bream harvested by angler diarists in 2011 suggests the 2008/09 pre-recruit year class that will enter the fishery in the coming years is relatively strong.

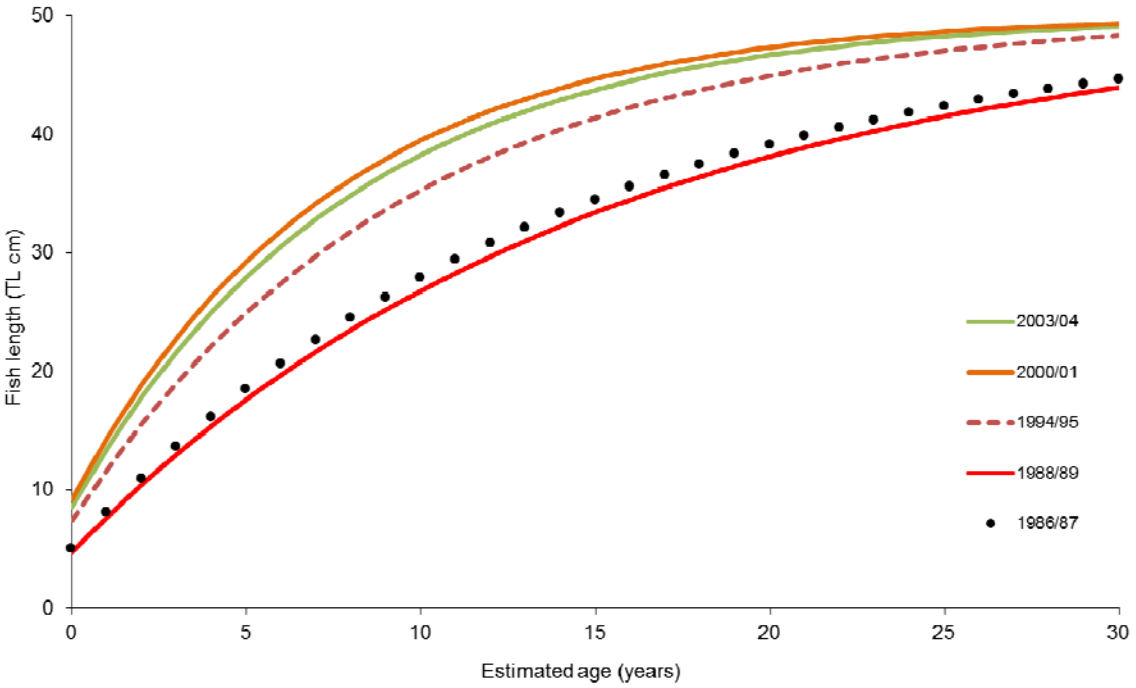


Figure 21: Von Bertalanffy growth models for the relatively strong year classes that entered the fishery in between the late 1980s and early 2000s.

Note: Growth rates of bream among year classes can be highly variable and consequently the time taken for individual year classes to attain the LML is similarly variable. The variability in growth rates makes it difficult to predict the time it will take for a particular year classes to enter the fishery. The models reveal that year-class growth has increased substantially since the late 1980s. The more recent year classes are entering the fishery at a younger age than those in the late 1980s. The causes of the variation in growth are unknown but are likely to include both density-dependent and -independent effects.

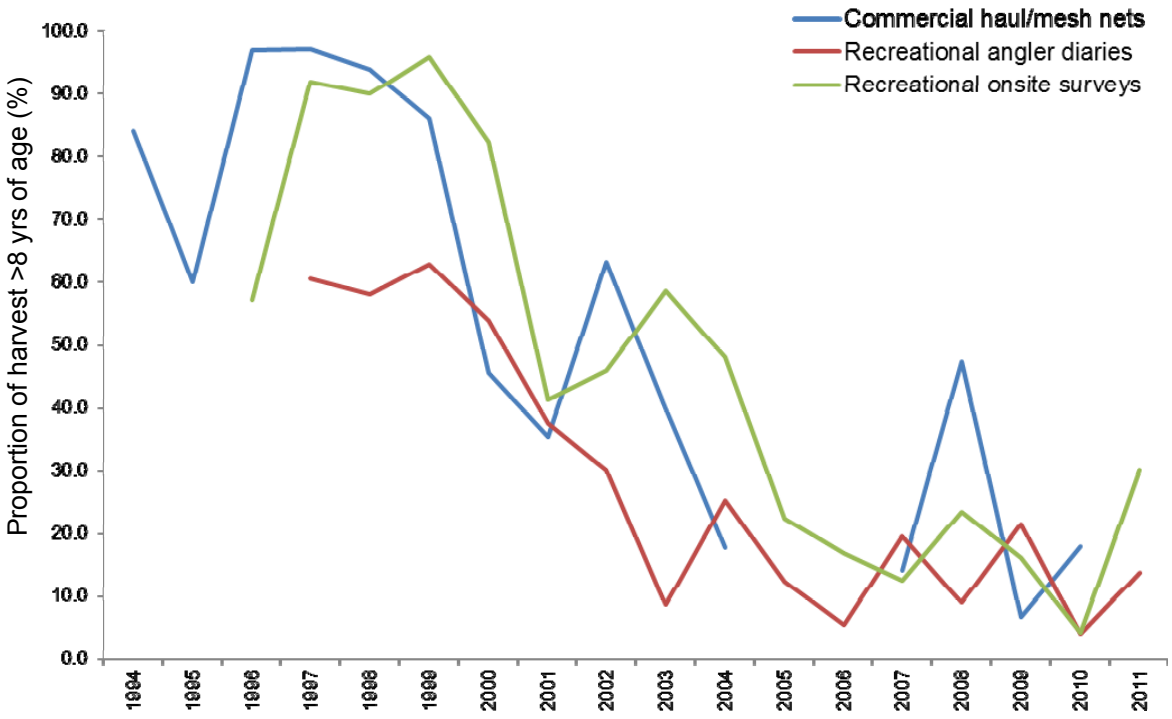


Figure 22: Estimated annual proportion of bream caught by commercial haul seines and mesh nets (combined), recreational angler diarists, and boat/shore-based recreational fishers surveyed during onsite surveys that were ≥8 years of age.

