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FINAL REPORT

Establishing historical baselines for key recreational and commercial fish stocks in Tasmania

S. Frijlink and J.M. Lyle

November 2013

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EXECUTIVE SUMMARY

This study contributes to a better understanding of changes in populations of important Tasmanian recreational and commercial fish through time. Understanding the past state of fish stocks, particularly their abundance, provides a benchmark or 'baseline' from which subsequent changes can be evaluated. This long-view approach to understanding the past state of a fishery can not only help to contextualise current stock levels but may have implications for the sustainable management of the fishery. Five species were investigated in this study - Southern Sand Flathead (*Platycephalus bassensis*), Blue Warehou (*Seriolella brama*), Greenback Flounder (*Rhombosolea tapirina*), Bastard Trumpeter (*Latridopsis forsteri*) and Southern Rock Lobster (*Jasus edwardsii*).

Methods employed for this project are consistent with those used in the emerging discipline of Historical Marine Ecology whereby historical observations are used to provide information – usually in the absence of standard fisheries data. In particular, knowledge gaps generally exist prior to the systematic collection of commercial fishing catch and effort data. In *this* study, two broad methodologies have been used: (1) analysis of historical documents and data, and; (2) social science methods documenting Local Ecological Knowledge (LEK) based on interviews with long-term recreational fishers. The relative contribution of each method towards understanding historical trends differed between study species due to several factors including ecological and biological characteristics, fishing methods and the timing at which they began to be intensively fished. Nonetheless, with a few exceptions, the two methodological components are temporally distinct – with historical records analysis used before about 1950 and LEK after this time.

While LEK can help understand temporal patterns especially for data-poor fisheries, there is potential for recall and perception biases to influence the interpretation of events and trends. The existence of robust and long-term datasets for the commercial Southern Rock Lobster fishery, however, provided an opportunity to indirectly evaluate the implications of such biases by comparing fisher perceptions with patterns in commercial catch rate data since the mid-20th century.

The results by species are summarised below.

Southern Sand Flathead

In Tasmania, Southern Sand Flathead are primarily targeted by recreational fishers: the species currently comprises around two thirds of all fish (by number) caught recreationally. While comparatively small quantities of Southern Sand Flathead are landed by the commercial fishery relative to the Tiger Flathead, commercial catch

returns have generally not differentiated flathead catches by species and thus a reliable time series of Southern Sand Flathead catches is not available.

Flathead (assumed to be primarily Southern Sand Flathead) were described from catches made from early explorers and catches and attitudes towards this species provided insights into the former states of flathead stocks. Prior to the second half of the 20th century the species was generally unpopular among Tasmanian consumers and had little commercial importance. This unpopularity was due to its 'ugly' appearance, its ubiquity ('commonness') and its reputation as a scavenger. Largely due to these perceptions, Southern Sand Flathead stocks were likely to have been in a unfished state up until the last 60 or so years. Based on interviews with fishers, it appears that stocks of legal-sized Southern Sand Flathead have declined considerably in both abundance and average size through time. Most fishers also reported that whereas the species tended to be widely distributed in large numbers, the distribution has become increasingly patchy in recent years.

Bastard Trumpeter

Unlike flathead, Bastard Trumpeter were very popular among Tasmanians soon after colonisation. These fish were abundant around inshore reefs and were generally caught using gillnets. Harvesting reduced densities of fish closest to populated areas, particularly Hobart. By 1916, most nearby areas had been fished and the average size of fish declined. Effort then expanded into unfished areas, particularly to the south west and west coasts and record volumes of the species were caught. By around 1940 however, few unfished areas remained and commercial catch rates and catches declined until the mid-1980s, when successive successful recruitment pulses appeared to increase their abundance. Catch rates declined again in the mid-1990s and catches over the past decade or so have remained low, in part linked to low market demand. Recently, recreational catch has exceeded the commercial catch. Fisher interviews suggest that, since the 1940s, catch rates may have declined as much as ninefold. They also report the increasing relative scarcity of the larger 'whitefish' and the lack of variation in size classes.

Blue Warehou

Blue Warehou, often called 'snotty trevally' or 'snotties', are known to be highly mobile with high inter-annual variation in their availability within Tasmanian waters. This variation in abundance was noted as early as the first half of the 19th century. When available, they were caught commercially by the gillnet fishery, which commenced in the south east and gradually spread to other areas. They have also been historically popular among recreational fishers, caught on line and with gillnets. Until around the 1980s, catch rates were good, suggesting that fishing activities to this date had little impact on this relatively fast growing species. However, overfishing in the Commonwealth managed commercial fishery during the 1980s and 1990s had a large impact on fish numbers, including the size of schools migrating into Tasmanian waters. Some fishers interviewed recalled catching upwards of 100 fish per net-set and would often restrict set times to avoid catching too many. Currently, catches are low and sporadic. The Commonwealth have implemented a stock rebuilding strategy.

Greenback Flounder

Flounder (assumed to be primarily Greenback Flounder) were often mentioned in the journals of early explorers who frequently caught them using seine nets off sandy beaches in Tasmania's south east. However, decades later, this method was responsible for the reduction of flounder numbers in the Derwent and Tamar estuaries, which were important sources of seafood for the fledgling colonies of Hobart and Launceston. This decline in local stocks eventually prompted remedial measures including the implementation of area closures and gear restrictions. The spread of the fishery to neighbouring waters and the rising prominence of other fisheries also shifted effort away from local flounder stocks at the time. Interview information suggests that although flounder stocks have in general not experienced the same degree of decline as some other species, localised depletions have occurred more recently. However, each of fishers interviewed held the view that the average size of legal-sized fish had not changed through time.

Southern Rock Lobster

Some early explorers and new colonists made explicit references to the abundance of Southern Rock Lobster on Tasmanian's inshore reefs. In unfished or lightly fished waters, dozens of fish could be captured in a short time using hoop nets ('cray rings') or by wading in knee-deep water. Their abundance promoted a commercial fishery in the south east using hoop nets. Originally destined for local markets, Southern Rock Lobster began to be exported interstate from the 1870s, where they obtained higher prices. In Tasmania, they were not highly regarded by consumers. Nonetheless, sufficient local and interstate demand existed such that localised changes in density became apparent by the late 19th century. However, it was not until the legalisation of lobster pots in 1925 that catches escalated, primarily in response to growth in demand from interstate markets. The fishery expanded to unfished areas and many scalefishers transitioned into the more lucrative Rock Lobster fishery. By the mid-1940s, catch rates fell while catches continued to rise. The average size of fish caught also declined over time and plateaued in the 1960s. By this time, management measures were implemented to address the decline in Southern Rock Lobster stocks.

While robust commercial data for the fishery has been available for many years, information collected through interviews with fishers has provided a supplementary view from which to assess changes in Rock Lobster stocks, particularly in shallow inshore areas. Over time, interviewees reported travelling further and fishing deeper whilst catching fewer and smaller Rock Lobster. While data vary between regions, and are limited in terms of respondent numbers, overall recalled catch rates (legal-sized Rock Lobster per pot-lift) declined from 5.9 in the 1950s to a current average of 0.7 Rock Lobster. This decline in recalled information is greater than was recorded in catch and effort data over the same period although consistent in general trend. Over the same period, fishers reported a 25% reduction in the average weight of legal-size Rock Lobster.

Concluding remarks

Despite important differences between species in terms of fishing methods, ecological characteristics, sectoral utilisation and patterns of exploitation, this research suggests that abundances of each of the study species has declined considerably since European settlement. While this is expected, and is a natural consequence of fishing,

the indications of the scale and speed of the declines for some species is of interest. Research needs have been indicated throughout this report to address knowledge gaps – particularly for species and/or regions for which additional information would facilitate a more accurate and complete picture of past and present fishery trends.

Comparisons between LEK and commercial catch rate data for the Southern Rock Lobster fishery suggests that while interviewees accurately perceived the direction of abundance trends they have tended to overestimate their scale, particularly changes that occurred prior to 1995. It is possible that factors apart from recall bias may help explain these discrepancies, such as fishery scale effects and differences in fishing behaviour between recreational and commercial fishers. In recognising these uncertainties, catch rate trends reported by interviewees and their inferences about patterns of abundance and stock status need to be considered as being indicative of the direction rather than magnitude of change. In spite of these uncertainties, many of the observations in this report will serve as a useful reference for fishers, managers and researchers as they seek to understand the past states of fish stocks and set management targets.

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1 INTRODUCTION

An understanding of how fish stocks and ecosystems have changed over time, particularly in response to human induced changes, can provide valuable information on the nature of fisheries dynamics, on the response of fish stocks to exploitation, and the response of fishers and institutional structures to changes in stock levels. In the context of the present study, baselines are abundance estimates (in absolute or relative terms) of fish populations at a given point or period of time which may serve as benchmarks from which subsequent changes may be evaluated and a basis for refining management objectives, actions and expectations.

Historical baselines for the world's marine fisheries are largely unknown (Pauly, 1995). Broadly speaking, the use of rigorous fishery-dependent and fishery-independent data to evaluate stock trends is a relatively recent phenomenon. As such, the use of 'unconventional' data and information sources to fill the gaps in fishery knowledge has accelerated in recent decades, particularly for data poor fisheries. Such information sources include vessel logbooks, fish market sales, paleoecological evidence, old photographs, newspaper articles, documented observations of explorers and naturalists, and interviews with long-term fishers (often termed Local Ecological Knowledge [LEK]). Together, the discipline of using such methods to establish insight into past ecosystem states is often termed Historical Marine Ecology (HME). While uncertainty surrounds the accuracy of some information sources, they are generally used in the absence of more precise and quantitative means of assessment or may be cross-referenced with more conventional data sources to provide important contextual insights. When interpreted in an ecological context, HME data can be used to estimate semi-quantitative baselines for historically exploited fisheries and can provide perspectives on prior ecosystem states (McClenachan, 2009).

The value of understanding the past status of exploited species has been discussed as the 'shifting baseline syndrome' (Pauly, 1995). Pauly described how generations of fisheries scientists often base their frames of reference to fisheries information on the previous generation of scientists, thus promoting erroneous starting points with regard to 'natural' conditions. From this, Pauly explained that "generational amnesia" often occurs whereby scientists, managers and fishery stakeholders have a shortened view of what ecological systems can and did sustain. The view was partly responsible for fuelling an interest in developing and improving means by which past ecosystem states could be understood. While much subsequent research has focussed on vulnerable and overfished species whose abundance and distribution have declined precipitously, other research on species still considered relatively abundant or sustainably fished has suggested significant changes in population dynamics and ecosystem roles over time.

In this study, HME methodologies have been used to help understand historical trends in stock abundance, distribution and average size of five marine organisms of significance to fisheries in Tasmania – Southern Sand Flathead (*Platycephalus bassensis*), Blue Warehou (*Seriolella brama*), Greenback Flounder (*Rhombosolea tapirina*), Bastard Trumpeter (*Latridopsis forsteri*) and Southern Rock Lobster (*Jasus edwardsii*). Consistent with the focus of this report, all species are important recreational species and, with the exception of Southern Sand Flathead, they are also

important commercial species. Two broad methodologies have been used to investigate these fisheries: (1) analysis of historical documents and data, and; (2) social science methods documenting LEK from long-term fishers. The relative contribution of each method towards understanding historical trends differ among the species studied due to various factors including ecological and biological characteristics, fishing methods and the timing at which they began to be fished. Nonetheless, with a few exceptions, the two methodological components are temporally distinct – for each species, historical research methods and LEK have been used before and after around 1950, respectively. The methods and their application are outlined below.

1.1 HISTORICAL RESEARCH

Historical research conducted for this study may be further divided into two categories corresponding to different time periods – pre and post British settlement. For the former, journals of early explorers represent the only source of information while for the latter, a variety of information and data sources exist. The utility of these sources of information, including potential limitations, biases and assumptions are discussed below.

1.1.1 Recorded Observations of Early Explorers

Prior to British settlement of the Derwent Estuary in 1803, there were numerous visits by British and French fleets along the south-east and east coasts. Most early explorers made detailed observations of landscapes, native inhabitants, flora and fauna, and most had fleet appointed naturalists and artists for this role. The importance of seafood in the diets of early explorers ensured that fish were eagerly sought (and described), generally with handlines and seine nets. The selectivity of these gear types and the tendency to fish off sandy beaches meant that flathead and flounder were commonly described. In contrast, Blue Warehou and Bastard Trumpeter, which are generally found around reefs, were not described.

There is a growing recognition of early explorers' observations as a source of historical information on marine animals (Saenz-Arroyo *et al.*, 2005; 2006; Roberts, *et al*., 2007; Parsons *et al*., 2009; McClenachan *et al*., 2012). For many, such accounts represent the earliest records of ecological information and thus may provide invaluable insights into largely unexploited fishery conditions. Much of the research to date incorporating explorers' observations has been focused on larger or more charismatic species (i.e. whales, dolphins, sharks, turtles), though the reliance upon seafood as a food source on seafaring expeditions has ensured that 'lesser' species have also been frequently described (Roberts, 2007; Parsons *et al*., 2009; Jackson *et al.*, 2011). While general reasons why historical data sources have been largely ignored within a management context have been described above, the reliance upon often isolated observations of explorers to depict past ecosystem states also presents challenges. Recorded observations may not necessarily represent typical conditions, particularly if they are not corroborated with further observations or other supporting information such as paleoecological data. Within the context of adventure and making discoveries, is also possible that some accounts may have been embellished. However, dismissing reported observations as 'mere anecdotes' disqualifies the only first-hand evidence we have on the natural history of some species. In view of the

potential for such information to be dismissed, Saenz-Arroyo *et al.* (2006) point out that early explorers' observations were generally made by prominent men committed to the advancement of knowledge and were often naturalists specifically employed to make such observations.

1.1.2 Historical Documents and Data

Historical texts used in this study include newspaper articles, diaries of early settlers, books, reports published by previous fisheries administrators and reports and associated documents produced for two Royal Commissions into Tasmania's fisheries (1882 and 1916). Historical data accessed for this study include early sales data for the Hobart and Launceston fish markets and early commercial fishing landings data. When available, supplementary information alluding to fishing effort provided through historical documents has enabled catch and sales data to be contextualised and species abundances to be better understood. Generally, historical information and data sources accessed were used to understand fishery trends from the time of British settlement to the middle of the 20th century. However, where available, more recent commercial catch and catch rate data has been used to compare catch rate estimates supplied through fisher interviews (below).

