A recreational angler based tagging program to understand the movements of Victorian King George Whiting to their spawning areas

Recreational Fishing Grants Program Final Report

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Executive Summary

Funding from the Recreational Fishing Grants Program has supported a partnership between scientists and recreational fishers in a tagging program to understand the movement patterns of King George Whiting in Victoria. Fishers have been tagging Whiting within Port Phillip Bay and Western Port since the beginning of 2017.

The Whiting tagging project has been very successful with a total of 765 Whiting over a range of sizes tagged. Most of the tagging has been due to the efforts of a small number of expert Whiting fishers, willing to return the prized fish to the water to support the science. Recreational fishers have also supported the project enthusiastically through reporting the recapture of 47 tagged fish (6 % return rate). This recapture rate also indicates relatively low tagging mortality and tag shedding.

A key finding of the project was that many Whiting were recaptured close to where they were tagged, indicating that they were either “site attached” or moved but then returned to the same location on a frequent basis. The tendency for Whiting to stay in the same localised areas for significant periods of time has implications for management of the fishery. The results suggest that concentrated fishing in specific areas could lead to “localised depletion”.

Movements over significant distances within the bays were recorded in a few cases, and some of these were consistent with a generalised movement towards the bay entrance with growth. Whiting can move over significant distances in a short period, with one fish moving 20 km at a rate of approximately 1 km per day.

Recaptured Whiting were found to have grown at an average rate of approximately 7 cm per year, consistent with estimates based on age and length. Growth amongst individuals was highly variable, however, most likely related to the water temperatures experienced over the period of liberty.

There is no evidence of juvenile Whiting moving between the bays, consistent with other evidence that juveniles remain in the same bay until they approach maturity. This has implications for fishery management, indicating that each bay should be treated as a separate management unit. There has also been no evidence of Whiting moving out onto the coast so far in the project. It will take a number of years for Whiting tagged in the bays to mature and move out along the coast, and over time we may expect to receive some recaptures from further afield.

Introduction

King George Whiting caught by fishers in Victorian bays are juveniles up to the age of 4 years that are too young to spawn (Hamer *et al.* 2004). Whiting older than this move out of the bays onto the coast, and tend to be older and larger in western Victoria (Hamer *et al.* 2004). Until recently the only known spawning area for Whiting was the Investigator Strait area, north of Kangaroo Island in central South Australia (SA), where Whiting are up to nearly 20 years of age (Fowler *et al.* 1999; 2000). An important question for the sustainability of the Victorian King George Whiting fishery is whether Victorian fish migrate to the known South Australian spawning ground, and are therefore subject to fishing pressure from the targeted fishery for large whiting in that area. Computer modelling studies have suggested that King George Whiting larvae drift to Victorian Bays from an area approximately between Portland and Beachport in south-eastern SA, suggesting that Victorian Whiting may be spawning in that area (Jenkins *et al.* 2000).

A recent project on stock structure of King George Whiting based on otolith (earbone) chemistry and genetics provided strong evidence that Victorian Whiting are not spawned in the known Investigator Strait spawning area in SA, and that adults originating from Victorian bays are not migrating to that area for spawning (Jenkins *et al.* 2016). A new spawning ground for King George Whiting was found off the coast of north-west Tasmania, but these fish are genetically distinct from Victorian Whiting (Jenkins *et al.* 2016). The results of the study support the original modelling in suggesting that the most likely scenario is that Victorian Whiting are spawning in far western Victoria to south-eastern SA. Otolith chemistry of larger whiting from western Victoria is consistent with what might be expected of fish from Victorian Bays (Jenkins *et al.* 2016).

There is also a very limited understanding of the movements of juvenile Whiting within or between the major bays before they move offshore for spawning. Evidence from otolith chemistry indicates that 2-year old Whiting (approximately 20 to 28 cm) have remained in the same bay since arriving as larvae (Jenkins *et al.* 2016). However, it is unknown whether older (3 to 4-year-old) juveniles remain in the same bay or move between bays. Movements of juveniles within bays are also poorly understood. The extent of movement of juveniles within and between bays has important consequences for management of the fishery, particularly in terms of spatial management restrictions and the likelihood of localised depletion.