Note: There was a significant decline in the proportion of older (>8yrs) bream harvested from the Gippsland Lakes between the late 1990s and the mid-2000s, and the proportion of the harvest >8 yrs remains low. Without adequate fishery-independent monitoring of the adult population it is difficult to assess whether there has been a change in the age structure of the population or just the harvest. Older bream may stil be present in the system, and over the past decade, faster growing cohorts (that have entered the fishery at a younger age), are dominating catches. However, a decline in the abundance of older bream would raise concercn as this would be having an impact on the reproductive capacity of the Gippsland Lakes population. Older bream are known to have a higher fecundity (Cashmore, 2002)

Table 5: Total mortality parameter estimates for three of the most abundant year-classes harvested by commercial and recreational fishers.

Year-class	Data source	Total mortality estimate
1989	Commercial haul seine logbook	0.4
	Commercial mesh net logbook	0.4
	Recreational boat-based onsite survey	0.4
	Recreational shore-based onsite survey	0.4
	Recreational general angler diaries	0.4
	Recreational research angler diaries	0.5 0.4 (Conron 2004) 0.7 (Morison and Conron 2009)
1995	Recreational research anglers	0.7 (Conron 2004) 0.7 (Morison and Conron 2009)
2003	Recreational boat-based onsite survey	0.7

Note: Estimates of total mortality for the Gippsland Lakes bream population are not considered to be high.

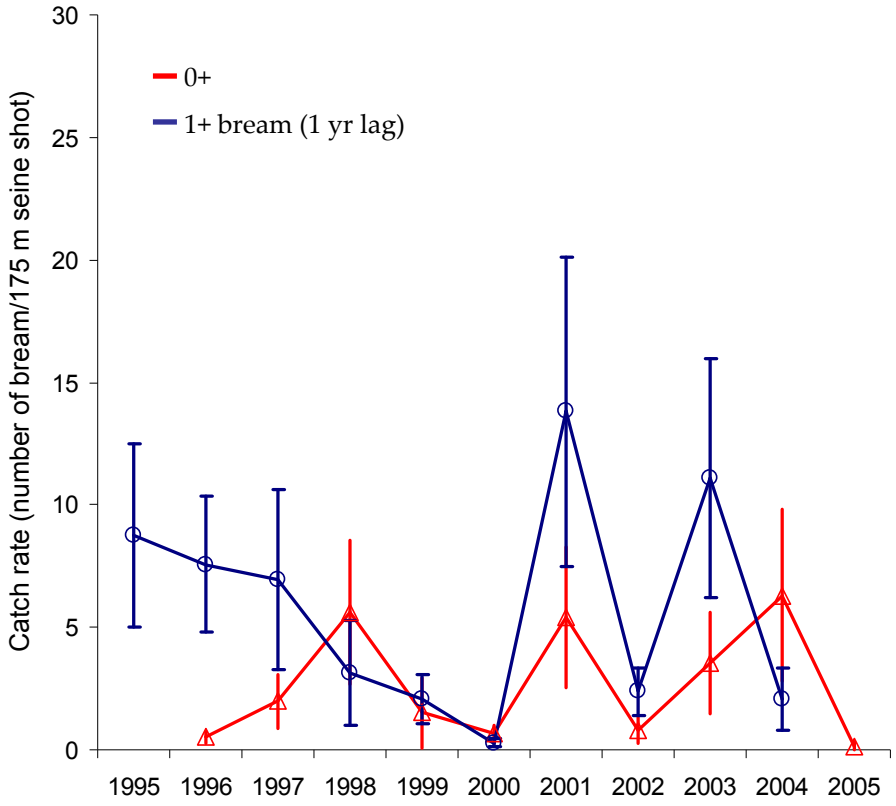


Figure 23: Fishery-independent pre-recruit survey annual catch rates using seine net from 1996 to 2005.

Note: The fishery-independent pre-recruit survey is used to assess year-class strength. The survey targets 0+ and 1+ yr old bream that are <10 and 15−10 cm FL, respectively. The survey was conducted between 1996 and 2005 in February and/or December using a 175 m research beach seine at 32 sites with the lakes proper.

Fishery-independent survey catch rates of 0+ and 1+ bream in February and December 2000 and 2001, respectively, were the lowest on record.

Average annual catch rates have been well below levels observed in 1981, where the average pre-recruit catch rate was 150 bream/shot.

The pre-recruit survey concluded in 2005. There were a number of limitations associated with the survey design that were identified including: the survey gear was not effectively sampling over dense seagrass, especially areas where there was a high epiphytic load on the seagrass, there were no survey sites in the rivers, deep holes, or in Lake Wellington, and the results of the survey were not representative of the whole Gippsland Lakes system.

In 2008, alternative survey methods were trialled including, 30 m seine, 2.2 m otter-board trawl, angler diarist using hook size 6 with sand worm, and underwater video. The otter-board trawl was most effective at sampling 0+ and 1+ year old fish, numerous sites in a small amount of time, the majority of habitat types in the rivers and lakes, and was easy to deploy from small, non-specific research vessels.