In spite of its potential to address gaps in fisheries knowledge, there are limitations and potential biases associated with the use of historical information, both qualitative and quantitative. As for all types of fisheries data, results need to be critically interpreted in view of potential biases, which are type and context specific. Regarding the type of qualitative data used for this study, strategic and selective reporting biases may be present. As to the former, Parsons *et al* (2009) suggest that in fledgling colonies, articles in popular publications that describe the abundance of fish may be written as advertisements to lure potential colonists or to encourage investment in the fishing industry. It is also possible that fisheries-based information printed in newspapers, books, reports and other documents may be informed by fishers wanting to influence a perceived outcome, such as less restrictive regulations. As for selective reporting biases, isolated reports can be motivated by unusual or remarkable events or observations, rather than a reflection of 'typical' conditions. Therefore, greater confidence may be taken when assessing information from those without obvious pecuniary interests and those reinforced with supporting information. The triangulation of methods used in this study will hopefully enable inferences provided through qualitative data to be guided more carefully.

1.2 SOCIAL RESEARCH

Over recent decades, there has been a growing interest in documenting the knowledge of fishers to provide information on fisheries dynamics and occurrences, particularly for data-poor fisheries. The collection of LEK has not only been useful in addressing knowledge gaps but may serve to engage stakeholders and facilitate their participation in fisheries management. In fisheries research, LEK has been used to investigate a wide range of phenomenon including population dynamics, the presence or absence of rare species, the impacts of anthropogenic disturbances and the timing and location of fishery events such as spawning aggregations and migrations. Studies may be further classified as those seeking to understand contemporary fisheries and those seeking to investigate temporal changes, though some studies such as the present study address

both. For studies that have investigated temporal changes in fish abundance and/or size, a wide variety of qualitative and quantitative approaches have been employed.

In this study, interviews with long-term avid fishers, both recreational and commercial, were used to collect information pertaining to fish abundance and size over the past 70 or so years based on recollections of catches and observations. Estimations of fishing effort were also collected, enabling catch per unit of effort (CPUE) to be estimated and abundances inferred. Commercial catch data exist for the investigated species over this period. However, with the exception of Southern Rock Lobster, historical changes in the preferential exploitation of commercial species and a lack of reliable effort data before 1995 makes this data unreliable for inferring temporal abundance changes. As such, population trends over this period are poorly understood, providing an opportunity for LEK to address this lack of understanding Irrespective of the limitations of available commercial data, the current study is primarily focussed on recreational fisheries. Therefore, abundances inferred through commercial fishing data alone may mask trends in the availability of fish to recreational fishers who generally fish in more accessible locations and may use less sophisticated equipment.

One of the more contentious aspects of LEK in fisheries research has been in the manner in which it has been used to develop quantitative trends in abundance. In an emerging field of research, some studies have used LEK methods in conjunction with fishery-dependent and fishery-independent data to cross-check and evaluate strengths and weaknesses of LEK data (Neis *et al*., 1999; Ainsworth and Pitcher, 2005; Ainsworth *et al*., 2008; Rochet *et al*., 2008; Parsons *et al*., 2009; Maynou *et al*., 2011; Daw *et al*., 2011; Halwass *et al*., 2013). Overall, the level of agreement between LEK and other data sources used in these studies has been highly variable which is not surprising given the different methodologies used to collect LEK and 'other' data and the manner in which agreement has been assessed. In view of this, O'Donnell *et al*. (2010) recommend that researchers recognise potential biases, acknowledge and explore strengths and weaknesses of LEK, state and evaluate the effect of assumptions and improve methods of quantifying bias. These recommendations are discussed below as they relate to the current study.

Perhaps the most obvious sources of potential bias affecting LEK data are those relating to respondent recall. The two most common cognitive phenomena thought to be responsible for inaccurately recalled information in this context are 'memory illusion' and 'personal amnesia'. Memory illusion is thought to occur due to the preferential tendency of individuals to recall past events that are pleasant, unusual or emotive (Matlin, 2004), which may therefore exaggerate recollections of previous fish abundances (Daw *et al*., 2011). Acting in the opposite direction, personal amnesia describes how individuals may update their perceptions of normality and therefore assume that previous conditions were similar to current conditions (Papworth *et al*., 2009). Overall, however, Van Densen (2001) suggests that the extent and direction of LEK skewness in this context is yet inconclusive. Nonetheless, the balance of relevant studies published suggests that, in general, memory illusion may play a more prominent role than personal amnesia.

Also acting at a cognitive level, there may be biases surrounding motivations for respondents to over-report or under-report data. Motivations may include pleasing

interviewers by telling them what they think they want to hear and 'wishful thinking' (Yasue *et al*., 2010). Also, strategic biases may also be imparted in LEK data if the interviewee thinks that their response may affect a preferential outcome. Clearly, such biases are difficult to detect, let alone quantify. However, the presence and degree of such biases need to be considered within the context of the respondent population and the matter under investigation.

Despite uncertainties, most studies that indicate the possible presence of memory or other biases also indicate limitations that may confound comparisons between LEK and cross-reference data such as formal stock assessment data. Most notably, some authors allude to the spatial differences concerning the manner in which different data have been derived (Neis *et al*., 1999; Ainsworth *et al*., 2008; Parsons *et al*., 2009; Daw *et al*., 2012). Such scale effects may account for discrepancies between data provided by fishers who may only fish a particular area and 'whole of fishery' stock assessment data. Therefore, localised depletions reported through LEK may not be reflected in fish populations within a broader context, irrespective of potential reporting inaccuracies.

While the interpretation of LEK results will need to be done within the context of potential bias effects, these may be minimised by designing studies according to the strengths and weaknesses of LEK approaches. Clearly, the influence of time on respondent's recall accuracy and how this may change according to the characteristics of individual species is of immediate concern. One study reported good agreement between LEK and stock assessment data for both the long term and short term, but less so for the medium term (ICES, 2007). This assessment is supported by a few studies where data convergence was apparent over the short term (Rochet *et al*., 2008; Parsons *et al*., 2009; Daw *et al*., 2012) and the long term (Neis *et al*., 1999; Ainsworth and Pitcher, 2005; Maynou *et al*., 2011). Commenting on longer term data agreement, Ainsworth and Pitcher (2005) suggest that "presumably, a steady depletion … becomes obvious over the course of several decades, where a short term trend can be mired in fluctuations". The difficulties involved in providing accurate abundance information for species that exhibit high inter-annual abundance fluctuations has been noted by various LEK researchers (Van Densen, 2001; Parsons *et al*., 2009; Daw 2010) who suggest that estimates improve for long lived and/or non-schooling species that exhibit limited temporal abundance variability. While it is well understood that high inter-annual variability may confound the precision of stock assessments derived from CPUE data (Maunder *et al*., 2006), an additional concern for LEK data may be that such variability is thought to impair the ability of individuals to accurately detect time trends (Van Densen 2001).

Given the small number of studies that have combined LEK with historical data to estimate temporal trends in fish stocks (Saenz-Arroyo *et al*., 2005; Parsons *et al*., 2009), it is hoped that the current study will make a valuable contribution to this emerging area of research. This study has been designed in view of previous research referring to the limitations, strengths, weakness and potential biases of historical and LEK data and results will be interpreted and discussed accordingly. For one species under investigation, the Southern Rock Lobster, the availability of long-term commercial CPUE data provides an opportunity for LEK data to be compared and cross-referenced, with implications for its validity across this study.

To date, most HME studies examining historical fish stocks have been conducted in areas that have sustained fishing pressure for many hundreds, if not thousands of years. As such, limited information is often available for large periods of time under investigation. Comparatively, a study of this nature in Tasmania represents a good opportunity to understand abundance trends dating back to times approaching pre-exploitation biomass levels. The relatively short time since the British colonisation of Tasmania, and hence the recent development of finfish[1] fisheries, means that information relevant to assessing changes over the period of exploitation is likely to be more accessible, comprehensive and accurate.

[1] While Tasmanian Aborigines consumed shellfish and crustaceans (including Southern Rock Lobster), they are generally believed to have discontinued eating scalefish around 3500 years before British arrival, although there is some debate on this.

2 GENERAL METHODS

While study methods specific to individual species are outlined in their respective chapters, general methods used in both historical research and interviews with fishers are presented below.

2.1 HISTORICAL RESEARCH

In broad terms, the historical research component of this study may be divided into two parts corresponding to two eras investigated – pre and post British settlement in 1803. Research for the former era comprised accessing and analysing journal accounts of early explorers for references to fish availability, abundance and size.

For the latter era, documents and data providing information pertaining to fish availability, abundance and size were accessed and analysed. Information relating to fishery developments, regulation and management were also sourced to provide contextual oversight. Documents examined included newspaper articles, diaries of early settlers, books, meeting transcripts, reports published by previous fisheries administrators and reports and associated documents produced for two Royal Commissions into Tasmania's fisheries (1882 and 1916). Historical data included early sales data for the Hobart and Launceston fish markets and early commercial catch data. More recent commercial catch and effort data was also used, when available, to compare with quantitative catch data provided through fisher interviews.

2.2 FISHER INTERVIEWS

Semi-structured, face to face interviews were conducted with fishers between December 2012 and February 2013. While the interviews are described in detail below, the aim of the interviews was to collect long-term information alluding to the abundance, size and distribution of five recreationally significant fish species found in Tasmanian waters – Southern Rock Lobster (*Jasus edwardsii*), Blue Warehou (*Seriolella brama*), Southern Sand Flathead (*Platycephalus bassensis*), Bastard Trumpeter (*Latridopsis forsteri*), and Greenback Flounder (*Rhombosolea tapirina*).

These species were selected due to their current and/or historical importance as target species for recreational fishers. With the exception of Southern Rock Lobster, species were also chosen due to the limited data available on their long term abundance. In view of the importance of identifying and quantifying biases associated with LEK (O'Donnell *et al*., 2010), Southern Rock Lobster was furthermore chosen as a candidate species due to the existence of commercial CPUE data for the time period covered by LEK interviews.

2.2.1 Pilot Testing of Survey Instrument

The survey instrument was tested prior to survey use through a series of 'mock interviews' conducted with peers with recreational fishing experience. Accordingly, some minor changes were made to the interview script.

2.2.2 Sample Selection

General guidelines on the selection of survey participants were informed by Huntington (2000). Consistent with recommendations provided by Davis and Wagner (2003) and Ainsworth and Pitcher (2005), the selection process was designed to systematically select experienced and knowledgeable fishers for interviews.

Interviewees were 'recruited' through articles published in Tasmania's three major daily newspapers (*The Mercury, The Examiner* and *The Advocate*), *Tasmanian Fishing and Boating News* and *Fishing Today*. For each publication, a description of the project was provided as well as an invitation to participate for persons with at least thirty years' experience fishing or diving in Tasmania. Two interviewees were also 'recruited' through a recommendation by a third party: they were both sent a copy of a project information sheet and contact details for the project, from which they contacted the primary investigator.

Persons who responded to the invitation to participate in the study were initially screened in terms of their previous fishing experience to assess whether they met key criteria and were eligible to be interviewed in detail. Potential participants were expected to have had many years of experience fishing for at least two of the candidate species and have fished within specific areas over a prolonged period. An information sheet outlining the scope and objectives of the study, the manner in which data was to be collected, a brief description of the interview process and a notification of approval from the Human Research Ethics Committee was sent to eligible participants.

2.2.3 Interview Scope and Outline

The design of the questionnaire was informed by Neis *et al*. (1999) and Neuman (2006), while observing technical and ethical recommendations by Bunce (2000) and Huntington (2000). The interviews were conducted according to a pre-defined set of topics and questions; however, there was sufficient scope for the direction of the interview to follow the participant's train of thought. This scope enabled the collection of anecdotal and qualitative information, much of which was used to contextualise quantitative accounts. Where possible, quantitative information relating to fish abundances was collected within the context of the effort required to catch them. As such, catch per unit of effort (CPUE) data were used to infer relative abundances of fish over time.

All interviews were conducted in person and recorded, with permission, on a digital sound recorder. A map of Tasmania and a booklet of coloured illustrations of fish were used to clarify uncertainties relating to fishing locations and the identification of fish species, respectively.

2.2.4 Interview Process

The interviews commenced by asking general background questions about interviewees' fishing experience in Tasmania, covering topics such as how many years they had been fishing, what regions they had fished, target species, fishing mode (i.e. boat based or shore based), methods and avidity. Respondents were then reminded of the scope and aims of the project, and the structure of the interview was outlined. In particular, it was explained why observations and recollections about fish

captures were of greatest benefit to the study when they related to discrete regions. In view of this, respondents were asked to nominate up to three of the candidate species on which the remainder of the interview was to be based. For each of the chosen species, questions pertained to temporal trends in catch rates (abundance), average size and distribution.

Species-based information

For each species, fishing mode/s, method/s and gear used, and how these had changed during the interviewee's fishing 'career', was determined. As well as guiding the interview and providing valuable contextual information, it is thought that eliciting such career history information will increase the likelihood of accurate interpretation of responses (Neis *et al*., 1999).

Also determined was information about the region/s in which the respondent had fished for the species. The regions were 'narrowed down' to the smallest areas feasible, e.g. a particular bay or specific stretch of coastline. When this was not possible, the following zones were used: east coast, south-east coast, west coast, south-west coast, north-west coast, north coast and north-east coast (Fig.2.1). If historical fishing data for a period of 30 years or more could not be confined within a specific zone, the interview component for the species in question was discontinued.

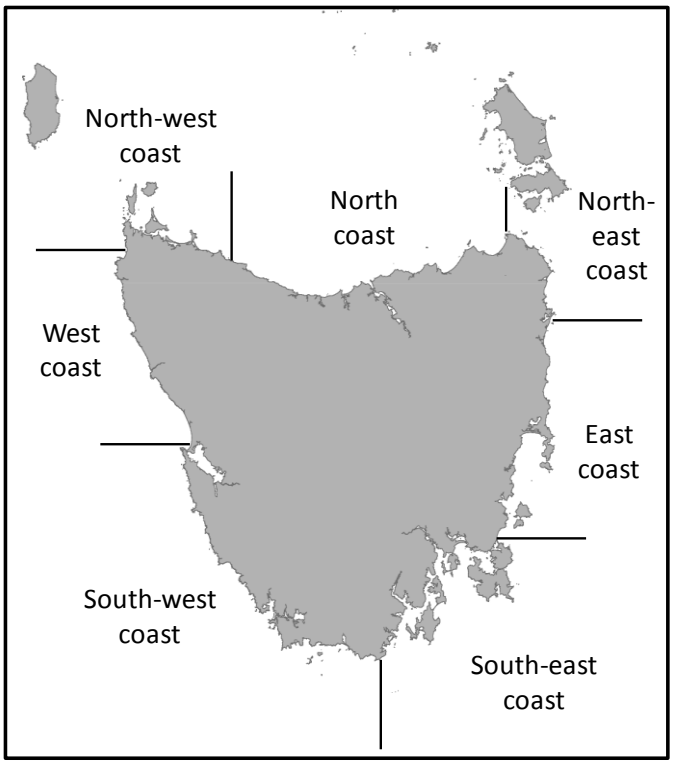

Fig. 2.1 Map of Tasmania showing the regions referred to in the report.