Funding from the Recreational Fishing Grants Program has supported a partnership between scientists and recreational fishers in a tagging program to understand the movement patterns of Whiting in Victoria. Fishers have been tagging Whiting within Port Phillip Bay and Western Port since the beginning of 2017. The results of the project will contribute greatly to our understanding of the biology and life history of King George Whiting. The project is also a science extension opportunity where recreational fishers have contributed substantially to the research and at the same time learnt about the biology and life history of this iconic species.

Objectives

1. To improve understanding of the movement patterns of King George Whiting in Victoria though a recreational fisher-based tagging program

2. To extend information on the biology and life history of King George Whiting to recreational fishers through their involvement in the research

Materials and Methods

Tagging by recreational fishers began in December 2016. Whiting were tagged using T-bar tags (Hallprint tags), which have been successfully used to tag King George Whiting in South Australia (Fowler *et al.* 2002). Fishers were supplied with packets of 50, sequentially numbered tags and an applicator gun. T-bar tags (Filament length 25 mm, marker length 40 mm) were positioned in the flesh beneath the first dorsal fin. The tag was inserted about 10-15 mm posterior to the start of the dorsal fin on an angle so that the tag streamed backward (See cover photo). The tag number, contact email and contact phone number were printed on the tag marker.

Fishers tagging Whiting recorded the tag number for each fish tagged, as well as the date and location (general location and ideally lat. and long. from GPS) and the length of the fish (fork length [preferably] or total length). Fishers re-capturing tagged Whiting also reported the tag number, re-capture date and location, as well as fish length (fork length [preferably] or total length). For fishers aware of the program there was also the option of returning a tagged fish to the water after recording details of tag number etc. Tagging and recapture information was communicated through a dedicated project email address and phone number.

Talks and demonstrations on tagging were given at fishing clubs when tagging kits and information leaflets were distributed. A video demonstrating the tagging technique was also made available on You-tube. A dedicated web-page was developed tracking the progress of the project and detailing the movement results as they come in (http://blogs.unimelb.edu.au/fisheries-ecology/king-george-whiting-tagging-project/).

Recreational fishers from the following fishing clubs were involved in the project:

- Bellarine Light Game and Sportfishing Club
- Western Port Angling Club
- Southern Boat Fishing Club
- Williamstown Sportfishing & Game Club
- Bellarine Pirates Angling Club
- St Leonards Angling Club
- Drysdale Sportfishing Club
- Mitcham Angling Club
- Snapper Point Angling Club
- Walkerville Angling Club
- Queenscliff fishing club

Tagging kits were issued to 48 fishers and a total of 3300 tags have been issued to date.

Results

Fish Tagging

A total of 765 Whiting have been tagged in the project, and these have nearly all come from five main areas (Figure 1): Southern Bellarine (Queenscliff to St Leonards) and Geelong Arm (Clifton Springs to Point Henry) in Port Phillip; and, Tortoise Head, Middle Spit and Somers in Western Port. The area with the most fish tagged was the Geelong Arm (Table 1).

Table 1. Area breakdown

Area	Fish tagged
Southern Bellarine	123
Geelong Arm	341
Somers	36
Tortoise Head	207
Middle Spit	35