A system-wide survey was initiated in 2010 using the otter-board trawl at 86 sites and a small beach seine at 8 sites during autumn and winter in the rivers and lakes.

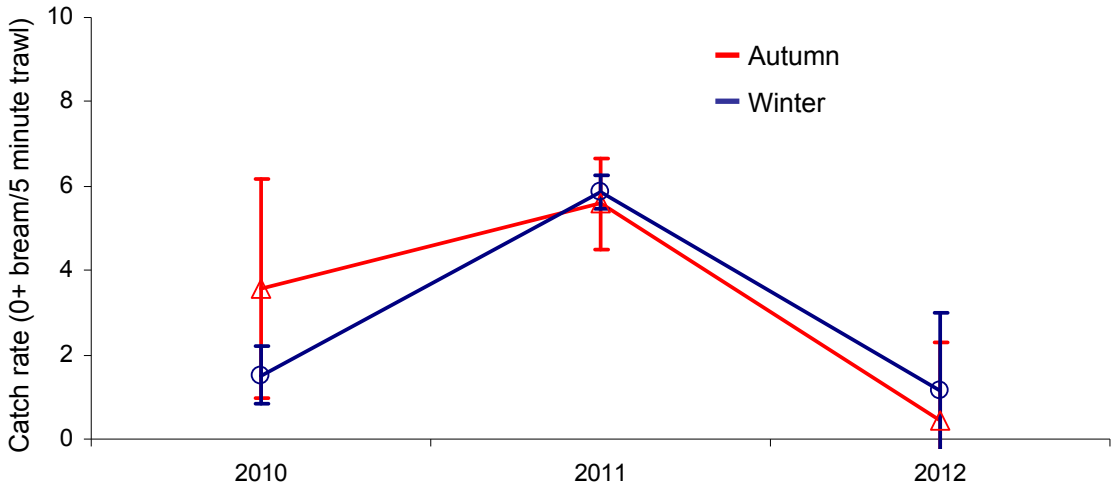


Figure 24: Fishery-independent pre-recruit survey annual catch rates using otter-board trawl from 2010 to 2012.

Note: Average annual catch rates of pre-recruit bream have remained relatively low indicating that future recruitment levels into the fisheries will remain lower than those observed historically.

The number of 0+ bream sampled in 2011 (spawned in spring 2010) is expected to result in a strong pulse of black bream entering the fisheries ~2015.

The small number of 0+ bream sampled in 2012 (spawned in spring 2011) may be the result of high river flows across system which created low salinity environments (<15 ppt) across the system. Freshwater flows are a major driver in the spawning success of black bream.