Abundance

The design of the questionnaire component pertaining to the collection of temporal CPUE estimates was guided by previous research suggesting that LEK may be more accurate in reporting contemporary and longer term observations than for medium-term observations (Neis *et al*., 1999; Ainsworth and Pitcher, 2005; ICES, 2007; Rochet *et al*., 2008; Parsons *et al*., 2009; Maynou *et al*., 2011; Daw *et al*., 2012). Accordingly, greater emphasis was placed on eliciting CPUE estimates that were both current and relating to the commencement of respondent's fishing careers than for the time period in between these two 'book-ends'.

Initially, fishers were asked whether they thought the abundance of the examined species had increased, decreased or stayed "about the same" over their fishing career. Regardless of the answer, fishers were then asked to estimate an average modern day catch rate, which was framed according to the species in question. For example, catch rates of Southern Sand Flathead were generally expressed as fish caught per hour whereas for Bastard Trumpeter, catch rates were expressed as fish caught per net-set (and later standardised according to net length). If fishers perceived that the abundance of fish had changed over time, they were asked to estimate the average catch rate, using the same metric, when they first started fishing for that species. When methods used to catch the species at the two points in time were deemed to be incompatible, the 'starting point' was forwarded to when the respondent commenced using methods compatible with current fishing methods. For example, numerous fishers began fishing for Southern Rock Lobster using rings but later transitioned to pots. On these occasions, catches made using rings were not compared quantitatively to pot fishing catch rates but were treated as ancillary data.

Where there had been appreciable improvements in the gear used (as would be expected when evaluating changes over a long timescale), catch rates were treated as compatible providing the fishing method was effectively unchanged. For example, all forms of line fishing were deemed compatible regardless of transitions from handlines to rods, or from cord line to monofilament (or braid). Similarly, catch rates of fish caught in hemp or cord gillnets were deemed to be comparable with catches from monofilament nets. When fishers indicated gear changes over time, they were asked whether they thought the changes had impacted their catch rates.

The majority of catch data collected related to recreational fishing. However, when the methods and locations used to catch fish commercially were consistent with recreational methods and locations, the data were determined to be comparable. For example, catch rates (fish per metre of net) of Bastard Trumpeter and Blue Warehou caught in commercial gillnets were pooled with catch rates of fish caught recreationally. Catch rates for commercially caught Southern Rock Lobster (fish per pot-lift) were restricted to shallow water locations where possible because these locations are more typical of recreational fishing effort, particularly during earlier years.

After determining catch rates for both points in time, respondents were then asked whether they thought the decline or increase in catch rates was steady over time or whether there were times when catch rates changed more abruptly. When respondents indicated the latter, interim catch rate data were also collected to quantify the change.

On many occasions, catch rates were plotted on a temporal trend diagram which was shown to respondents, who were given the option to confirm or reconsider.

Fishers were also asked to recall details of their best catch, in terms of numbers of fish caught and when the event took place. This analysis was limited to Bastard Trumpeter, Southern Rock Lobster and flounder and the manner in which this data was collected depended on the nature of the species and/or fishing methods used. Examples include the most Bastard Trumpeter caught in a gillnet (and later standardised according to net length) and the most Southern Rock Lobster caught in a single pot-lift. Questions about memorable events, such as best fishing catches, should reduce potential recall bias effects and can be an effective means of evaluating abundance changes (Saenz-Arroyo *et al*., 2005; Parsons *et al*., 2009). Presumably, remembering significant rather than typical events will remove the potential for memory illusion bias effects. Also, the incorporation of a secondary means of collecting abundance information should impart rigor to the process of estimating temporal trends by providing a means to validate or cross-reference CPUE estimates (Neis *et al*., 1999).

Size

As for changes in abundance over time, changes to the size structure of fish of exploited fish populations may also reflect the extent of ongoing fishing pressure (Gulland and Rosenberg, 1992). In a general sense, the impacts of prolonged and intensive fishing on decreasing the average size of individuals are well understood (Cheung *et al*., 2012; Shackell *et al*., 2010; Audzijonyte *et al*., 2013). These sources report that selective harvesting removes the oldest and largest individuals and may facilitate the evolution of animals with a smaller size-at-age owing to selective fishing pressures on faster growing fish.

Respondents were asked whether they thought the average size of the species of interest had increased, decreased or stayed about the same over their fishing careers. Irrespective of the response, fishers were then asked to estimate the current average size of (legal-sized) fish caught. As the manner in which 'size' was expressed was not defined, fishers either provided length or weight data (the former was later converted using species specific length-weight relationships). A tape measure was used to help quantify lengths. When respondents encountered difficulties answering size-related questions, the solicitation of fish sizes was expressed according to expressions commonly or colloquially used by fishers. For example, enquiries of flathead and Rock Lobster length were generally expressed as millimetres "over the measure". If fishers perceived that the abundance of fish had changed over time, they were also asked to recall average fish sizes for when they first started fishing. As minimum legal-size limits were not present for most species during earlier years, fishers were asked to refine their estimates in light of current size limits.

Fishers were also asked about the relative proportions of legal-sized to undersized fish in current catches. To make this easier to understand, the question was framed according to the answer provided for the current average number of fish caught. For example, if the respondent estimated the average number of legal-sized flathead caught per hour to be five, the question would be as follows:

> *"Earlier, you mentioned that, on average, you currently catch about five legal-sized flathead per hour. In addition to the five you keep, how many undersized flathead would you also normally catch, on average, in an hour's fishing?"*

A similar line of questioning was also undertaken to determine the relative proportions of 'legal' sized to 'undersized' fish when respondents first commenced fishing. As legal fish sizes were generally either non-existent or different at that time, respondents were asked to base their estimations on the current minimum legal-size limit.

For each species, fishers were also asked to recall their largest fish caught and the approximate year of its capture. Similar to estimations of respondents' largest catches (above), the collection of this data is unlikely to be affected by memory illusion bias effects and should impart rigor to the evaluation of temporal size data by providing a supplementary dataset for cross-checking purposes.

Depths Fished and Distances Travelled

To provide context for temporal trends in fish abundance and size, fishers were also asked about changes in two measures of fishing behaviour:

1. The average depth range in which they fished, both currently and when they first commenced fishing.
2. The average distances travelled on the water to access fishing grounds, both currently and when they first commenced fishing.

Whilst responses to these questions undoubtedly reflect the increased capacity of boats available to fishers, they also provide insight into changing fisher behaviour that is likely to be linked to fishing quality. Generally, abundance data collected over time is not sensitive to serial depletion of fishing sites (Saenz-Arroyo *et al*., 2005) and density gradients often exist from fisher access points. This is particularly evident for species that aren't highly mobile. Distances travelled by fishers to fishing sites may be seen as a trade-off between the costs of travel (i.e. boat running costs and time) and the perceived benefits of being able to catch more fish when travelling further. As such, the increasing travelling capacity of boats and the existence and degree of density gradients from access points guide fisher behaviour to this end. It is not intended to quantify the relative impacts of these factors in this study. However, by evaluating changes to fishing behaviour, particularly in view of qualitative information on abundance and size changes, the importance of localised declines in fish stocks in guiding the cost-benefit equation may be inferred.

Distribution

Information on any observed changes to the distribution of the species in question was solicited. In particular, respondents were asked whether there are areas where the species is no longer caught or whether they are now caught in areas where it was not previously caught.

Non-species Specific Questions

Observed changes in the presence and distribution of other species (both candidate and non-candidate species) was also solicited. This was done by asking respondents if they had noticed species in areas where they were not previously found and whether there were species that were no longer in areas previously found.

2.2.5 Interview Results

Thirty three interviews were conducted by the same interviewer between December 2012 and February 2013. As two fishers were jointly interviewed during two interviews, the total number of interviewees was 35. The average interview duration was 85 minutes. All interviewees were recreational fishers (either current or former), 15 had also worked in the commercial fishing industry and two were former charter boat operators. Interviews were conducted at places nominated by the interviewees.

The age of interviewees ranged between 50 and 86 years, with a mean age of 71 years. Most respondents started fishing for one or more of the study species at a young age (mean 11 years). The number of years fishing experience ranged from 40 to 75 years, with a mean of 59 years and, with one exception, all respondents were male.

The number of species discussed per interview ranged from one to four, with an average of 2.8. While information for nine species were canvassed during interviews, sufficient information and data were collected to permit analyses on five key species – Southern Rock Lobster, Blue Warehou, Southern Sand Flathead, Bastard Trumpeter and Greenback Flounder.

3 SOUTHERN SAND FLATHEAD

3.1 INTRODUCTION

While six species of flathead are found in Tasmanian waters, two in particular support commercial and recreational fisheries – the Southern Sand Flathead (*Platycephalus bassensis*) and the Tiger Flathead (*Neoplatycephalus richardsoni*). Southern Sand Flathead, the focus of this study, are found from Bremer Bay in Western Australia to Jervis Bay in New South Wales but are most common in New South Wales, Victoria and Tasmania (Edgar, 1997). They are found in estuarine waters and coastal waters to 100m but are most common in shallow waters on sandy or muddy substrates (Jordan, 1999).

Annually, approximately 10 tonnes of 'flathead' have been caught commercially on lines in Tasmania in recent years, assumed to be primarily Southern Sand Flathead. In addition a further 40-50 tonnes of flathead, mainly Tiger Flathead, are taken by Danish seiners operating in State fishing waters. By contrast; recreational catches of flathead (over 90% of which is Southern Sand Flathead) were estimated to be in the order of 290 tonnes in 2007/08, substantially greater than the commercial catch from Tasmanian waters (Lyle *et al*., 2009). By numbers, flathead accounted for almost two thirds of all finfish caught by Tasmanian recreational fishers.

Despite the great importance of Southern Sand Flathead to Tasmania's recreational fishers, the stock status is unknown, though undersized fish appear highly abundant and the size limit is set above the size at sexual maturity. The lack of historical knowledge relating to population dynamics underscores the role of studies such as the present one in addressing information gaps.

3.2 HISTORICAL RESEARCH

3.2.1 The Early Explorers

The earliest published account of flathead captures in Tasmania can be attributed to William Anderson, a surgeon on Captain Cook's second voyage to Australia. When summarising the fish species caught by rod and seine net over a five day anchorage in Adventure Bay in 1777, Anderson described flathead as follows:

> *It partakes both of the nature of a round and flat fish, having the eyes near each other, the head and fore part of the body brown sandy colour with rusty spots and whitish below. It seems to live in the manner of flat fish at the bottom, from the quantity of slime with which it is always cover'd.* (Cook *et al*., 1821)

Anderson also remarked that flathead were "next in number and superior in goodness to the elephant fish". Interestingly, later accounts before and after the colonisation of Tasmania do not provide many references to Elephant Fish. Therefore, it is assumed that the greater relative abundance of Elephant Fish was a temporary phenomenon and did not reflect relative baseline abundances of either species. This illustrates a problem with historical accounts, which is that they are typically isolated observations

from a variable system and do not necessarily represent the general state. In some cases we are able to validate the observations, as here with ratios to elephant fish, but in other cases the observations can't be validated and need to be treated cautiously.

A year later, again at Adventure Bay, William Bligh reported catching "flat-headed fish called foxes" in his seine net (Bligh, 2005). Interestingly however, flathead were not described or alluded to in journal entries of other explorers. This is particularly peculiar in light of the abundance of the species and the effectiveness of fishing methods used (seine netting and angling) to catch flathead. One possible exception is a journal entry by Francois Peron, naturalist for Nicholas Baudin, in which he mentions catching "stargazers"[2] whilst seine netting in the D'Entrecasteaux Channel in 1802 (Peron, 1809).

3.2.2 1803 to present

The Recreational Fishery

Unlike other species investigated in this report, most early references to flathead were made in relation to recreational fishing. The earliest published reports of flathead fishing were recorded in the diary of keen angling enthusiast Reverend Robert Knopwood (Knopwood, 1977) in relation to the Derwent estuary:

> *…caught some very fine flatheads.* (2 June 1805)

> *With a friend….in two hours opposite my house we caught in the bay 5 dozen of rock cod and 1 dozen flatheads.* (2 October 1805)

In 1846, a paper in the *Tasmanian Journal of Natural Science, Agriculture and Statistics* portrayed flathead as both numerous and ravenous:

> *It has frequently occurred to me that these rapacious fish appear to be actuated by a spirit of revenge; for should one be wounded by a hook, it will be the first to fly at a second bait, although the water may teem with fish of the same description.* (The Rapacity of Tasmanian Fish, 1846)

The author also asserted that flathead (and sharks) were more voracious than pike, presumably the European freshwater pike. Four newspaper articles reporting on recreational fishing trips in the second half of the 19th century make reference to the abundance and ease of capture of flathead at different locations around Tasmania:

> *Flatheads, a species of the finny tribe which is not to be despised, abounds in d'Entrecasteaux Channel and hundreds of them were landed on the deck of the Tasman that afternoon.* (*The Cornwall Chronicle,* 8 December 1873)

> *Near Hobart he may obtain excellent saltwater fishing, and fill his basket with perch, whiting, flathead, rock cod, silver trumpeter, mackerel etc.* (*The Mercury,* 18 January 1873)

[2] It is unclear whether this is a reference to flathead or stargazers (family Uranoscopidae).

> *Our river (Port Sorell) just now is teeming with fish, particularly flounders and flathead, and some very large hauls of the latter have been taken with hook and line lately – as many as 12 dozen to one line in a few hours.* (*The Launceston Examiner,* 23 March 1883)

> *A party who visited South Arm at Easter obtained 25 dozen flathead and 15 dozen rock cod for the day's fishing.* (*The Launceston Examiner,* 8 April 1899)

In terms of quantifying catch based on effort, the reference to fishing at Port Sorell probably provides the most useful information. At the same location, in 1854, numerous flathead were reported as being caught "seven pounds in weight" (*The Courier*, 27 July 1854). However, at that size, they are more likely to be Tiger Flathead or Blue-spot Flathead (*Platycephalus speculator*). Nonetheless, Last *et al*. (1983) suggest that Southern Sand Flathead can grow to 3.1 kg.

Years later, in 1930, a newspaper article provided a further account of the numbers of flathead available to anglers, this time at Swansea:

> *Large quantities of fish are being caught daily in the bay, Messrs. Campbell and Chappell, from the Bay View Hotel, getting seven dozen flathead in an hour. Seven dozen flathead in one hour is passably good fishing, although it cannot be said to come within the higher branches of the angling art.* (*The Mercury,* 6 March 1930)

Commercial Fishery

The first available reference to the sale of flathead was made by a Launceston newspaper favourably remarking on the abundance of fish supplied to the Hobart Fish Market (*The Launceston Examiner*, 13 June, 1868). In the following years, articles reporting on the potential for commercial fishing to feed the growing colony of Launceston made reference to the large numbers of flathead available in the Lower Tamar (*The Cornwall Chronicle*, 24 Feb 1871), Port Dalrymple (*The Cornwall Chronicle*, 26 March 1873) and between Ulverstone and Penguin (*The Launceston Examiner*, 22 October 1889).