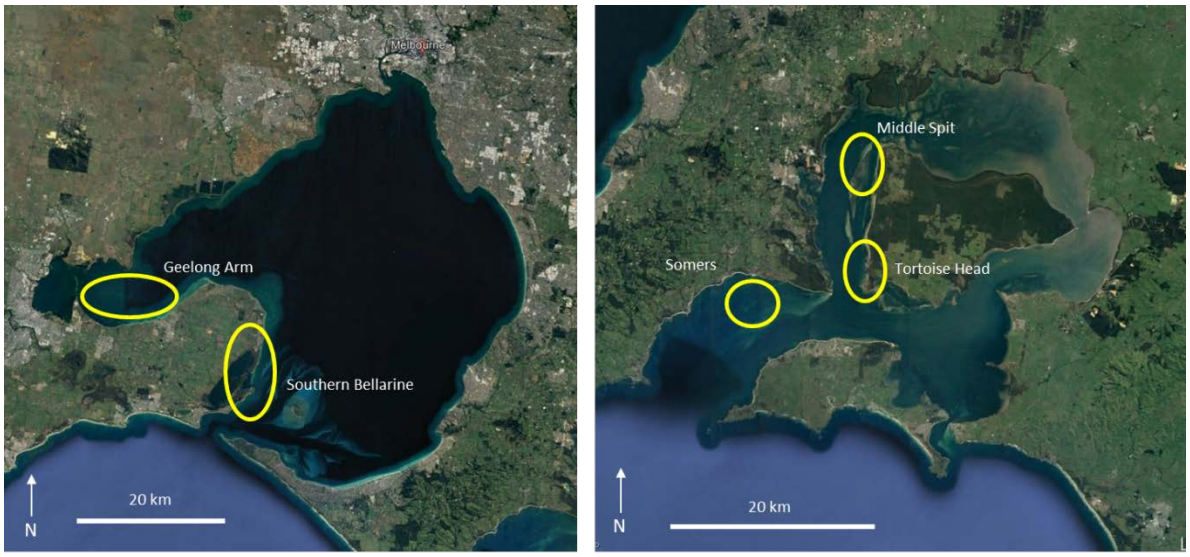

Figure 1. Main areas for King George Whiting tagging in Port Phillip Bay and Western Port.

Tagged Whiting have ranged in size from 20 cm to 48 cm (Figure 2). Good numbers of large (38 cm +) Whiting were tagged early in the project, mostly in the Queenscliff and Somers areas (Figure 2). These large fish were from the strong 2013 year-class and were 3 to 4 years of age. More recently the tagged fish have tended to be smaller, reflecting the entry of the strong 2016 year-class into the fishery. These smaller fish, around or under legal size, have mostly been tagged in the Geelong Arm area (Figure 2). Recently, good numbers of moderately sized Whiting have also been tagged in the Tortoise Head area of Western Port (Figure 2).

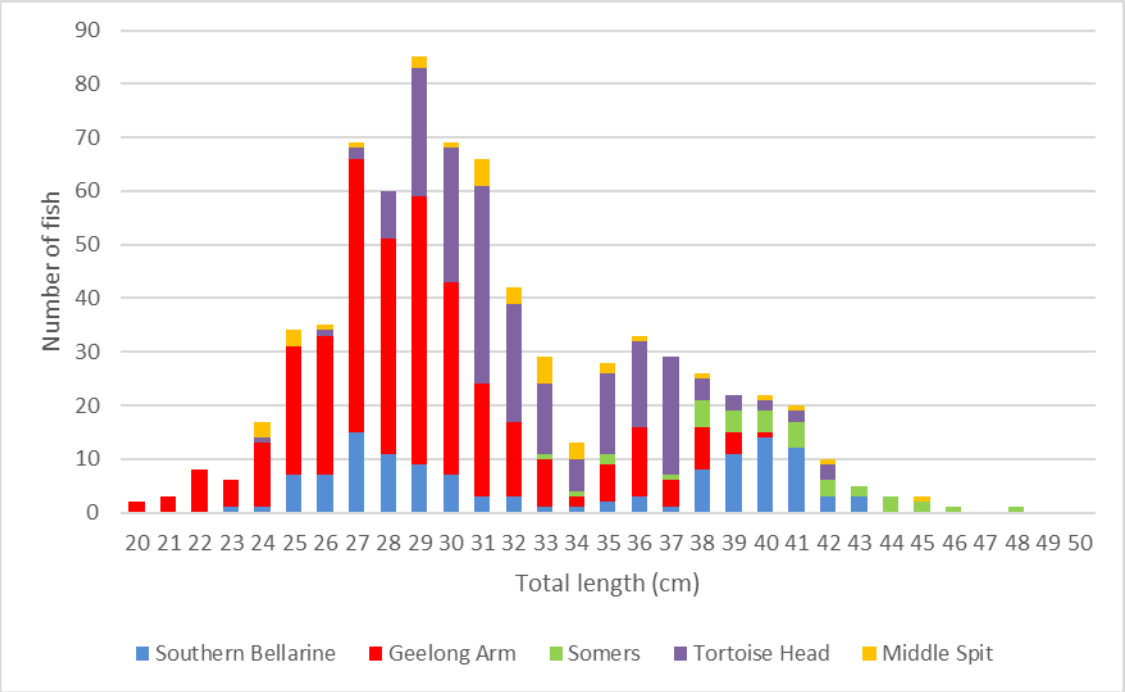

Figure 2. Number and size of King George Whiting tagged in five areas between December 2016 and November 2019.