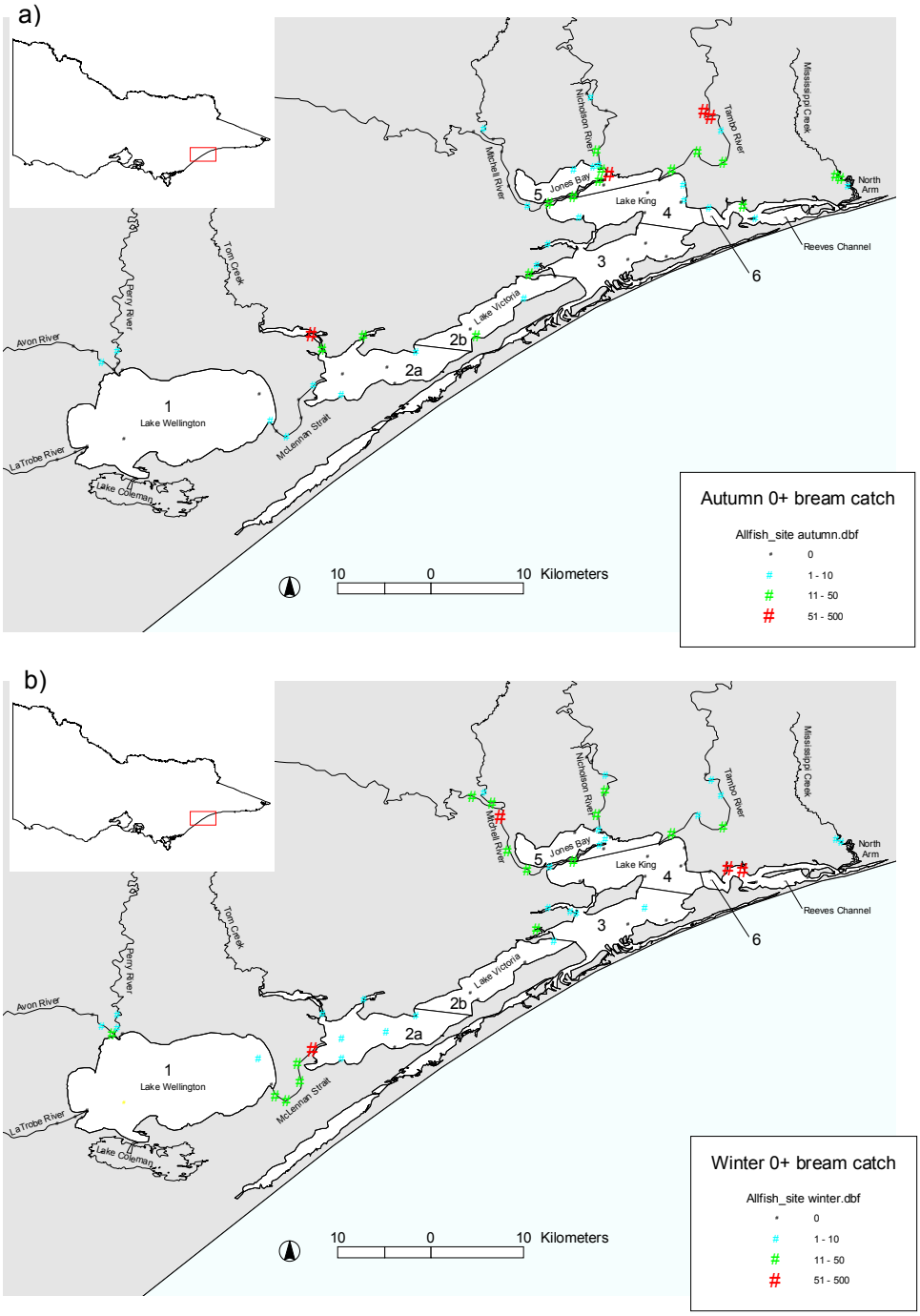


Figure 25: a) Autumn and b) winter, site-specific (86 sites) catch rates (number/5 minute tow; see legend) of pre-recruit bream (<10 cm FL) averaged for the 2010 to 2012 survey years (duration of the current survey).

Table 6. Summary of the commercial catch of bream and effort targeting bream and other species in the Gippsland Lakes.

	Mesh net		Haul seine	
Variable	Effort (km-lifts)	Catch (tonnes)	Effort (shots)	Catch (tonnes)
Minimum	930.0	24.2	130.0	2.1
Maximum	3833.4	245.0	1883.0	195.9
Long-term average (34-years)	2314.6	91.6	908.8	57.3
10-year average	1406.8	44.2	303.7	10.7
5-year average	1159.5	58.0	278.2	16.5
2011/12	1244.5	83.7	322	12.7
Trend in 5-year moving average over the past 10 years	Decreasing	Stable	Decreasing	Stable

Integrating local knowledge

As part of the assessment process for bream in the Gippsland Lakes, commercial and recreational fishers were provided with semi-structured local knowledge surveys. The surveys were designed to give stakeholder groups an opportunity to provide valuable information on the status of bream in the Gippsland Lakes, to fill current information gaps, and to complement scientific knowledge in providing a comprehensive assessment.

Survey groups

Recreational sector:

- Ten recreational fishers from the General Angler Diary Program that fish in the Gippsland Lakes were surveyed over the telephone.
- Two hundred and thirty two recreational fishers were interviewed during onsite surveys over past two years.

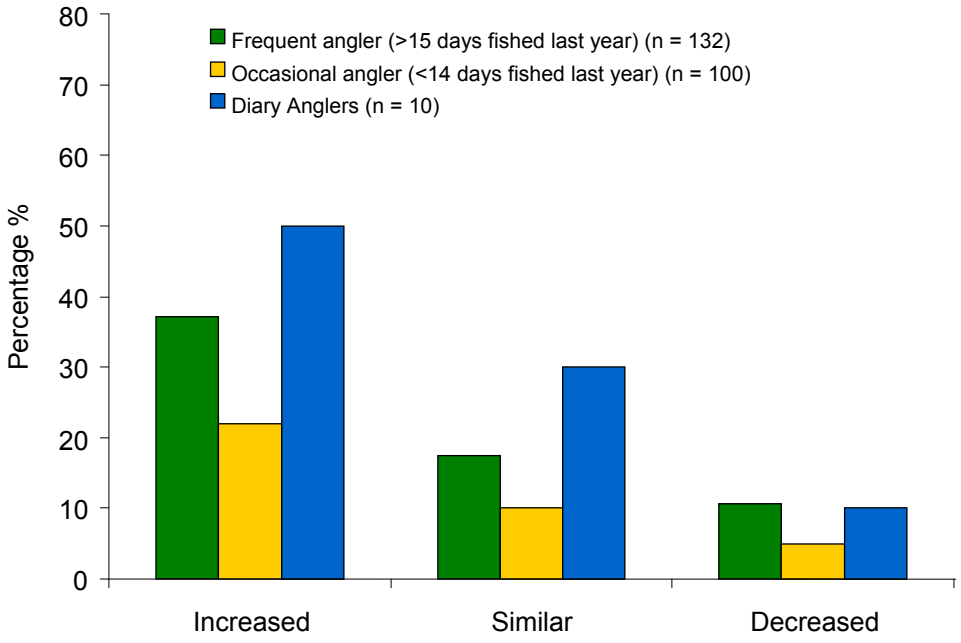
Commercial sector:

- There are currently 10 commercial fishery access licenses in the Gippsland Lakes.
- Commercial fishers provided general feedback via phone conversation/email.