While flathead appeared to be eagerly sought in northern Tasmania, available information suggests that flathead were generally unpopular as a food fish in the Hobart Town colony. This was likely influenced by the ready availability of more highly esteemed fish including Bastard Trumpeter, Striped Trumpeter and flounder. The following quote by a Victorian writer visiting Hobart encapsulates this position:

> *The poorest Tasmanians will not eat the inferior kinds of fish; flathead they scorn at a gift, while in Melbourne they sell for silver and almost as dear as whiting.* (*The Mercury*, 5 May 1869)

This attitude was also reflected in an unpublished assessment of the eating qualities of Tasmanian fish that was compiled for the 1882 Royal Commission. On a descending scale from 1 to 4, flathead were rated 4; as were wrasse and conger eels.

While the 1882 Royal Commission arose from concerns about the sustainability of some exploited fish species, there were no apparent concerns about flathead stocks

(Tasmania, Parliament, 1882). From the following quote, it is apparent that while very abundant, flathead were largely overlooked as a commercial species due to their unattractive appearance and ubiquity in Tasmanian waters.

> *They may be considered the scavengers of our shallow waters, for they are found everywhere around our coasts, in estuaries and around wharves, all year round. When no other fish are obtained, the flathead may always be depended upon. They are good edible fish and would be much more highly prized for the table were it not that they are repulsive looking and are so common.*

Interviews conducted for the Royal Commission indicate that the availability of other fish species to feed the colony during the warmer months meant that flathead were more commonly supplied to the Hobart Fish Market during winter months. One commercial fisher interviewed, William Henry Martin, distinguished between Southern Sand and Tiger Flathead. Of the former, he remarked:

> *In winter, a few boats take them. They are taken to supply the wants of the market when other fish are scarce.*

A summary of fish sales at the Hobart Fish Market in 1888 indicates that flathead were the seventh most numerous fish sold of 20 listed species (Johnson, 1980). The average price of 1 shilling per dozen (p/d) fish meant that flathead were the third cheapest fish (after Garfish and Australian Salmon) and were the same price, on average, as Mullet and Jack Mackerel. As sales data were reported in terms of fish numbers, and not weight, a meaningful comparison may be made when comparing the price of flathead with fish of a similar estimated average weight. When this is done, flathead were considerably cheaper than Black Bream (10s p/d), flounder (5s p/d), Gurnard (3s p/d), Jackass Morwong (4s p/d) and Blue Warehou (4s p/d).

After 1888, the volumes of fish caught or sold were not reported again until 1904. From then until 1924, fish sales at the Hobart Fish Market (and the Launceston Fish Market from 1920-1923) show that average annual sales of flathead ranged between 0.2 and 0.8 million fish (Fig. 3.1). As most fish were caught using handlines in inshore waters or by beach seine nets, it is likely that Southern Sand Flathead dominated catches. The absence of an export market for flathead and the concentration of Tasmania's population around the two main cities suggests that market sales would have approximated total annual state-wide commercial catches.

From around 1912, numerous reports described the growing scarcity of many fish species to supply local and export markets. However, this trend did not appear to influence local negative attitudes towards flathead. The following quote was taken from an overview of Hobart's fishing industry and was made in reference to a description of different fish species commonly caught in graball nets:

> *Flathead are treated with contempt and are looked upon as the farmer does the weeds that spring up in his crop. This fish are not taken as there is practically no market for it.* (*The Mercury*, 13 August 1912)

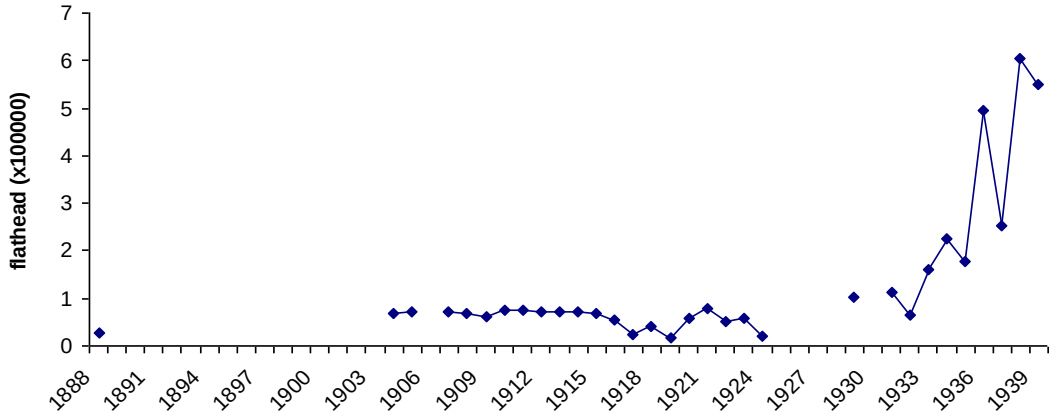

Fig. 3.1. Commercial flathead catches from 1888 to 1939. Catches from 1933 onwards are likely to comprise a high proportion of tiger flathead due to trawling efforts in deeper waters.

Two years later, an article described the escalating problem of fish scarcity, a problem not apparent for the relatively underutilised flathead:

> *Flathead are generally plentiful in Tasmanian waters, but quantities of more sought after fish coming into market are said to show an alarming decrease.* (*The Mercury*, 20 July 1914)

The overall scarcity of fish was particularly pronounced in the south-east and was an important factor precipitating the 1916 Royal Commission which investigated means to develop Tasmania's fisheries to procure fish supplies more effectively. Despite the relative health of the flathead fishery, sales at the Hobart Fish Market declined between 1916 and 1919 (Fig. 3.1). In whole of fishery terms, labour or consumption shortages relating to World War 1 were dismissed as contributing factors by the Fisheries Commissioners as boats were increasing in capacity and quantity (Tasmania, Parliament, 1919/20). From an article commenting on information supplied by a Dunalley fisherman to the Royal Commission (*The Mercury*, 22 July 1916), it appears that, despite the fish shortages, some fishers did not consider the price of flathead to be worth the effort of taking them to market:

> *The fishermen, with more industry and better systems, could catch many more fish than they did. Instead of being taken to market, flathead were thrown overboard. It was easy to catch 200 dozen flathead a day and the price obtainable for them was 2s 6d per dozen.*

In 1916, flathead were the cheapest fish at the Hobart Fish Market, along with Jack Mackerel, Whiting, Australian Salmon and Wrasse (Tasmania, Parliament, 1917). As such, supplying the market with less lucrative varieties of fish may have been the domain of fishers working closer to Hobart due to transport and freight logistics for fishing operations further afield. Boats were primarily sail powered and land-based trading routes were poorly developed. The persistent low demand for more abundant fish such as flathead against a backdrop of growing scarcity of more prestigious species seemed to perplex the Fisheries Commissioners (Tasmania, Parliament, 1919/20):

> *The ordinary law of supply and demand should, one would think, meet the position, but the difficulty is the reduced supply of fish of the better variety. The ordinary common fish, flathead, etc., are abundant, but only a limited sale of these can be obtained, as the supply exceeds the demand.*

From the 1930s, the introduction of Danish seining (a form of trawling) in Tasmanian waters was reflected in a sharp rise in the quantities of flathead caught. The increase in Danish seine activity coincided with a rapidly developing export market for flathead, principally Tiger Flathead. From 1932 to 1938, flathead catches increased tenfold to over 6 million fish. Catch data do not differentiate flathead species but, due to the domination of tiger flathead in Danish seine trawls, it may be inferred that catches of Southern Sand Flathead were relatively insignificant. Despite the growing demand for flathead in mainland states, the prevailing attitude in Tasmania was summed up by Mr S Fowler, visiting fisheries officer for the Council for Scientific and Industrial Research (the predecessor of the CSIRO):

> *Tasmania appeared to possess enormous supplies of these valuable fish, but perhaps because of that, did not appreciate them. The flathead, in his opinion, was one of the choicest fish in the world.* (*The Mercury*, 25 November 1936)

The interstate market for (primarily) Tiger Flathead from Danish seine trawling strengthened over the following decades and forms a valuable component of Tasmania's current commercial scalefish fishery. On a lesser scale, a commercial fishery for line caught flathead (primarily Southern Sand Flathead) has also persisted to the current day. The line fishery operates in inshore waters, primarily off the east, south-east and north-east coasts. Since the mid-1990s, the line fishery has consistently averaged around 10 tonnes per year. Also consistent has been the commercial catch per unit effort (Hartmann and Lyle, 2011), suggesting no major changes in fish abundance over that time.

3.3 FISHER INTERVIEWS

Twenty-two respondents provided information on flathead, with three fishers providing separate information for two distinct regions (Table 3.1). As this study focuses on species caught within defined regions over long time scales, these multiple contributions were treated as discrete data entities. Most interviewees provided data and information relating to the east and south-east coasts. However, the northern, north-eastern and north-western coasts were also represented.

The earliest recollection of flathead captures was 1940, though the average year of commencement of flathead fishing was 1961. With the exception of one respondent who discontinued flathead fishing in 2005, all respondents have continued to fish for flathead. One interviewee fished commercially for flathead in the D'Entrecasteaux Channel from 1945 to 1953.

Table 3.1. Summary of particulars for interviewees

Name	Region 1	Region 2[1]	Started	Finished
Fisher 1	E		1948	current
Fisher 2	E	Great Oyster Bay	1947	current
Fisher 3	E	Great Oyster Bay	1947	current
Fisher 4	E	Prosser Bay	1960	current
Fisher 5	E	Marion Bay	1955	current
Fisher 6	E	Great Oyster Bay	1960	current
Fisher 7	E	Great Oyster Bay	1960	current
Fisher 8	N	Tamar River	1945	current
Fisher 8	N	Bass Strait	1945	current
Fisher 9	NE	Musselroe Bay	1975	2005
Fisher 10	NW		1955	current
Fisher 11	NW	Wynyard	1955	current
Fisher 12	NW		1983	current
Fisher 13	SE		1975	current
Fisher 14	SE	Tasman Peninsula	1974	current
Fisher 15	SE	Great Taylor Bay	1970	current
Fisher 16	SE	Port Arthur	1968	current
Fisher 16	SE	Norfolk Bay	1968	current
Fisher 17	SE	FHB and Norfolk Bays	1971	current
Fisher 18	SE	Norfolk Bay	1975	current
Fisher 19	SE	Port Arthur	1967	current
Fisher 19	SE	Norfolk Bay	1967	current
Fisher 20	SE		1947	current
Fisher 21	SE		1950	current
Fisher 22	SE		1960	current

[1]Specific locations have been provided only when reported flathead fishing pertains to such. If no entry is provided, respondent reported fishing at various locations within Region 1 over the duration of their fishing career

3.3.1 Abundance

Quantitative Interview Data

Measures of abundance were expressed as the estimated average number of legal-sized flathead (300 mm fork length) caught per hour "on the water". Estimating CPUE in this manner incorporates 'search time', which should provide a more reliable measure of CPUE than 'fishing time', especially when encountering patchiness between fish communities (Maunder *et al*., 2006).

All interviewees reported declining catch rates over time. There was an overwhelming decrease in the estimated catch rate of flathead, from about 30 p/h in 1940 to a current average of 6.6 p/h – a decline of 78% (Fig. 3.2). The highest reported catch rate was provided by a former commercial flathead fisher. He suggested that in 1950, the average number of flathead (>300 mm) caught per hour in the D'Entrecasteaux Channel was 48.

Data were also collected to enable an assessment of changes in catch rates of all flathead, irrespective of size caught over time (Fig. 3.3). By this measure, catch rate declines were less marked (i.e. decreased by around 50%) and reflect an increasing proportion of fish less than 300 mm in catches.

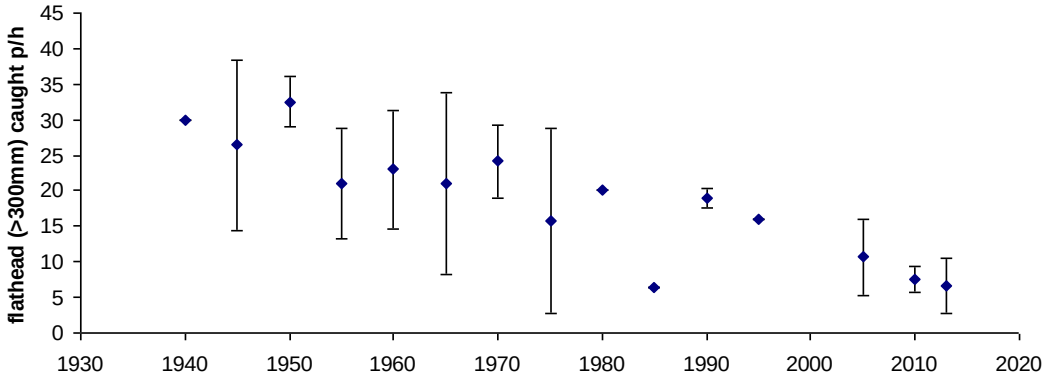

Fig. 3.2. Mean reported number of flathead (>300 mm) caught per hour (+/- SD), between 1940 and 2013.

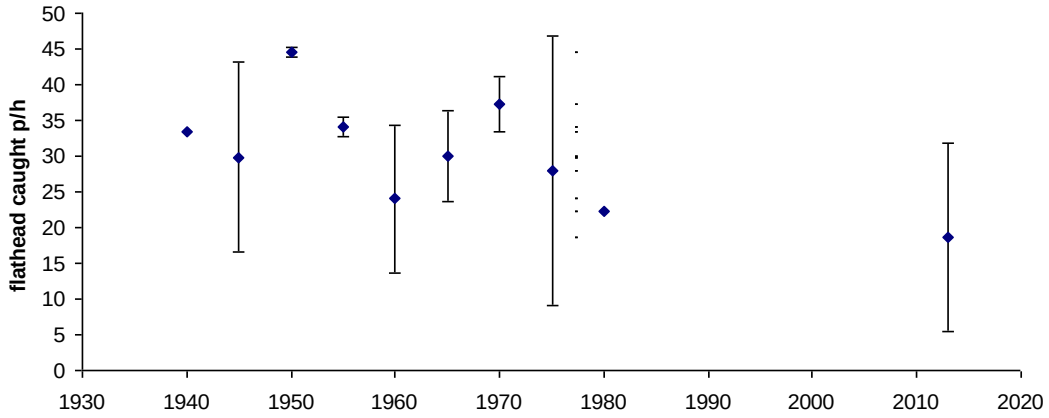

Fig. 3.3. Mean reported number of flathead (all sizes) caught per hour (+/- SD), between 1940 and 2013

Qualitative Accounts of Abundance

The earliest accounts of flathead fishing were recollections of great abundance, regardless of location. Some fishers mentioned that catching two fish at a time (using a two hook rig) was at least as common as catching a single fish. While most fishers interviewed had access to boats from a young age, the quality of shore-based fishing meant that much flathead fishing was done from shore. One fisher described shore-based fishing for flathead near Hobart in the 1950s:

> *You'd go to South Arm or Opossum Bay, you'd catch all the flathead you ever wanted to catch off the jetty or if you was in a dinghy it was a bonus for ya.*

Amid stories of great abundance, there were also recollections of excess and wastage – a recurring theme across all species investigated. Some fishers quantified early catches in terms of the number of chaff bags or bins filled. Three fishers recalled the practice of using excess flathead as manure and two recalled the wasteful disposal of flathead caught during fishing competitions. One fisher from Swansea recounted the following:

> *They had this fishing competition out off Swansea and we got 300 odd flathead, and we was nowhere near the top boat. And they took 'em in and dumped 'em and counted them on the oval and they took a truckload to the tip.*

While respondents generally expressed regret over the wasteful manner of prior excesses, some explained that in earlier decades, in the absence of bag and size limits for recreational catches, it was acceptable to retain large numbers of fish. Paradoxically, some fishers suggested that there has been a growing tendency among recreational fishers to attain and exceed their bag limits in more recent times. Reasons provided by fishers include growing time constraints, the relatively greater capacity of individuals to freeze fish and higher costs involved in fishing (and therefore a need to offset expenses by keeping more fish).