Peter Kellam of the Bellarine Pirates and St Leonards Angling Club was the most prolific tagger, accounting for approximately half of all the tagged fish, mostly from the Geelong Arm area (Table 2). Chris Garnar of the Western Port Angling Club tagged the most fish in Western Port (Table 2). Don Newman, also of Western Port Angling Club, tagged the largest Whiting of 48 cm. Along with Gordon Robinson and Alex Van Camp, these five fishers tagged 90% of the fish tagged in the project (Table 2).

Table 2. Top taggers

Fisher	Fish tagged
Peter Kellam	359
Chris Garnar	189
Don Newman	69
Gordon Robinson	29
Alex Van Camp	20

Recaptures

There have been 47 recaptures of tagged fish over the course of the project (Appendix 1), giving a return rate of approximately 6%. The longest time between tagging and recapture was 16 months, and the shortest was 45 minutes. The fish at liberty for 16 months also showed the most growth from 33 to 44 cm. Many of the fish were recaptured within 40 days of tagging, and then there was a relatively even distribution of recaptures up to 12 months after tagging (Figure 3).

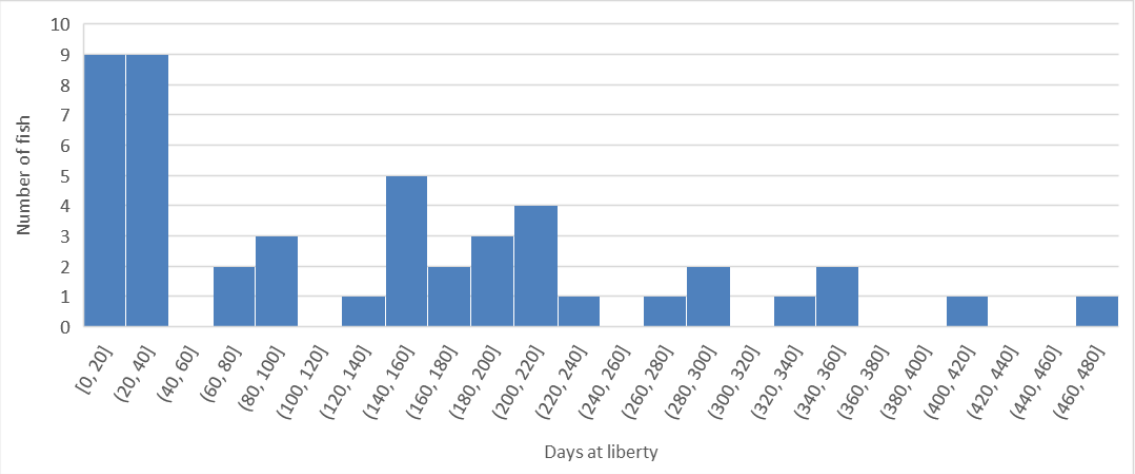

Figure 3. Number of days between tagging and recapture for King George Whiting tagged between December 2016 and November 2019.

Most of the fish have been recaptured within 5 km of the location where they were tagged, even after 16 months, and many were recaptured at the same location as they were tagged in both Port Phillip and Western Port (Appendix 1).

Larger scale movements within the bays have also been recorded. Movements up to 10 km in both east and west directions occurred in the Geelong Arm (Appendix 1). The largest movement by any tagged Whiting in the project was from Leopold in the Geelong Arm to "The Warmies" at Newport, a distance of 55 km over a period of approximately 6 months (Figure 4). This fish was relatively small and grew from 29 to 32 cm (Appendix 1). Two more smaller fish moved approximately 25 km from Curlewis in the Geelong Arm to Werribee South in Port Phillip Bay over a 5-month period (2-3 cm growth) (Figure 5). A larger Whiting moved from the Leopold region of the Geelong Arm to Swan Island in southern Port Phillip over a 14-month period (Figure 6), with growth from 33 to approximately 43 cm (Appendix 1).

In Western Port a tagged Whiting moved 20 km from Somers to Dickies Bay (San Remo) over 11 months (5 cm growth from 35 cm to 40 cm) (Figure 7). Another of the recaptured fish in Western Port showed the greatest short-term movement recorded so far, from Somers to Middle Spit (over a 3-week period), approximately 24 km (Figure 7).