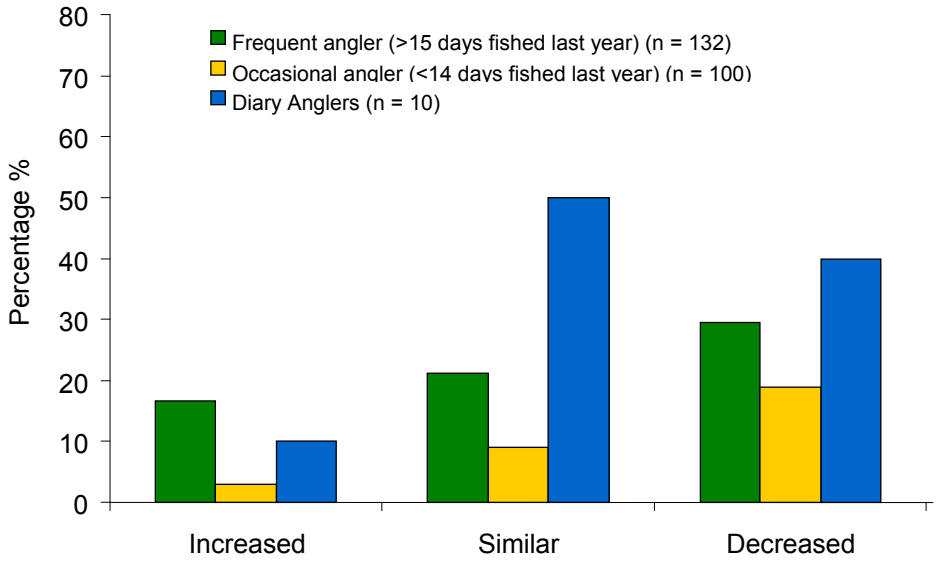
Results

Recreational sector:

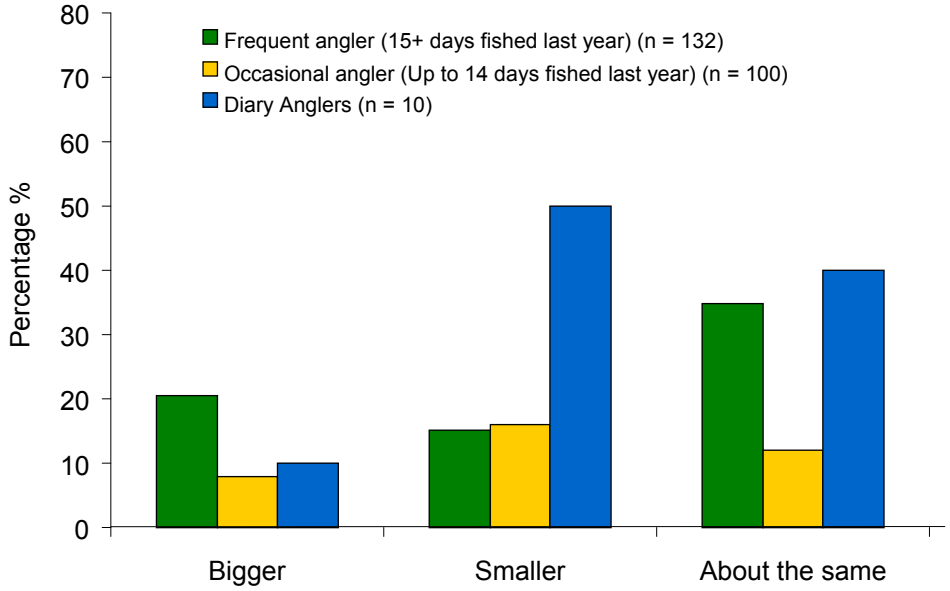
*How would you describe the abundance of **undersize** black bream in the Gippsland Lakes over the past 12 months compared to the previous 3-4 years?*



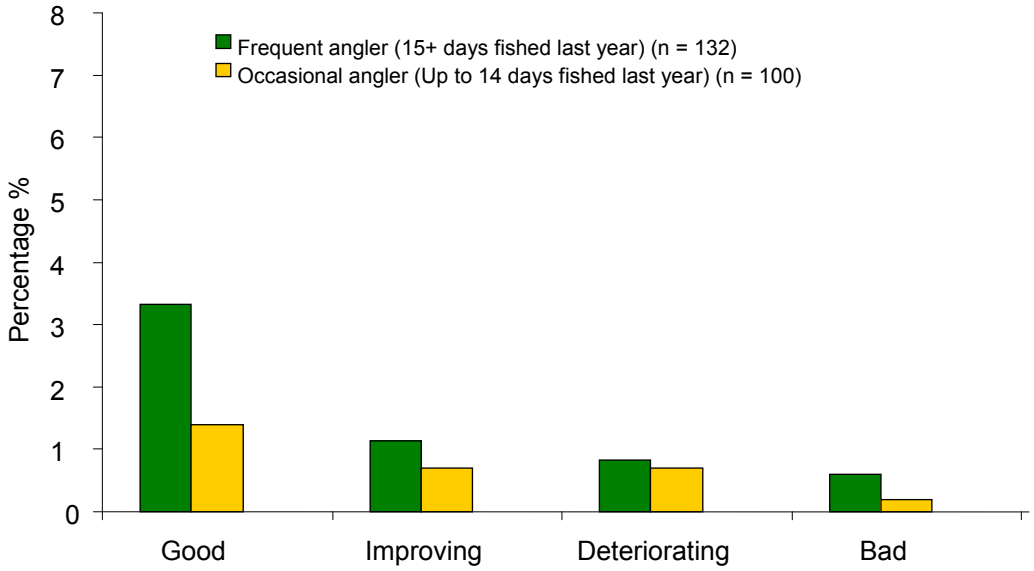
*How would you describe the abundance of **legal sized** black bream in the Gippsland Lakes over the past 12 months compared to the previous 3-4 years?*



*Would you say the **average size** of black bream in the Gippsland Lakes that you've caught over the past 5 years has gotten bigger, smaller or about the same?*



*In general how would you describe the **status** of black bream stocks in the Gippsland Lakes?*



Recreational fishes reported that, generally, the abundance of undersize bream had increased, the abundance of legal size bream had decreased or was similar (over the past 12 months compared to the previous 3-4 years), and that the status of bream stocks in the Gippsland Lakes was 'good'.