A recurring theme across interviews was the increasing degree of 'patchiness' in the distribution of flathead. In earlier years, most fishers suggested that flathead were abundant, ubiquitous and more uniformly distributed, while in recent years locating flathead has become a process of locating a 'patch'. Whilst the degree of perceived decline and the prevalence of 'patchiness' varied between fishers and locations, the pattern was broadly similar. The following comment was made in relation to fishing in the D'Entrecasteaux Channel:

> *Forty years ago, you could have gone anywhere down there and you could have got your flathead. Then after a while, you had your spots, you know what I mean. You line up this and that and there was your spot, a little area where you would get more. Then it went from them areas and you'd go to four areas before you'd find your spot. And even then you might not even get your feed. So you'd have to move around a lot and vary the whole place before you got a feed of flathead.*

Similar comments were provided by fishers within each region studied. One interviewee, a former commercial line-caught flathead fisher in the D'Entrecasteaux Channel stated:

> *The quantity is not the same these days. They are there but you gotta cover a much bigger area. Catch rates now would be less than half of what they used to be.*

Comments consistent with this were made by numerous long-term flathead fishers from the east and south-east coasts, though a fisher from the north-west coast reported a similar pattern of decline by commenting "the distances between flathead beds have got longer and you wait longer to get onto another one". While most interviewees still fish in the same general areas for flathead as they did when they first started fishing, five respondents mentioned avoiding specific areas due to the lack of fishing success. Three mentioned certain areas in the Tamar River while the water off Dolphin Sands and the mouth of the Swan River were also mentioned. The following quote is provided for the latter location:

> *We used to fish the mouth of the Swan. And just inside we'd throw a handline in and you'd get big flathead, not king flathead but beautiful big sandy flathead, around 4-500mm. And you'd go around there now and you wouldn't see one.*

You might get one in a day or something like that….it wouldn't be worth going around there now.

Fishers were also asked when they noticed the greatest changes in flathead abundance. Of the 17 respondents who felt sufficiently confident to offer a response, ten suggested since 2000 and four thought it occurred between 1990 and 2000. Five fishers suggested that the decline has coincided with a shift from other forms of fishing, in particular net fishing.

3.3.2 Size

Estimates of the average size of flathead were provided as length data. With the exception of one respondent who had observed no significant change in the average size of flathead, all other respondents reported a decrease in the average size of flathead greater than 300 mm during their fishing careers. The average reported length of flathead when respondents first started fishing and over most recent fishing season were 400 mm and 333 mm, respectively. When data were grouped by decade, the average reported length of flathead greater than 300 mm was 415mm during the 1940s and 1950s and just under 400 mm during the 1960s and 1970s (Fig. 3.4).

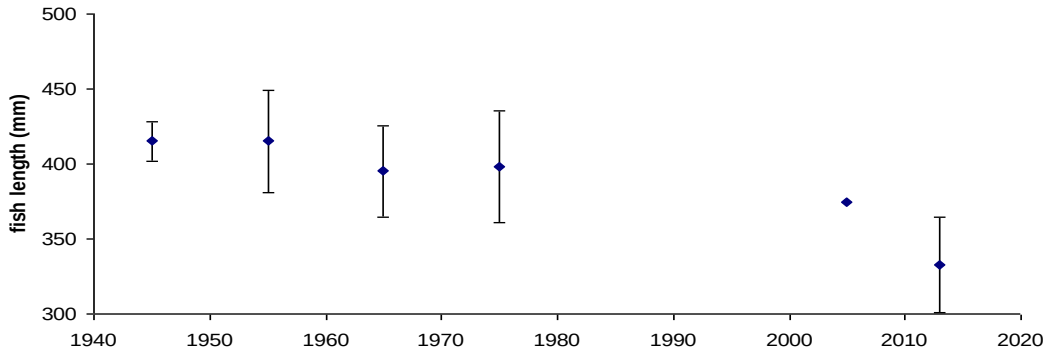

Fig. 3.4. Mean reported length of flathead caught over 300 mm (+/- SD), between 1945 and 2013

When lengths were converted to weights, the average reported weight of flathead caught in the 1940s and 1950s and during 2012/13 were 572 g and 274 g, respectively, more than a 50% decline over 70 years (Fig. 3.5).

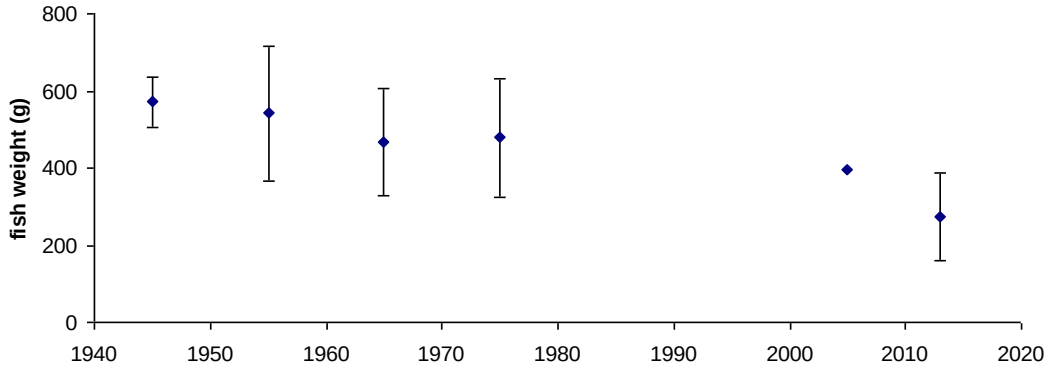

Fig. 3.5. Mean reported weight of flathead caught over 300 mm (+/- SD), between 1945 and 2013

Fishers also provided 'previous' and current estimates of the relative proportions of fish greater and less than 300 mm in their flathead catches. When data were aggregated into a decadal time series, a steady decrease in the proportion of fish over 300 mm was observed, implying an increase in the proportion of undersized fish in catches (Fig. 3.6). In the 1940s, the reported mean proportion of fish caught less than 300 mm was in the order of 10% whilst the reported mean for 2012/13 was about 60%.

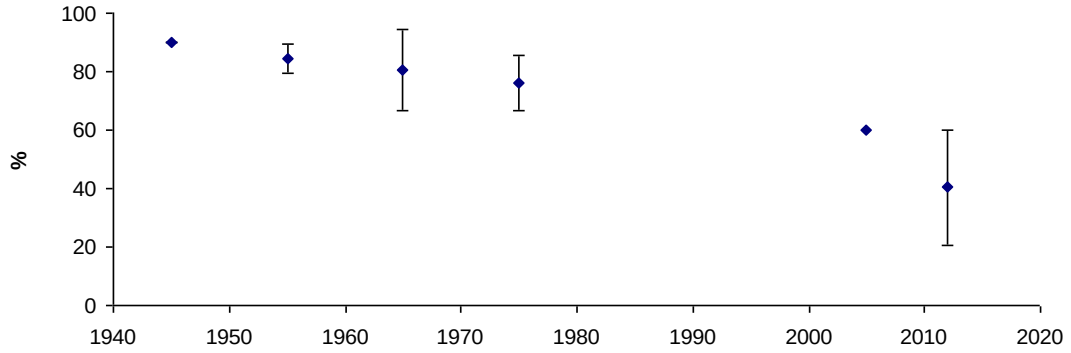

Fig. 3.6. Estimates of the relative proportion (%) of total flathead caught (+/- SD) that were greater than 300 mm, between 1945 and 2013.

Qualitative Accounts of Fish Size

A frequent recollection was that, despite the absence of a size limit until 1981, fishers generally did not keep flathead less than about 350 mm in length when they first started fishing due to the abundance of larger fish. Many fishers expressed dismay over the average size of flathead caught in recent years. One long-term fisher in Great Oyster Bay expressed the following:

> *The funny thing about the flathead is why they're not improving in size. For years, you got all sized fish, but now, unless you find a patch, you're wondering where all the big fish are all of a sudden. We often say to each other, we never*

thought we'd be out here looking for flathead and not catching a fish other than little ones like this [gestures to approximate a fish of around 20cm]. *I've often said to M----y I never thought the day would come when I'd have to hunt around the bay for four or five hours to get a feed of size flatties. Sometimes, that is what you got to do.*

Fishers who indicated a decrease in flathead average size over time were asked when they first noticed the decline. Overwhelmingly, respondents suggested that the size decline followed a similar trajectory to the decline in abundance.

Catch Weights

By combining reported catch rates (numbers) of fish greater than 300 mm with estimates of average fish weight (converted from length data), it is possible to examine the pattern of catch rates based on biomass retained per hour fished through time (Fig. 3.7). These results suggest a considerable decrease in the weight of retained fish over the last 70 years, from around 18 kg per hour in 1940 to around 2 kg in 2012/13, a decline of almost 90%.

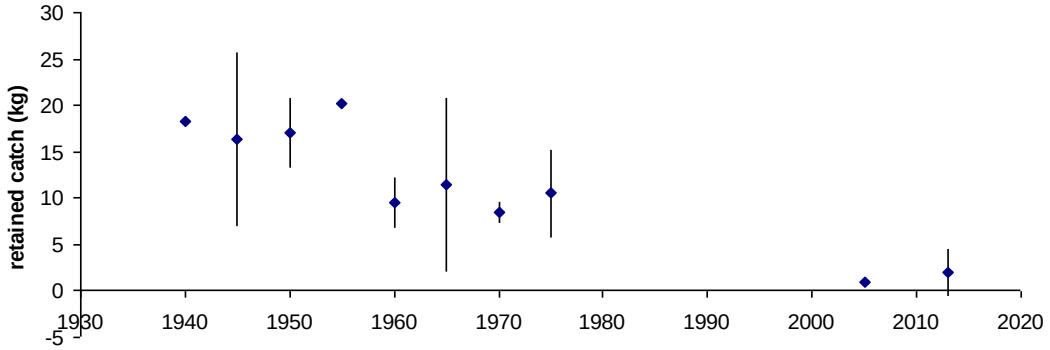

Fig. 3.7. Estimates of retained biomass (kg) of flathead (+/- SD) per hour of fishing based on catch rate and size data, from 1940 to 2013

3.3.3 Fisher Behaviour

Fishers were asked to estimate the average distance they would normally travel on the water in order to fish for flathead; both when they commenced fishing and in their most recent year of fishing. As ranges rather than point estimates were provided by fishers, the data were analysed according to both the lower and the upper bounds of the reported ranges. These points represent minimum and maximum distances, respectively. In total 24 fishers were able to provide usable data.

Overall, the data demonstrate a trend of increasing minimum and maximum distances travelled on the water over the period surveyed (Fig. 3.8). This trend is most apparent for maximum distances. The average on water travel range for when fishers commenced fishing was 0.3 to 1.8 km. Nine fishers commenced fishing from the shoreline, in which case their minimum value was 0. Currently, the average distance range of respondents is between 1.2 and 6.8 km. The trends are likely due to the

combined effects of access to more powerful vessels and decreased abundances of flathead in more accessible areas necessitating greater travel and searching times. On one hand greater travel and search times effectively reduce the time spent fishing on a trip but on the other act serve to maintain catch rates at acceptable levels by actively seeking patches of fish. It may be relevant to note that changes in fishing behaviour of this nature can bias interpretation of other data.

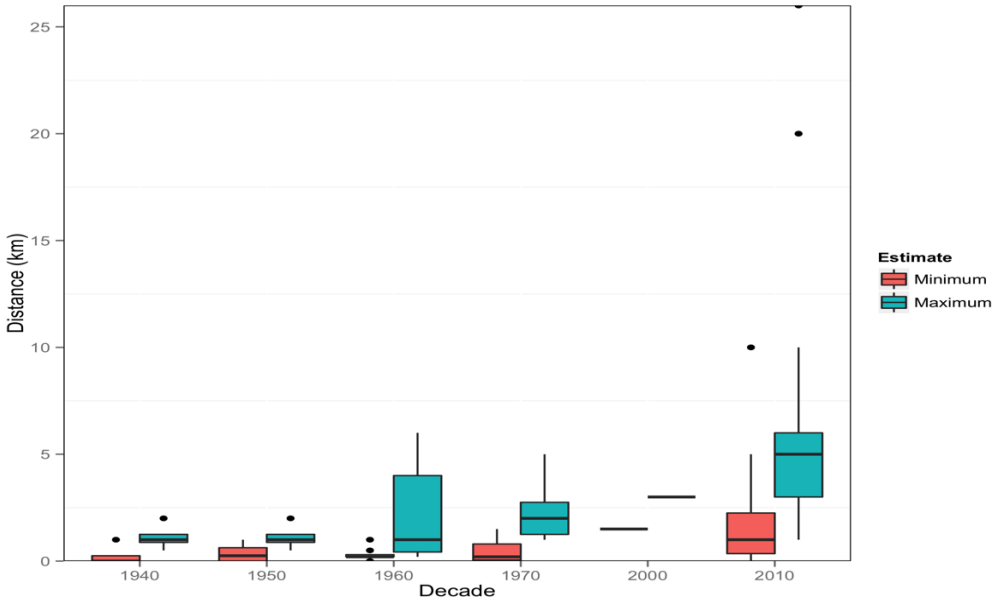

Fig.. 3.8. Estimated maximum and minimum distances travelled on the water to go flathead fishing over time (box and whisker plots). The upper and lower "hinges" within each box correspond to the first and third quartiles (the 25th and 75th percentiles). The upper and lower whiskers extend from the hinge to the highest and lowest values within 1.5* the distance between the first and third quartiles, respectively. Data points beyond the end of the whiskers are outliers.