The growth rate of Whiting was estimated from the change in length from tagging to re-capture (Figure 8). The average growth rate for recaptured fish was approximately 0.2 mm per day, which equates to about 7 cm per year. There was also a wide variation in growth rates amongst individual fish, with approximately 30% of the variation in growth due to factors other than time at liberty (Figure 8).

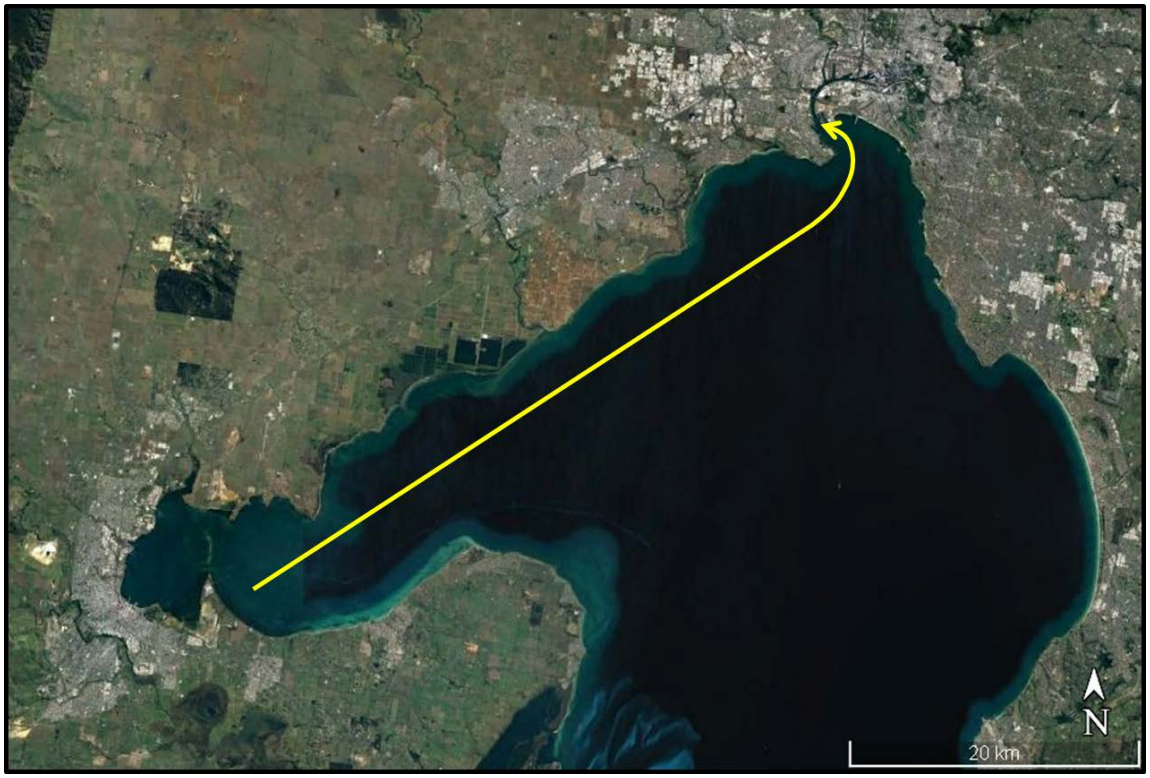

Figure 4. Tagging and recapture locations in Port Phillip for a Whiting at liberty for 194 days

Figure 5. Tagging and recapture locations in Port Phillip for Whiting at liberty for 159 and 154 days respectively

Figure 6. Tagging and recapture locations in Port Phillip for a Whiting at liberty for 414 days.

Figure 7. Tagging and recapture locations in Western Port for Whiting at liberty for 291 days (recapture at San Remo) and 21 days (recapture at north Middle Spit).