Commercial sector:

Feedback from the commercial sector on the status of bream stocks in the Gippsland Lakes included that 'due to the return of normal rainfall, the abundance of bream in the lakes was high. Juveniles through to large adults were abundant, larger bream were in the lakes and small bream were traversing the shallows'. Bream stocks were reported to be 'healthy'.

Life-history and ecology

Distribution and movement	• Occur from the central coast of New South Wales to the central west coast of Western Australia. • Found in estuaries, coastal lakes and sheltered coastal waters. • Individuals complete much of the life-cycle within a specific estuary. • In the Gippsland Lakes, adults often remain in an area for only a short time and are capable of moving distances up to 30 km/day. • In the Gippsland Lakes, foraging occurs throughout the lagoons from late summer to autumn before moving into salt wedge-dominated areas of the estuary to spawn. • When the Hopkins River is flooding, individuals will leave the estuary and shelter in marine areas such as nearby reefs. • Movement between low and high salinity environments may be frequent. Multiple migratory behaviours (classified as estuarine resident or migrant where both irregular and cyclic patterns of movement were observed) between low and high salinity environments have been observed among different fish from the same estuary. These results suggest that movement may not be completely controlled by the nature of the environment. • In the Little Swanport estuary, Tasmania, small scale movement patterns have been linked to tidal cycles. Individuals typically move with the current during both incoming and outgoing tides, travelling distances of several kilometres during each cycle. • In the Little Swanport estuary, Tasmania, downstream movement to the middle and lower estuary occurs during periods of high freshwater inflow. Individuals were found to return upstream after a period of approximately 10 days, when salinities had increased to >10. • Reproductively active individuals have been found to aggregate in the upper regions of the Little Swanport estuary during spawning season, and are dispersed throughout the system towards the end of the spawning period.
Stock structure	• Tagging programs in Victorian waters have identified movement of a few individuals from the Gippsland Lakes to Corner Inlet, and as far as New South Wales. • Tagging studies in New South Wales and South Australia suggest that bream exhibit limited coastal movement and are largely confined to estuaries. • A high level of genetic divergence and a very low level of gene flow have been identified among populations from multiple estuaries in Western Australia, suggesting limited migration. • Variation in the growth rates and age at maturity of populations among estuaries of south-western Australia suggest separate discrete populations exist. • Genetic research in Victorian estuaries provides evidence for isolation by distance, where there is less migration occurring between estuaries that are separated by a larger distances.
Growth	• Egg size at hatching is 1.7 mm; eggs are spherical and pelagic; eggs attain a diameter of 0.7–0.8 mm. • The size of larvae after 22–28 days is ~10 mm. • Metamorphosis of larvae to the adult form occurs at a size of 11.7 mm. • Growth is relatively slow. • Maximum size of 60 cm TL (3.5 kg). • Longevity of 29 years.
Hybridisation (the process of combining different species to create a hybrid)	• The distribution of black bream in eastern Australia overlaps with the closely related yellow-fin bream, *A. australis*, which occur from Wilson's Promontory in Victoria, to northern Queensland. • Where both black bream and yellow-fin bream occur in the same area, hybridization is considerable.
Reproduction	• Spawning occurs in pelagic waters within estuaries during spring and early summer (around September to February), and may begin earlier in estuaries with higher salinities and temperatures. • The salt-wedge of estuaries is used to find spawning locations that have a salinity range of 15 to 35 ppt. • Individuals in spawning condition have been observed in two south-western Australian estuaries with salinities as low and high as 3.5 and 45.2, respectively, where there is no salt-wedge formation. • Successful spawning has been linked to periods of low freshwater discharge. • The timing of spawning does not appear to influence growth rates.

	• Eggs hatch after two days. • Hypoxia, low salinity and lowered temperature have been shown to reduce embryo survival and hatch rates. • Hypoxic conditions are detrimental to early development and may result in deformities. • Black bream mature after two years at a size of >20 cm TL. • Sexual development in black bream is not clearly defined; some suggest that the species may be protogynous (starting as females and later changing to males), gonochoristic (two distinct sexes that do not change during a life-time), rudimentary hermaphrodite (where residual ovarian tissue develops in a fully developed testis, or residual testicular tissue develops in a fully developed ovary). • Highly fecund; females are capable of producing several million eggs per season. • Fecundity increases considerably with fish length. • Multiple batch spawner.
Habitat and environment	• In the Gippsland Lakes, suitable larval settlement and nursery areas are dominated by seagrass, with salinities of ~19–22 and a temperature of ~21 °C; however, further research is required to better define optimal conditions for larvae and juveniles. • Juveniles are capable of inhabiting salinities ranging from 0 to 48. • Higher concentrations of eggs and larvae in the Gippsland Lakes occur at sites where the water column is highly stratified (difference in salinity >10), suggesting haloclines may enhance larval survival. • Strong recruitment in Victorian estuaries is associated with years of well-developed salinity stratification (usually associated with reduced freshwater flows) in the estuary over the spring spawning season. A negative relationship between recruitment and freshwater flows, together with a positive relationship with surface salinity has been found for the Gippsland Lakes. • There is a relationship between the combination of water column stratification (difference between surface and bottom salinity) and freshwater flow, and recruitment of 0+ juveniles in the Gippsland Lakes. Significant freshwater flows after the spawning period may increase the available habitat for juveniles in their first year of life by allowing them to spread from rivers into the lakes where extensive seagrass beds occur. • Recruitment in the Gippsland Lakes may be a result of a two-phase mechanism: successful spawning and larval survival occurs in the salt wedge under relatively low flow conditions; higher freshwater flows after the spawning period create a suitable habitat for juveniles in the lakes. • Climate change is likely to result in both a seasonal shift and a regime shift in the amount of freshwater flow entering Victorian estuaries. It is predicted there will be a marked reduction in the rainfall and associated flows over the spring period but little reduction in rainfall over the summer to autumn period. These changes, which include lower flows over the spawning period, may be favourable for black bream.
Foraging	• Both juveniles and adults are opportunistic feeders, with the composition of the diet reflecting the most available prey species. • Diet includes shellfish (e.g. mussels and cockles), polychaetes, crustaceans (e.g. prawns and crabs), small fish (e.g. gobies) and algae (e.g. *Enteromorpha* and *Ulva*). • Copepod nauplii are an important dietary component for larvae in the Hopkins River estuary. • Juveniles in the Gippsland Lakes feed on a diverse range of abundant small prey in seagrass habitats including polychaetes, bivalves and amphipods. Adults feed in deeper un-vegetated habitats on a range of prey including a high proportion of bivalves, with larger fish consuming highly mobile prey such as fish, crabs and shrimps.