3.4 DISCUSSION

For many years since British colonisation, Southern Sand Flathead were a much maligned species in Tasmania, particularly from a commercial perspective. This perception appeared to be due to its appearance, its reputation as a scavenger, its wide abundance and the availability of more highly esteemed fish. Until more recent times, relatively low local demand for flathead likely helped ensure that stocks remained healthy, particularly relative to more highly regarded species which were fished more intensively. This premise was supported by both Royal Commissions into Tasmania's fisheries (1882 and 1916), whereby widely reported abundance declines for many species were not apparent for flathead. Despite decreasing market availability of preferred species during these times, the demand for flathead did not appear to increase – such was the entrenchment of values and perceptions surrounding flathead at the time. It is likely that such values and perceptions were predisposed by early Tasmanian's identity with Britain, in this case fish commonly eaten in the 'mother country'. While popular Tasmanian fish at the time had 'morphological equivalents' of commonly eaten fish from the North Atlantic, the same does not appear to be true for flathead.

Despite prejudiced consumer attitudes towards flathead, the species appeared to attract interest among recreational fishers from an early time in Tasmania's post-colonial history. Its popularity among fishers seems to have been due to its widespread availability and abundance coupled with its ease of capture using relatively unsophisticated fishing methods (ironically, similar reasons given for its lack of popularity with seafood consumers). Such reasons underpin the popularity of flathead nowadays and as such, flathead have become the 'bread and butter' marine angling species in Tasmania, accounting for nearly two-thirds of all finfish (by number) caught in the state. Clearly, since the latter half of the 20th century, former prejudiced attitudes have been replaced with a widespread appreciation of the species and its edible qualities. It is also likely that declining catch rates for other popular species have shifted fishing effort towards flathead. Despite a growing appreciation, the history of recreational flathead fishing is characterised by accounts of greed, wastage and, more recently, relatively poor compliance with fishing regulations. Creel surveys conducted during 1997/98 (Lyle and Campbell, 1999) and 2000/01 (Lyle *et al*., 2002) revealed that retained catches of Southern Sand Flathead were comprised of an average of 40 and 30%, respectively of undersized fish by number.

Unlike other species that were heavily fished in the early years following British settlement, it is feasible that Southern Sand Flathead stock levels were close to pre-exploitation levels until around the early to mid-20th century. This assumption is based on the limited degree of commercial exploitation and presumed minor impacts from the recreational sector owing to low population size and hence numbers of fishers (see Appendix 1), coupled with limited boat capacities. Furthermore, flathead catch rates from the 1940s and 1950s provided through fisher interviews are comparable with catch rates reported in historical documents. Interviewees suggested that the number of fish caught at the time was only limited by the time it took to re-bait lines and remove fish from hooks. Since then however, information provided through interviews suggests a steady decline in flathead catch rates; from an average of 30 fish per hour in 1940 to a current average of 6.6 fish, a decline of almost 80% based on fish greater than 300 mm.

Unfortunately due to the lack of a quantitative stock assessment for the species it is not possible to compare these observations with 'comparable' data on catch rates or abundance over the same period of time. However, commercial CPUE data for the Tasmanian line fishery from 1995 to 2010 (Hartmann and Lyle 2011) suggest that catch rates, and by proxy abundance, has changed little since the mid-1990s. Reasons for this apparent discrepancy between interview data and commercial catch rates are unclear but recall bias is likely to be an issue as is the fact that there were very few observations provided between 1975 and 2010, so limited inferences can be made during that period.

Fisher interview data also indicated a steady decrease in the average size of flathead over time. This was expressed using two measures – (1) estimates of average fish length at both fishing career commencement and in recent times, and (2) the relative proportions of fish greater and less than 300 mm for both time periods. Of the former, size comparisons suggest that since the 1940s, the average length of flathead (over 300 mm) has fallen from over 400 mm (over 500 g) to about 330 mm (just over 250 g). When coupled with declining catch rates, it appears that catch rates based on

weights have experienced a ninefold decline since the 1940s. Over the same period the proportion of undersized fish in catches is suggested to have risen from around 10% to around 60%, though in some areas, the proportion of undersized fish was reported to be as high as 90%.

Whilst the results from interviews suggest considerable recent declines in abundance of the legal-sized stock of flathead, the study is limited in terms of respondent numbers. The number of fishers interviewed was insufficient to facilitate regional comparisons – most interviewees provided information relating to the south-east and east coasts, which account for over 80% of total state-wide catch (Lyle *et al*., 2009). Due to the widespread popularity of flathead fishing in Tasmania and the breadth of inshore and estuarine locations in which they are fished, further research would enable a greater degree of confidence in whole-of-fishery perspective and may facilitate region-based assessments.

In summary, it appears that the growing popularity of recreational flathead fishing among Tasmanians has had a significant impact on the abundance and average size of legal-sized fish, particularly since the middle of the 20th century. Since then, fishers tend to travel further, whilst catching fewer and smaller fish. While greater numbers of boat launching areas and a growing numbers of recreational fishers with increasing access to more powerful boats has enhanced fishing opportunities to many, the apparent decline in Southern Sand Flathead size and numbers over time should be a topic of ongoing investigation.

4 BASTARD TRUMPETER

4.1 INTRODUCTION

Bastard Trumpeter (*Latridopsis forsteri*) was one of the first fish species to have been commercially exploited in Tasmania. Their apparent abundance around reefs close to the newly established Hobart Town meant that they were an important source of seafood for the fledgling colony. Their exploitation was further aided by the relative ease at which they could be caught using gillnets set within accessible shallow inshore reefs.

Bastard Trumpeter have also long been recognised as an important fish by recreational fishers. Bastard Trumpeter feed mainly on small crustaceans, such as amphipods and isopods, making the species difficult to catch using traditional angling methods. Accordingly, they are fished almost exclusively with gillnets and have traditionally been a key target species among recreational netters.

Until quite recently, the life history of Bastard Trumpeter had remained a mystery. This was mainly due to the infrequency in which sexually mature fish were caught. While aspects of their biology are still uncertain, it is now understood that this species resides on inshore reefs till about 4-5 years of age (and approximately 50 cm long), moving offshore into deepwater sites as they approach maturity, apparently remaining in that habitat for the remainder of their lives (Harries and Lake 1983, Murphy and Lyle 1999). Prior to this migration, fish undergo a colour change, from a reddish-brown to a silvery-blue colour. Hence, younger and older fish have traditionally been referred to as ‘red bastards’ and ‘whitefish’, respectively. The whitefish are also known as ‘summer fish’ by some fishers.

Due to their life history, both commercial and recreational fisheries are based almost entirely on juvenile fish. The concerns of managing a fishery defined by this characteristic have been expressed by various authors (Harries and Lake, 1983; Harries and Croome, 1989; Barrett *et al*., 2007). Apparently motivated by this concern, Harries and Croome (1989) evaluated historical Bastard Trumpeter fishery trends against a backdrop of changes to the management and governance of the fishery.

4.2 HISTORICAL RESEARCH

4.2.1 Commercial Fishery

Unlike many other fishes of importance to recreational fishers, Bastard Trumpeter were not described in published accounts of Tasmania’s early explorers. This is probably due to their usual methods of capture – line fishing and seine netting – which are not conducive to the capture of Bastard Trumpeter. Nonetheless, after British settlement in Tasmania, the proximity of Hobart to productive Bastard Trumpeter grounds and their popularity among early settlers ensured that the species became an important item of seafood for the new colony. Their susceptibility to capture using gillnets provided a ready source of fish from a simple fishing gear requiring relatively little skill or experience to operate. The hardiness of Bastard

Trumpeter in surviving long periods in captivity in well-boats further enabled fish to arrive at markets alive and in good condition. This was particularly important as live fish were often held for extended periods in cauffs at the wharves, from where they would be sold directly to the public.

In the 1800s, much of the fishing undertaken to supply Hobart with seafood was done within the local vicinity. Eventually however, fishing activity caused localised depletions of fish near Hobart. Concerns about this, and for the unimpeded migration of newly introduced salmonoids, ultimately led to the banning of seine and gillnet fishing in the Derwent estuary above Hobart in 1865. Six years after the closure, most fisheries had reportedly improved; however, the following excerpt from an article published in *The Mercury* in 1871 (26 October) suggests that the Bastard Trumpeter fishery was one that had not improved in the Hobart vicinity:

> *The large white-bellied trumpeters are taken by a fixed net called a graball net-set amongst the kelp beds. The mesh of this net is of such size that none but marketable fish can be taken, all others passing through. It follows that these fish could never be eradicated by such a net, as a large percentage would always escape, and breed till marketable. Yet these fish have all but disappeared from the kelp beds near Hobart Town, where they were once numerous. Is not the destruction obvious?*

While the Salmon Commissioners recognised the impact of seine netting on indigenous fish, particularly juveniles, the gillnet ban was purely motivated by preventing the capture of migrating salmonoids, including smolts. It appears that they assumed the impact of gillnets to be largely benign from a whole of fishery perspective. In regards to the quote above, it is assumed that the scarcity of Bastard Trumpeter – in this case the larger 'whitefish' – was being realised in waters downstream of the net ban, based on the prevailing regulations. At the time, there was little or no understanding of the reproductive size of the species and their scarcity seemed to be met with both incredulity and in growing recognition of the impact of gillnet fishing. Nonetheless, an angling report two years later however suggests that Bastard Trumpeter were still plentiful near Hobart:

> *It may not be generally known that Kangaroo Point offers almost unlimited sport to the followers of Isaac Walton. But such is really the case. In early morn that is between three and six o'clock-the waters in the vicinity of the wharf abound with silver trumpeter and perch; and so late as last Friday morning one fisherman alone hooked ten dozen fine fish in little over an hour.* (*The Mercury*, 18 January 1873)

This quote is particularly curious for two reasons. First, against a backdrop of reported Bastard Trumpeter declines in the area, the catches reported are particularly questionable as the same article also provides an advertisement for accommodation targeted to fishers at Kangaroo Point. Second, given that fish were caught using lines, it is possible that "silver trumpeter" referred to striped trumpeter and not Bastard Trumpeter, though it is also possible that all fish caught on lines were perch (jackass morwong).

The 1882 Royal Commission on the Fisheries of Tasmania was assembled amid concerns about the sustainability of some popular fish species within the area fished at the time – between Seymour on the east coast and Port Davey (Tasmania, Parliament, 1882). One species of concern, the Bastard Trumpeter, was reportedly becoming increasingly scarce, especially in fishing grounds closer to Hobart. Robert Smith, a commercial fisher interviewed for the Royal Commission stated:

> *They are not as plentiful as they used to be, owing to overfishing.*

Other interviews conducted at the time suggest that the larger 'whitefish' were becoming relatively scarcer than the smaller 'red bastards'. In one example, the Hobart Fish Market clerk, Mr Joseph Barnett testified:

> *Notwithstanding the greater number of men fishing, and the new grounds worked, there are fewer white-bellied bastards brought in, but not fewer red Bastard Trumpeter brought to market.*

While other interviewees asserted that overfishing was causing the decline in Bastard Trumpeter catches, the Commissioners favoured the view that indiscriminate seine netting, especially within the Derwent estuary, was affecting stocks by destroying small juvenile fish (paper fish):

> *It has been stated that, by the improper use of seine nets, immense quantities of the paper fish and other young fry are every season ruthlessly destroyed upon the sandy beaches, and that the valuable mature silver bastard and other important market fish are becoming scarcer every year. It is reasonable to suppose therefore that the wanton destruction complained of in the upper water of estuaries may have more to do with the increasing scarcity of the silver bastard in the outer reefs than the cause usually advanced by the fishermen themselves, i.e. overfishing.* (Johnson, 1882)

At the time of the Royal Commission, the upper reaches of the Derwent estuary had been closed to seine netting for 17 years and subsequent improvements to the health of fish stocks were observed. Accordingly, the Commission recommended maintaining the prevailing closure in addition to a prohibition of gillnetting near river mouths to prevent the capture of migrating fish; though fish species requiring protection by this measure were not specified. For other areas, it was further recommended to introduce a minimum gillnet mesh size of 4 inches. These proposals were implemented with the passing of the *Fisheries Act* 1889 as were minimum legal-sizes for some species. For Bastard Trumpeter, a minimum legal-size of 12 inches was introduced. While the changes to netting regulations likely conferred some benefit to Bastard Trumpeter populations, the Royal Commission report suggested that specific measures to address Bastard Trumpeter declines were unnecessary:

> *Although it has been shown that there has been a falling off in later years with regard to such fish as the silver bastard, trumpeter and perch, and even a disappearance or scarcity of trumpeter in the more accessible grounds, ascribed to overfishing, we are not inclined to suggest any protective measure in this direction.*

In addition to identifying issues and suggesting remedial measures, work undertaken by the 1882 Royal Commission included comprehensively documenting and describing the main fisheries. This included anecdotal and descriptive accounts of the relative prominence of various fisheries, thus alluding to catch volumes. However, the first quantitative record of catches was based on fish sales at the Hobart Fish Market for 1888 (Johnson, 1890). In that year, 41,724 Bastard Trumpeter were sold. Assuming an average weight of 1kg per fish, this value is represented as 41.7 tonnes in Fig. 4.1. At the time, fishers targeting Bastard Trumpeter generally fished "the middle grounds" between January and March. The report describes these grounds as "those fishing reefs and banks lying in the more exposed situations of estuaries – such as Wedge Bay and Adventure Bay, in the Derwent – in depth of water from five to six fathoms". The boats used were open centre-board ex-whaleboats fitted with fish-wells in the hull, perforated to allow water to pass freely to keep fish alive for market. Johnson (1890) suggests that 86 boats were engaged in the entire fishing industry state-wide, though it is not possible to determine what proportion of these fished for Bastard Trumpeter. However, as 63% of all fishing boats were worked from Hobart, the sales data are likely to considerably underestimate state-wide catches as fish were landed in other ports. Furthermore, some fish landed at Hobart by-passed the market and were hawked on the streets.

Sales data for the Hobart Fish Market represent the first systematic recording of 'fisheries data' in Tasmania. This was reported annually by the Commissioners of Fisheries from 1904 until 1923 for the Hobart market and from 1920 to 1923 for the Launceston market. From 1904 to 1915, an average of 58[3] tonnes of Bastard Trumpeter was sold annually at the Hobart Fish Market (Fig. 4.1). By 1918 however, catches as inferred by sales, fell precipitously to an estimated 3 tonnes. Despite potential inaccuracies involved in using sales rather than catch data, the Commissioners considered that the sales data provided a "fair idea of the relative trend of the supply of fish" (Tasmania, Parliament, 1919/20). A pattern of depressed catches was evident for most species from as early as 1910 until improvements were observed in the 1920s. The Commissioners dismissed the idea that this was due to the impacts of World War I as the number of fishers and boats were increasing. By 1917, approximately 120 boats operated in southern Tasmania (*The Mercury*, 26 July 1917). Furthermore, many fishing boats were becoming equipped with oil engines, thereby increasing their range and decreasing travelling time (*The Mercury*, 20 July 1914). Instead, it appeared that fish stocks, including Bastard Trumpeter, within the fishing grounds worked to that date had been depleted:

> *It has been clearly demonstrated that for some years past, a shortage of the choicer kinds of fish has occurred, for which no satisfactory explanation has been forthcoming. The fishermen report the fish are now not present in any quantity on the known fishing grounds, and that fishing for scale-fish, in spite of the high prices obtainable for their catch, is daily becoming less remunerative, causing many of them to give up the pursuit of scale-fish altogether and take up the more lucrative business of catching crayfish for the mainland markets.* (Tasmania, Parliament, 1922).