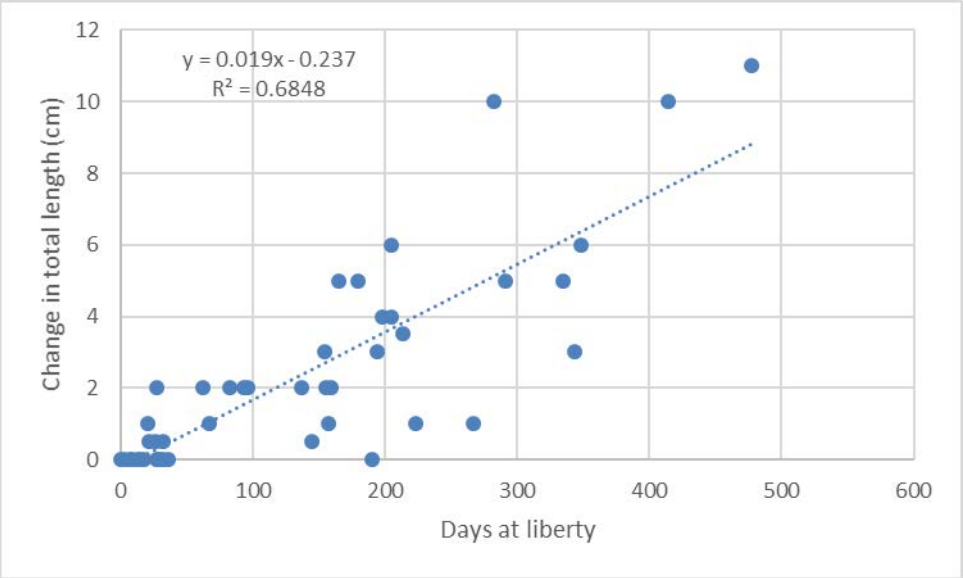

Figure 8. Relationship between change in total length and days at liberty for recaptured Whiting. The slope of the linear regression line indicates the average growth rate.

Discussion

A key finding from this study was that many of the Whiting showed little movement between tagging and recapture, even for periods of liberty up to and over a year. The impression that fish are "site attached" may be affected by fisher behaviour. For example, if fishing is concentrated in certain locations, then tagged fish may move but would be more likely to be recaptured when they returned to the tagging location. Certainly, the results indicated that even if tagged fish move, they are returning to the same locations on a frequent basis. A lack of movement is evident in Western Port where significant numbers of fish were tagged and recaptured at Tortoise Head and Middle Spit, but no fish were shown to move between these two areas. More localised movement was evident for fish tagged and recaptured in the Geelong Arm, with movements of 5 to 10 km not uncommon. Evidence from tagging studies in South Australia also showed that movements of young juvenile (< 30 cm) Whiting were localised in the northern Gulfs (Fowler *et al.* 2002). The tendency for Whiting to stay in the same localised areas for significant periods of time has implications for management of the fishery. The results suggest that concentrated fishing in specific areas could lead to "localised depletion".

Movements of significant distances were recorded in a few cases. The general expectation based on previous research is that juvenile Whiting will move southwards in the bays as they grow and leave the bays as they approach maturity. This expectation is based on the fact that all fish in the bays are juveniles up to 4 years of age (Hamer *et al.* 2004), while adult populations on known coastal spawning grounds include mature fish up to 20 years of age (Fowler *et al.* 1999; 2000; Jenkins *et al.* 2016). In South Australia, tagging showed that older juvenile (> 30 cm) whiting showed directed movement from the northern gulfs southward to the mouths of the Gulfs where the coastal spawning areas are located (Fowler *et al.* 2002). In this study only two fish have shown the expected southward movement towards the entrances of the bays, one from Leopold in the Geelong Arm to Queenscliff in Port Phillip, and the other

from Somers to San Remo in Western Port. Both Queenscliff and San Remo are known as areas where relatively large whiting are caught, consistent with movement to these areas with growth. It is expected that over time there will be more recaptures showing southward movement in the bays as tagged fish grow and approach maturity

There were also significant movements of tagged fish recorded that did not fit the expected southward movement pattern. Three smaller fish moved north-east from the Leopold-Curlewis area in the Geelong Arm, two moved to Werribee South and the third made the longest recorded movement in the project to “The Warmies” in Newport. In Western Port, one recapture showed that Whiting are capable of relatively rapid, large scale movements. This fish moved from Somers northwards to north Middle Spit in a period of only 21 days, representing an average speed of approximately 1 km per day. At this stage the reasons for these larger-scale movements that do not fit the expected southward pattern are not understood, although the fish that moved from the Geelong Arm to “The Warmies” over winter-spring may have been seeking warmer water.

So far in the project none of the tagged juvenile Whiting have been found to move between the bays. This is consistent with results from otolith (ear bone) chemistry studies showing that 2-year old Whiting in Port Phillip, Western Port and Corner Inlet have remained in the same bay since settlement as larvae. Evidence from the two studies suggests there is no mixing of juveniles amongst the major bays. This has important consequences for management of the fishery as it indicates that the fishery in each bay is independent and should be treated as a separate management unit.