References: Butcher 1945; Butcher and Ling 1962; Gorman 1962; Dunstan 1965; Gorman 1965; 1972; Harbison 1974; Wallace 1976; Holt 1978; Rigby 1982; Sherwood and Backhouse 1982; Ramm 1983; Rigby 1984; Ramm 1986; Longmore et al. 1990; Kuiter 1993; Rowland and Snape 1994; Newton 1996; Coutin et al. 1997; Chaplin et al. 1998; Haddy and Pankhurst 1998; Morison et al. 1998; Neira 1998; Potter and Hyndes 1999; Sarre and Potter 1999; Sarre 1999; Haddy and Pankhurst 2000; Sarre and Potter 2000; Sarre et al. 2000; Walker and Neira 2001; Norriss et al. 2002; Partridge and Jenkins 2002; Partridge et al. 2003; Burridge et al. 2004; Elsdon and Gillanders 2005; 2006; Burridge and Versace 2007; Gomon et al. 2008; Hassell et al. 2008; Hindell et al. 2008; Hassell 2009; Roberts et al. 2009; Jenkins et al. 2010; Sakabe and Lyle 2010; Roberts et al. 2010; Sakabe et al. 2011; Jenkins and Spooner 2012; Williams et al. 2012.

Description of the fisheries

	Commercial fishery	Recreational fishery
General description	Gippsland Lakes is the only remaining targeted commercial bream fishery in Victoria. Since the closure of other Gippsland estuaries to commercial fishing in the early 2000s the Gippsland Lakes has produced between 80 and 95% of the total annual Victorian commercial catch of bream, with the remaining coming from Port Phillip Bay (The Department of Primary Industries, Queenscliff, unpublished).	The National Recreational and Indigenous Fishing Survey (Henry and Lyle 2003) estimated that from May 2000 to April 2001, the total retained recreational bream catch from Victorian waters was 203 tonnes (~507,000 fish). Approximately 50% of this catch came from the Gippsland Lakes, with all other estuaries contributing <10% each. It was estimated that in 2000/01, recreational fishers took ~53% of the total annual Victorian retained catch (by weight) of bream (Henry and Lyle 2003). Since 2001, the recreational proportion of the total Victorian bream catch is estimated to have increased to approximately 80% (Department of Primary Industries 2008). This is due to a reduction in Gippsland Lakes bream catches taken by the commercial sector since 2003, and the closure of targeted commercial bream fisheries in Mallacoota Inlet, Tamboon Inlet and Lake Tyers (Department of Primary Industries 2008).
Fishing methods	Haul seines and multifilament mesh nets are the main commercial methods used to target bream in the Gippsland Lakes.	Virtually all recreational catch for bream is taken by angling using rod and reel, and hand line. A range of baits, lures, hook types and sizes are used. A small proportion of the catch is taken by spear fishing.
Fishing areas	Figure 1 shows the commercial fishing regions of the Gippsland Lakes system.	Boat-based angling for bream occurs primarily in larger more open estuarine waters. Shore-based angling for bream occurs primarily in riverine areas of estuaries.
Seasonality		Fishing effort is highest during the warmer months when there is an influx of visitors to coastal locations.

Management arrangements

Commercial fishery	Recreational fishery
Commercial bream catches occur as a component of a multi-species commercial finfish fishery. The commercial fishery is currently managed primarily by: • Input (effort) controls (including limited entry licensing, restrictions on fishing equipment and methods, and closed areas/seasons) • Indirect catch controls such as legal minimum size limits. The following management controls have been introduced to the Gippsland Lakes commercial fishery: • Commercial fishing is permanently banned from rivers flowing into the Gippsland Lakes and within 400 m of the mouths of these rivers. • Commercial fishing is banned in the North Arm and Lake Reeve, and only seine netting is allowed from May to November in the Cunningham Arm at Lakes Entrance. • The Gippsland Lakes is closed to commercial fishing from midday Friday until the following Sunday evening throughout the year, as part of a voluntary code of practice. This restriction is designed to minimize interactions between commercial fishing and other recreational users of the estuary. • Haul seine nets are restricted to a maximum length of 732 m and mesh nets to a maximum length of 1300 m (working alone) or 2200 m (working with crew). • The commercial legal minimum length (LML) for bream fishing in the Gippsland Lakes was raised from 26 to 28 cm total length in 2003. The number of licensed commercial fishers in Victorian waters was reduced by a third between 1986/87 and 2010/11. The majority of the licence removals occurred as a result of voluntary licence buy-back schemes conducted in 1999/00 and 2005/06. In 2012 there were 10 fishery access licence holders in the Gippsland Lakes.	**Recreational fishing licence** Since 15 July 1999, recreational fishers have been required to hold a recreational fishing licence (RFL) to fish in marine and inland waters. Recreational fishers under 18 years of age or over 70 years of age, or those holding one of a range of concession cards are not required to hold a licence. **Gear restrictions** Recreational fishing remained unrestricted, other than size limits, until 1992, when regulations specified a maximum of four lines per person and two hooks per line when fishing in marine waters, and a maximum of two lines with two hooks per line in inland waters. This regulation was modified in 2009 to include two hooks per line or one bait jig when fishing in both marine and inland waters. **Bag and size limits** A daily bag limit (DBL) and possession limit of 10 bream per person applies to recreational fishing in all Victorian waters. The minimum legal size for bream is 28 cm TL.