[3] Fish numbers, rather than weights were reported, to estimate weight, an average of 1 kg per fish has been applied. This is likely to be conservative in light of fish weights discussed in this chapter.

Like many fish species, reports of Bastard Trumpeter scarcity were numerous (e.g. *The Mercury*, 12 July 1916; 26 July 1917). Surprisingly however, the following quote by fisheries Commissioner and commercial fisher, W. Gates suggests that productive fishing grounds were still available:

> *We have a fish called the whitefish which arrives in the middle of February and leaves in the middle of May. One was caught on a line by a fisherman and nets were tried, with the result that 180 dozen were caught in a very short time.* (*The Mercury*, 22 May 1915)

Despite this account, it appears that the growing scarcity of Bastard Trumpeter was noted by fishermen at least six years before the market supply was affected from 1916, particularly for the larger 'whitefish' (*The Mercury*, 5 October 1909; 20 July 1914). The lag period before the decline in supply suggests that fishers were avoiding depleted areas and fishing grounds further afield. However, the sharp decline from 1916 further suggests that boats were working at the edge of their range limitations though unfished waters still existed at the time, particularly on the west and south-west coasts. Such limitations, combined with a crisis in overall fish supply and the recognition of fisheries development potential underpinned the appointment of a second Royal Commission in 1916.

For a number of years after the 1916 Royal Commission, the supply of fish remained suppressed. This was particularly evident for Bastard Trumpeter: from 1918 to 1920, the volume of Bastard Trumpeter brought to market as a proportion of total fish sales (by numbers) fell from a steady average of around 7% to between 1 and 4% (Fig. 4.2). After the appointment of the Sea Fisheries Board as fisheries administrators in 1924, catches of Bastard Trumpeter again approached levels seen prior to 1910 (Fig. 4.1). This time, fisheries data for individual species were recorded and reported as the weight of total state-wide catches. While data were not available till 1926, the average annual weight of Bastard Trumpeter landings from 1926 to 1940 was 91 tonnes. In 1932 and 1939, over 170 tonnes were caught. It appears that efforts undertaken by the second Royal Commission to expand and develop Tasmania's fisheries were having a profound impact on Bastard Trumpeter catches. Harries and Croome (1989) suggest that the rise in catches was due to the expansion of fishing operations to more remote regions, particularly the west and south-west coasts. By 1939, the number of boats engaged in scale-fishing state-wide had risen to 235, though many of these boats either fished almost exclusively for barracouta or Southern Rock Lobster (Sea Fisheries Board, 1939).

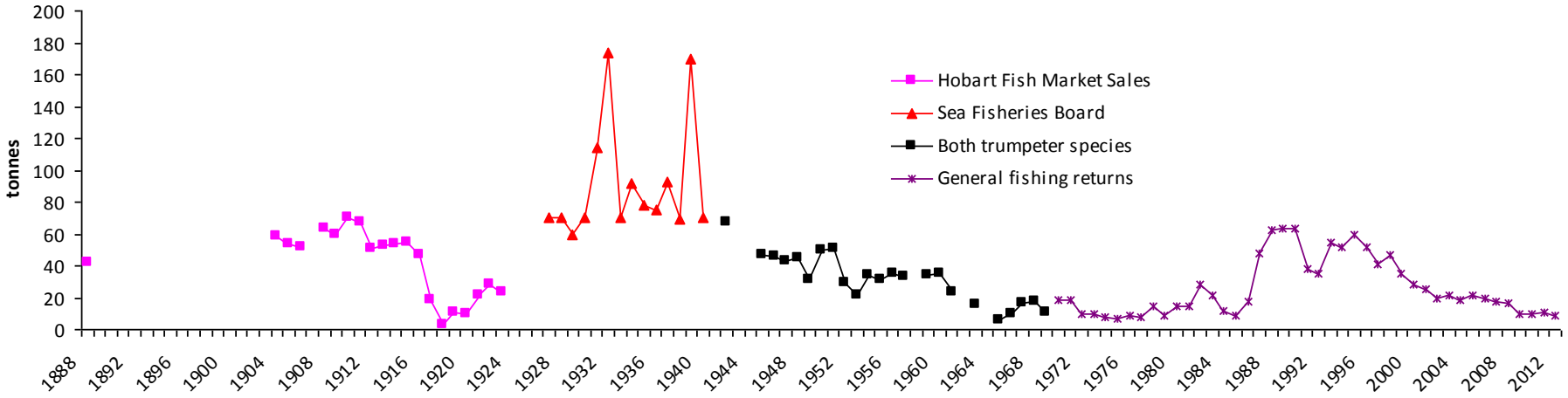

Fig. 4.1. Annual Bastard Trumpeter catches for the Tasmanian commercial fishery from 1888 to 2012.

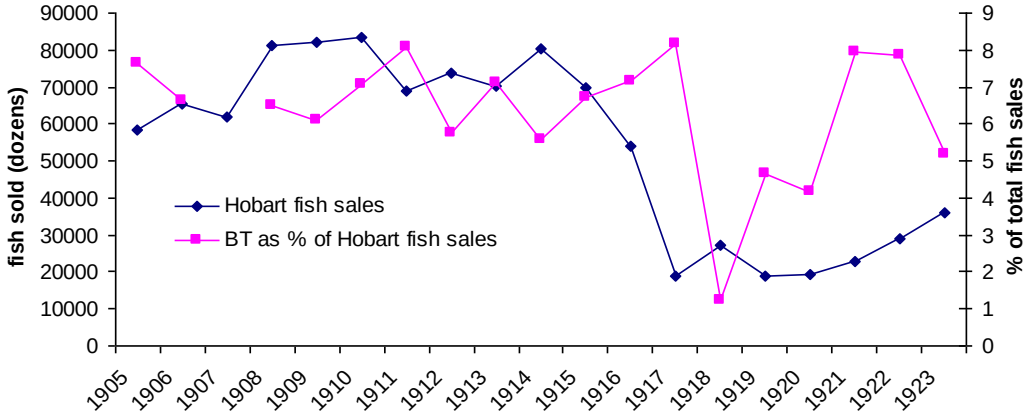

Fig. 4.2. Total fish sales at the Hobart Fish Market and the percentage attributed to Bastard Trumpeter, from 1905 to 1923

From 1941, marine fisheries were administered by the Department of Agriculture. Until 1944 however, little fishing activity occurred due to World War II and little data were made available. From 1944, a more accurate system was developed to record catch data but unfortunately up to 1967, catches of Bastard Trumpeter were not differentiated from striped trumpeter, and therefore total trumpeter catches for this period are presented in Fig. 4.1. Despite this, based on examining the relative catches of the two trumpeter species from 1966/76, it can be reasonably assumed that Bastard Trumpeter comprised the bulk of catches during this period (Harries and Croome, 1989). Overall, catch data from 1941 to 1969 show a steady decline in trumpeter catches. From 67 tonnes in 1942 to 11 tonnes in 1969, it appears that the bonanza experienced from the fishery expansion to the west coast in the 1930s was over. From the 1940s, there were few areas left unfished to exploit and subsequent catches were mainly made by fishing pre-worked reefs. To examine catches per decade, annual average catches in the 1940s, 1950s and 1960s were 47, 35 and 17 tonnes, respectively – a sharp decline from an average of 101 tonnes in the 1930s. As catch values from the 1941 to 1967 also include striped trumpeter, the scale of the decline in Bastard Trumpeter catches is furthermore evident. The following quote from a commercial Bastard Trumpeter fisher who commenced fishing in the 1940s supports the view that the boom days of the fishery were over (Bridge, 2007):

> *These fish were reducing in numbers when I joined the family business in 1947, and I never saw the great catches which had been made in years before and which still motivated my uncle to this fever.* (p. 60)

Between 1970 and 1986, annual state-wide catches of Bastard Trumpeter averaged 13.6 tonnes and appeared to move within a range of between 10 and 20 tonnes. However, from 1987 to 1998, catches again increased – an average of 51 tonnes per year was caught over this period. It appears that this period of increased catches was due to both increased fishing effort and successful successive recruitment pulses in the early 1990s (Murphy and Lyle 1999).

From 1995 (60 tonnes), catches again commenced a downward trend which has continued to the present (8.4 tonnes in 2012). Two catch rate measures presented by

Hartmann and Lyle (2011) indicate little change over this period. However, from 1995, the same report suggests that total catches rather than catch rates may be a better indicator of the abundance of Bastard Trumpeter which are presumed to be at low levels. Nonetheless, other developments are likely to be implicated in the decline in catches including changes in fisheries management, changing market preferences and the reduced availability of Blue Warehou, which is caught using the same fishing gear (Lyle and Tracey, 2012a). Currently, most Bastard Trumpeter are caught commercially as a by-product of the Banded Morwong and Blue Warehou fisheries.

Historical Accounts of Fish Size

The first identified reference to the average size of Bastard Trumpeter suggested that in 1869, fish sold at the Hobart Fish Market were between 2 and 8lbs (0.9-3.6kg) in weight (*The Mercury*, 5 May 1869). Thirteen years later, a paper published in conjunction with the 1882 Royal Commission report stated "Bastard trumpeter attains a size of about 21 inches and rarely exceeds 6 to 7 lbs weight" (Johnson, 1882). Despite the attempts of the Royal Commission to thoroughly document fisheries of commercial importance, average weights of individuals were not provided for any species except Rock Lobster. Nonetheless, an account provided by a fisher interviewed by the Commissioners suggested that the larger 'whitefish' were becoming scarce relative the smaller 'red bastards' in the south-east of the state owing to overfishing.

The recommendation for a legal-size limit on Bastard Trumpeter by the Royal Commission (and subsequently enactment in 1889) further suggests that, by the 1880s, smaller fish were being brought to market. This assertion is supported by a letter to the editor of *The Mercury* in 1909, complaining that 60% of Bastard Trumpeter at the Hobart Fish Market were only 12 inches long (*The Mercury*, 5 October 1909). This account coincided with a time in which Bastard Trumpeter stocks in the commonly fished waters of the south-east were fast becoming depleted, as discussed above. It appears that larger fish were becoming increasingly difficult to find and small fish were being supplied to markets.

The next reference to Bastard Trumpeter sizes suggests that in 1917, the average weight was 3 lb (1.4 kg). This account was particularly curious as, at the time, catches were beginning to decline from an apparent exhaustion of the commonly fished grounds. While no accounts relating to fish size were provided during the period of fishery expansion to the west coast, it is assumed that average fish sizes increased during this time as fishers worked 'new' waters.

4.2.2 Recreational Fishery

Bastard Trumpeter are a prime target species for recreational gillnet fishers. It appears to be commonly understood that recreational gillnetting has a long-standing historical legacy in Tasmania and it further appears that the practice has its roots embedded in working class traditions of supplementing family food provisions rather than fishing for sport. It is likely that this legacy underpins the relatively high average age of gillnet fishers in modern times compared with that for the general population of recreational fishers in Tasmania (Lyle and Tracey 2012a). Unfortunately, little historical information is available on catch rates of Bastard Trumpeter or other net

caught fish from which the abundance of such species can be inferred for the recreational sector. One possible exception, from the Angling Notes column in *The Mercury* in 1908, describes a catch of Bastard Trumpeter made by a supposed recreational net fisher near Hobart:

> *There used to be good trumpeter fishing near the limekilns till a greedy netsman came along and scooped up twenty dozen. The place has been no good since.* (*The Mercury*, 23 September 1908)

Despite the near absence of historical information on recreational netting catch rates, an assessment of historical commercial catches (above) is likely to provide an indication of recreational catch rates during corresponding periods and regions given that both sectors use similar gear.

State-wide Effort and Catch

Until the 1980s and 1990s, very little was known about broad-scale recreational netting effort or catch, respectively in Tasmania. Studies conducted since then will be briefly summarised. Potential fishing effort before the 1980s may be inferred by changes in gear regulations before then and with reference to Tasmanian population trends presented in Appendix 1.

The recreational fishery for Bastard Trumpeter is almost entirely based on the use of 'graball' nets – a type of gillnet currently defined as having a mesh size between 105 and 140 mm. Until the 1960s, the distinction between the commercial and recreational fishery was not defined by gear type – non-commercial fishers were not restricted in the number and length of graball nets used. In 1966, non-commercial fishers were restricted to the use of two graball nets of 75 m each. In 1974, the net length was reduced to 50 m, though fishers were still allowed to fish with two nets. It was under this state of gear provision that the earliest reliable information on graball net usage was provided: an Australian Bureau of Statistics survey in 1983 estimated that 15,000 people used gillnets at least once a year, 30% of whom fished with graballs at least once a fortnight (ABS, 1984).

A requirement for the licensing of recreational graball nets was introduced in 1995. Another regulation change in 2003 restricted the number of licensed graball nets to one per fisher. Taking into account this change, the total number of licensed graballs has remained around 8000 to 9000 since 1995. Nonetheless, a large proportion of licensed gillnet fishers report little or no gillnetting activity (Lyle and Tracey, 2012a). From the late 1990s, overall gillnetting effort among recreational fishers has fallen from around 43,000 net days to around half that amount in 2010 (Lyle and Tracey, 2012a). This decline in effort is thought to have been largely influenced by the general ban on night netting in 2004.

Four recreational fishing surveys conducted since 1997 have provided annual catch estimates for Bastard Trumpeter (Lyle, 2000; Lyle, 2005; Lyle *et al*., 2009; Lyle and Tracey, 2012a). These surveys have consistently demonstrated that Bastard Trumpeter are amongst the top two target species for recreational gillnet fishers, Blue Warehou also being a highly significant target species (refer Chapter 5). In chronological order, the numbers of Bastard Trumpeter retained by recreational gillnet fishers are estimated to have been around 36,000 (1997), 32,000 (2000/01), 23,000

(2007/08) and 28,000 (2010). For 1997, 2000/01 and 2010, the respective average sizes of retained Bastard Trumpeter were around 0.6, 1.3 and 1.0 kg. The respective minimum legal-sizes for these years (320, 350 and 380 mm) may account for the average size increase between 1997 and 2010, although given the reliance of the fishery on irregular recruitment pulses, average fish sizes at any given time are largely dependent on these events.

Based on the values presented above, the proportion of the total state-wide catch of Bastard Trumpeter attributed to the recreational sector in 1997, 2000/01 and 2010 was 20, 62 and 75%, respectively. The increasing proportions over time are more a reflection of declining commercial catches than expansion in the recreational fishery.