The estimated growth rate from tagging of approximately 7 cm per year is consistent with the rate estimated from length and otolith-based age for 2 to 3-year-old juvenile Whiting in Victoria (Hamer *et al.* 2004). There was significant variation in the growth rate amongst individuals which may have been caused by a number of factors. An important contributor to this variation would be seasonal changes in growth, with Whiting known to grow mostly over the warmer months and show little growth in the cooler months (McGarvey and Fowler 2002). Therefore, the growth would be strongly affected by period of liberty of recaptured Whiting in relation to the seasons experienced during that period. Growth of Whiting also slows as they reach maturity (McGarvey and Fowler 2002), but this should not have been a major factor in the present study because all fish were juveniles. Finally, some of the variation may have come from measurement errors, and it is also possible that growth of some fish may have been affected by the tagging process.

There has been no evidence of Whiting moving outside of the bays so far in the project. Fishers are still catching some large (40 cm +) whiting, but they are harder to find this year compared to the previous 2 years, most likely because some have now moved out onto the coast. As this movement offshore happens and fish grow and mature over time we may expect to receive some recaptures from further afield.

Summary

The recreational fisher based King George Whiting tagging project has been very successful. Significant numbers of Whiting over a range of sizes have been tagged in Port Phillip and Western Port. Most of the tagging has been due to the efforts of a small number of expert Whiting fishers, willing to return the prized fish to the water to support the science. Recreational fishers have also supported the project enthusiastically through reporting the capture of tagged fish. The recapture rate of 6% is comparable to other tagging studies (Fowler *et al.* 2002), indicating a satisfactory rate of reporting of recaptures. This recapture rate also indicates relatively low tagging mortality and tag shedding.

A key finding of the project was that many Whiting were recaptured close to where they were tagged, indicating that they were either "site attached" or moved but then returned to the same location on a frequent basis. The tendency for Whiting to stay in the same localised areas for significant periods of time has implications for management of the fishery. The results suggest that concentrated fishing in specific areas could lead to "localised depletion".

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Recaptured Whiting were found to have grown at an average rate of approximately 7 cm per year, consistent with estimates based on age and length. Growth amongst individuals was highly variable, however, most likely related to the water temperatures experienced over the period of liberty.

There is no evidence of juvenile Whiting moving between the bays, consistent with other evidence that juveniles remain in the same bay until they approach maturity. This has implications for fishery management, indicating that each bay should be treated as a separate management unit. There has also been no evidence of Whiting moving out onto the coast so far in the project. It will take a number of years for Whiting tagged in the bays to mature and move out along the coast, and over time we may expect to receive some recaptures from further afield.

Acknowledgments

Our sincere thanks to all the fishers who enthusiastically participated in this project through tagging Whiting or reporting the recapture of tagged Whiting. In particular we thank our "champion" Port Phillip and Western Port taggers, Peter Kellam and Chris Garnar. We also thank the fishing club administrators who facilitated talks and training sessions on tagging at the beginning of the project. Special thanks also to Don Newman who recaptured the most tagged whiting and tagged the largest whiting.

We thank the Recreational Fishing Grants Program for providing funding from Victorian recreational fishing licence revenue to support this project. We gratefully acknowledge the

support given to the initial application by VRFish and Fisheries Victoria. We also thank the Victorian Fisheries Authority for helping to promote the project through social media.

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Appendix 1. Details of recaptures of tagged King George Whiting