Assessment data and methods

Source	Description
Fishery-independent	**Bream haul seine trawl survey** A haul seine trawl net (175 m long, 3 m drop, 38 mm mesh in the wings and 16 mm mesh in the bunt) was used to survey the relative abundance of (how old/size) bream in the Gippsland Lakes from 1996 to 2006. Surveys were usually conducted in November/December each year. The net was deployed approximately 200 m from the shore and covered an area of approximately 4750 m^2.
Commercial fishery-dependent	Victorian commercial fishers are required as a condition of their licence to record their fishing activities in a logbook and to submit this information to DPI. Commercial fishers provide the following information: • Gear code and net length/number of hooks/jigs • Area code • Number of shots • Fishing time • Weight of species caught and not returned to the water. **Assessment:** A general linear regression model was used to standardise CPUE data. Residuals versus fitted values were examined to check for any extreme outliers and assess the need for data transformation. Prior to analyses, the data was logarithmically transformed after adding small constant (0.5) to satisfy the assumption of normality with a constant variance. We used the data from fishermen who target bream by employing gear type Estuary Seine Bait Seine (Small Mesh < 30mm), Haul Seine (Medium Mesh 30-59mm), Haul Seine (Large Mesh 60-100mm), Multifilament Meshnet, Multifilament Mesh 60-74mm, Multifilament Mesh 75-94mm and Multifilament Mesh 95-124mm. The data from area 1 and area 13 only contributed 2 and 58 records, respectively, to the data so these records were excluded from final analyses. Furthermore, 43 records did not have any information about area and were excluded. Fishermen with less than 24 months of fishing data were also excluded from the analysis. Statistics for each of the terms included in the parsimonious model were as follows: month (F-statistic=18.57; df=11; P-value=<0.0001), area (F-statistic=82.95; df=9; P-value=<0.0001), gear-type (F-statistic=70.35; df=7; P-value=<0.0001), fishermen (F-statistic=64.16; df=46; P-value=<0.0001), Tambo River flow (F-statistic=30.24; df=1; P-value=<0.0001). The R-squared value for the model was 0.41.

Recreational fishery-dependent	**Offsite telephone diary surveys** Off-site telephone diary surveys of recreational fishing were carried out in 2000/01 (Henry and Lyle 2003) and 2006/07 (Ryan *et al*. 2009) to provide regional and State-wide estimates of total recreational catches of key target species, including bream. **Onsite access point creel surveys** Onsite access point surveys of recreational fishing have been carried out since 1995 to provide time-series' of information on catch rates and the size structure of a range of fish species, including bream. Survey data is collected from March to November (Autumn–Spring); includes the Mitchell, Tambo and Nicholson Rivers; shoreline and boat ramp surveys are conducted (Mitchell River: 2 boat ramps, 9 shoreline locations; Tambo River: 1 boat ramp, 6 shoreline locations; Nicholson River: 1 boat ramp, 1 shoreline location. Since 2000, >20,000 interviews have been conducted with anglers. • **Assessment:** A generalised linear model with Tweedie distribution for response variable (CPUE) was used to standardise CPUE data. A Tweedie distribution was used as it could handle the large proportions of zeros (~65%) uniformly. Separate parsimonious models were selected for retained CPUE and released CPUE based on Wald F tests. Statistics for each of the terms included in the parsimonious models were as follows: Onsite survey retained CPUE: season (excluding summer where no sampling occurs), angler type (≥15 days/year, 5-14 days, <5 days), target (1st target species bream, 2nd target species bream, other species) and platform (shore-based, boat-based); there was no effect of fishing zone (Tambo/Nicholson, Mitchell) or river flow (Tambo River, Mitchell River). Onsite survey released CPUE: angler type, target, fishing zone; there was no effect of season, platform or river flow. **Volunteer general angler diary program** A voluntary angler diary program established in 1997 provides time-series' of information on recreational angler catch rates, and the size/age composition of key target species, including bream in the Gippsland Lakes.
Length and age monitoring	Since the 1990s there has been routine sampling of length- and age-frequency distributions of bream landed by commercial and recreational fishers. Otoliths used for bream ageing are prepared and aged following standard procedures outlined in Morison *et al.* (1998). A nominal birth date of 1 January is assigned when ageing black bream. Age-frequency information is presented by spawning year so abundant year-classes can be identified and tracked across multiple sampling years. Ages referred to in this report represent the age of a particular year-class of bream as of 1 January. Catch curve analysis using age data was carried out to generate bream mortality estimates (http://www.ncfaculty.net/dogle/fishR/gnrlex/catchcurve/catchcurve.pdf). The relationship between the natural log of catches and fish age was used to estimate total mortality. To standardise for variable catch, each age/length-frequency matrix was converted to a probability density by year (the sum of the frequencies of length at each age class for a given year summed to one). Each cell in the matrix was multiplied by 1000.

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