Tagging Angler	Total Length (cm)	Tagging Location	Recapture Angler	Total Length (cm)	Recapture Location	Days at liberty	Distance travelled
Daniel Sparks	38	Queenscliff	Gordon Robinson	39	Queenscliff	32	< 1 km
Daniel Sparks	39	Queenscliff	S. Planken	44	Queenscliff	335	< 1 km
Kevin Hunter	38	Queenscliff	Mick White	38	Queenscliff	29	~ 5 km
Don Newman	38	Somers	Don Newman	38	Somers	8	< 100 m
Don Newman	39	Somers	Don Newman	39	Somers	13	< 100 m
Don Newman	38	Somers	Don Newman	40	Somers	93	< 100 m
Don Newman	40	Somers	Don Newman	41	Somers	67	< 100 m
Don Newman	44	Somers	Geoff Wall	47	Somers	343	< 5 km
Don Newman	41	Somers	Kiara Lacey	42	Somers	267	< 1 km
Don Newman	35	Somers	Malcom Green	40	Sam Remo	291	~ 20 km
Don Newman	34	Middle Spit	Bruce Styles	35	Middle Spit	20	< 2 km
Don Newman	34	Middle Spit	Chris Cassar	36	Middle Spit	83	< 5 km
Don Newman	33	Middle Spit	Steve Kraulis	44	Middle Spit	477	< 5 km
Don Newman	38	Middle Spit	Bruce Styles	38	Middle Spit	3	< 1 km
Don Newman	35	Middle Spit	Brian Willis	37	Middle Spit	62	< 5 km

Don Newman	39	Somers	Bill Griffiths	39.5	Middle Spit	21	24 km
Don Newman	38	Balnarring	Vic Way	38	Merricks Beach	32	< 5 km
Chris Garnar	37	Tortoise Head	Alex Van Camp	38	Tortoise Head	223	< 1 km
Chris Garnar	35	Tortoise Head	Chris Garnar	35	Tortoise Head	190	< 100 m
Chris Garnar	32	Tortoise Head	Chris Garnar	32.5	Tortoise Head	145	< 100 m
Chris Garnar	31	Tortoise Head	Geoff Gwyther-Jones	33	Tortoise Head	96	< 1 km
Chris Garnar	33	Tortoise Head	Brian Willis	36.5	Tortoise Head	213	< 1 km
Chris Garnar	36	Tortoise Head	Dylan Affrey	36	Tortoise Head	8	< 1 km
Chris Garnar	37	Tortoise Head	Steve Duke	41	Tortoise Head	205	< 2 km
L. Garnar	31	Tortoise Head	Rocky	33	Tortoise Head	27	< 2 km
Chris Garnar	39	Tortoise Head	Barry Mott	39	Tortoise Head	27	< 1 km
Sean Brodie	39	Tortoise Head	Sean Brodie	39	Tortoise Head	28	< 50 m
Chris Garnar	34	Tortoise Head	Steve Duke	35	Tortoise Head	157	< 1 km
Stu O'Brien	33	Clifton Springs	Travis Chislom	37	Clifton Springs	198	< 1 km
Peter Kellam	30	Leopold	Peter Kellam	30.5	Leopold	26	< 2 km
Peter Kellam	29	Curlewis	Allen Maher	31	Werribee South	159	~ 25 km

Peter Kellam	27	Curlewis	Norm Dickens	29	Curlewis	155	< 1 km
Peter Kellam	27	Curlewis	Michael Jacobs	30	Werribee South	154	~ 25 km
Peter Kellam	33	Leopold	Daryl Lyons	~ 43	Swan Island	414	~ 40 km
Peter Kellam	29	Leopold	Peter Kellam	31	Clifton Springs	137	9.2 km east
Peter Kellam	27	Leopold	Des Fielder	?	Clifton Springs	208	~ 10 km east
Peter Kellam	27	Leopold	Cliff Rossack	37	Leopold	282	< 2 km
Peter Kellam	28	Leopold	Alan Grant	33	Curlewis	180	< 5 km
Peter Kellam	27	Clifton Springs	Will	27	Clifton Springs	15	< 1 km
Peter Kellam	29	Clifton Springs	Ricky Wilson	35	Curlewis	205	< 5 km west
Peter Kellam	28	Clifton Springs	Peter Kellam	34	Curlewis	348	4.9 km west
Peter Kellam	27	Curlewis	Eddie Obeliunas	?	Clifton Springs	17	~ 5 km east
Peter Kellam	29	Curlewis	Kane Heatley	34	Clifton Springs	165	~ 5 km east
Peter Kellam	33	Clifton Springs	Peter Kellam	33	Clifton Springs	18	< 100 m
Gordon Robinson	41	Queenscliff	Gordon Robinson	41	Queenscliff	45 minutes	< 100 m
Gordon Robinson	39	Queenscliff	Mick White	39	Queenscliff	36	~ 5 km
Peter Kellam	29	Leopold	Vo Tang	32	Newport “The Warmies”	194	~ 55 km