4.3 FISHER INTERVIEWS

Seventeen interviewees provided information on Bastard Trumpeter, 13 of whom still use gillnets. Eight interviewees reported on their involvement in the fishery in both the east and south east regions. One provided information regarding the north east coast. The earliest 'starting time' among fishers interviewed was in the early 1940s and the mean year of commencement was 1957 (Table 4.1).

Table 4.1. Summary of particulars for interviewees

Name	Region 1	Region 2[1]	Started[2]	Finished
Fisher 1	E	Marion Bay	1950	current
Fisher 2	E	Great Oyster Bay	1965	1990
Fisher 3	E	Orford	1955	current
Fisher 4	E	Swansea / Friendly Beaches	1945	current
Fisher 5	E		1960	current
Fisher 6	E	Swansea / Friendly Beaches	1945	current
Fisher 7	E	Coles Bay	1980	2000
Fisher 8	E	Orford	1950	current
Fisher 9	NE		1955	current
Fisher 10	SE	Eaglehawk Neck	1965	current
Fisher 11	SE	D'Entrecasteaux Channel	1945	current
Fisher 12	SE	Southport	1950	current
Fisher 13	SE	Great Taylor Bay	1970	2010
Fisher 14	SE		1940	2000
Fisher 15	SE		1965	current
Fisher 16	SE	Port Arthur	1965	current
Fisher 17	SE		1965	current

[1] Specific locations have been provided only when Bastard Trumpeter fishing pertains to such. If no entry is provided, respondent reported fishing at various locations within Region 1 over the duration of their fishing career.

[2] Starting dates have been rounded off in 5 year increments.

4.3.1 Abundance

Quantitative Interview Data

Measures of abundance were expressed as the estimated average number of Bastard Trumpeter caught per 50 m of net. Reported estimates of trumpeter catches from nets longer or shorter than 50 m were scaled down or up, respectively.

All interviewees reported declining trumpeter catch rates over time though three fishers reported that catches had either remained static or improved since 1995. One fisher reported an increase in catch rate since 2005. Overall however, the magnitude of catch declines over respondent's fishing careers was substantial – from 17.5 fish per 50 m net-set in 1940 to a current average of slightly more than two trumpeter per net-set currently (Fig. 4.3).

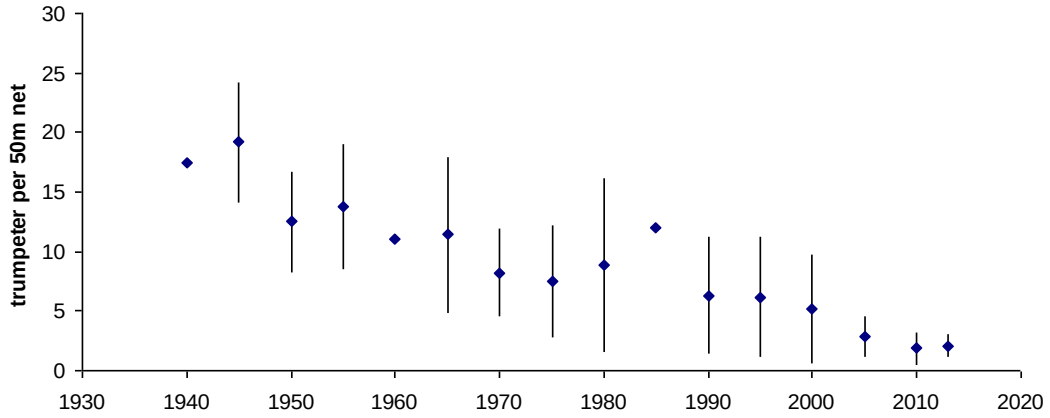

Fig. 4.3. Mean reported average number of legal-sized Bastard Trumpeter (+/- SD) per 50 m net-set, between 1940 and 2013

Fishers were also asked to recall the most Bastard Trumpeter they had ever caught in a single 50 m net-set (again, catch values were standardised for nets longer or shorter than 50 m). This question was generally confidently answered, probably due to the memorable nature of large catches. When plotted on a time series, there appeared to be a slight decrease in the size of largest catches over time, though the 'noise' within the data does not enable this trend to be confidently established (Fig. 4.4).

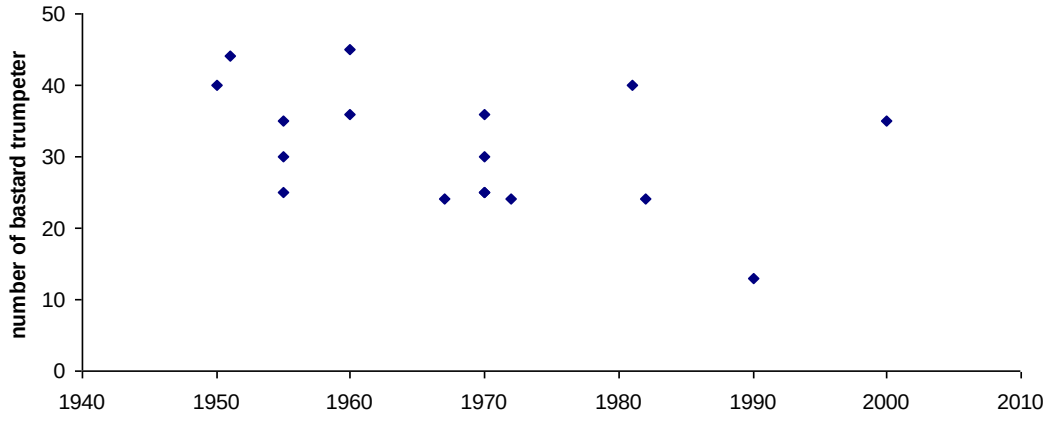

Fig. 4.4. Reported largest catches of Bastard Trumpeter (+/- SD) per 50 m net-set over time

Perhaps more revealing was an assessment of when largest catches were made within the context of an individual's fishing career. To do this, each respondent's fishing career was divided into three time periods of equal lengths representing 'early career', 'mid-career' and 'late career' (Fig. 4.5). The results demonstrate that for 13 of 17 fishers, largest catches of Bastard Trumpeter occurred during the first third of their fishing careers, indicating a general decrease in the abundance of Bastard Trumpeter over time.

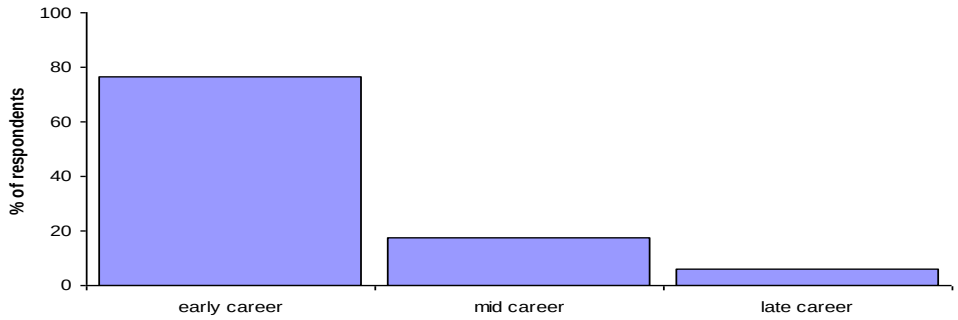

Fig. 4.5. Timing of respondent's largest Bastard Trumpeter catches relative to their fishing career 'stage'

Qualitative accounts of abundance

Comments from fishers regarding the availability of Bastard Trumpeter over time were consistent with the pattern of estimated catch rates, i.e. they suggest a considerable decrease in trumpeter abundance. Some of the older fishers provided anecdotes of very large catches, frequently giving fish away and limiting the length of soak times to avoid catching too many fish. The following two quotes from different fishers described these changes:

> *Back in the day, you would give fish away if you caught too many. If you got too many, you would give them to other fishermen or your neighbours. But now, you don't see that anymore. There's not enough fish to give away, especially when you're pulling empty nets. We never left our nets in for more than an hour or we'd have too many fish, and they'd roll the net up like a rope.*

> *Back in the 40s, 50s, 60s, there was always trumpeter there. There was always trumpeter, it didn't matter what time of the f----n year you'd set nets, you'd get trumpeter. But that's not the case now. It's gradually dwindled, dwindled and dwindled till it's gone. It's gone from getting two or three dozen out of a net to getting down to two dozen, down to a dozen, 6, 4, now you've got a f----n job to get any.*

A few interviewees described how they have had to become increasingly strategic to catch Bastard Trumpeter over recent years, particularly in regard to where they set their nets. This was apparently linked to intensive fishing of accessible areas and kelp loss.

Some fishers suggested that catches of Bastard Trumpeter increased as a result of fishery regulation changes, particularly the reduction in the number of graball nets to one per person in 2003 and the banning of night netting in 2004. However, with the exception of one fisher who reported that higher catches have been maintained since 2003/04, respondents suggested that the effects of more restrictive regulations on catch rates were only temporary. Over the term of interviewee's Bastard Trumpeter fishing experience, there was no apparent consistency regarding the timing of abundance declines, though around half considered the decline to be steady over time.

Some fishers also provided comments about declines in abundance of other reef-dwelling fish over their fishing careers. Fish included Jackass Morwong, Banded Morwong and Long-snouted Boarfish and these may warrant investigation in future studies.

4.3.2 Size

Fishers were asked to estimate the average length of Bastard Trumpeter caught both when they first started fishing and during their most recent fishing season. Twelve fishers indicated a decrease in size over time, four did not notice a change and one fisher thought that recently caught fish were larger than when he first started fishing (in the 1940s). When estimated fish sizes were plotted, a decrease over time was observed since the 1960s (Fig. 4.6). Some fishers indicated that, while the average size of most fish caught had not changed much, captures of the larger 'whitefish' in recent years were becoming increasingly rare. Furthermore, five fishers mentioned that there seemed to be less size variation among caught fish, particularly in the past two decades.

When estimated 'before' and 'after' lengths were aggregated, mean lengths[4] were 409 mm and 373 mm, respectively. After converting to weight, respective 'before' and 'after' weights are 1.29 kg and 0.96 kg.

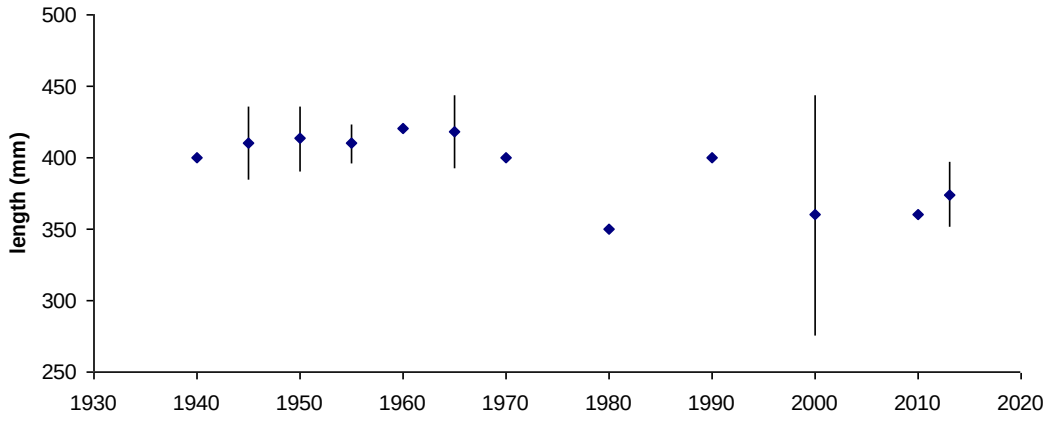

Fig. 4.6. Mean reported length of Bastard Trumpeter (+/- SD), between 1940 and 2013

[4] Total lengths and fork lengths were not differentiated, though total length is assumed

Fishers were also asked to recall the largest Bastard Trumpeter they had ever caught. There was no clear increase or decrease in fish size over time (Fig. 4.7). The timing of these captures was also examined, within the context of individual respondent's fishing careers. Accordingly, only two fishers reported catching their largest ever fish during the latter third 'chapter' of their fishing careers to date (Fig. 4.8).

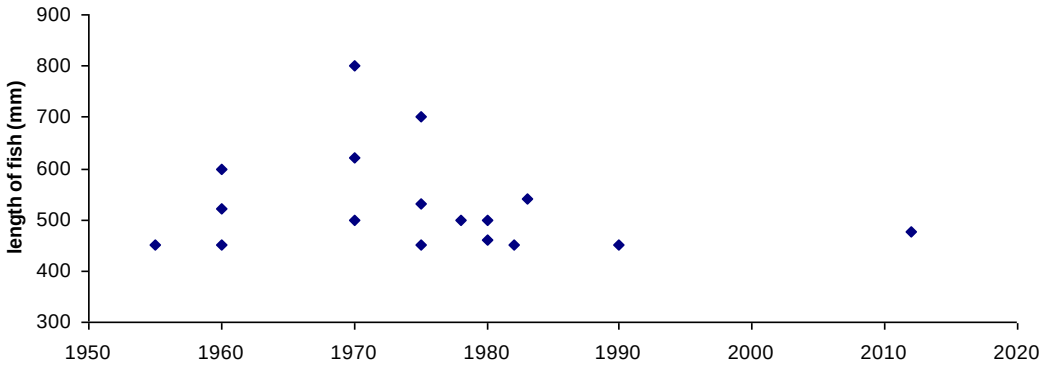

Fig. 4.7. Largest individual Bastard Trumpeter caught over the fishing careers of respondents

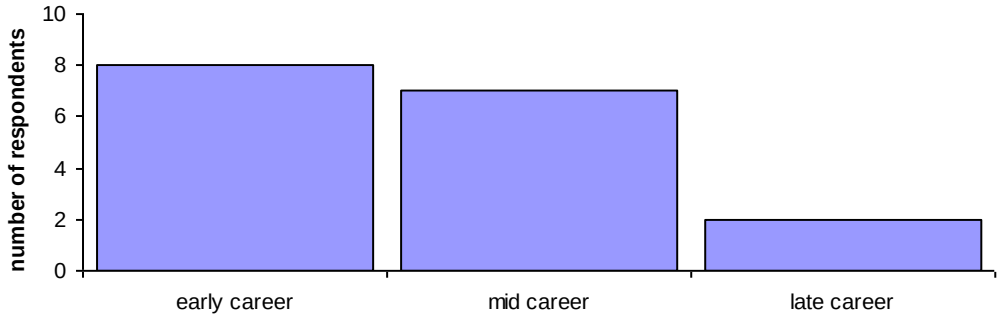

Fig. 4.8. Timing of the capture of respondent's largest Bastard Trumpeter relative to fishing career 'stage'

4.3.3 Fisher Behaviour

Fishers were asked to estimate the average distance range they would normally travel on the water in order to set their nets; both when they commenced fishing and in their most recent year of fishing. As distance ranges rather than point estimates were provided by fishers, the data were analysed according to both the lower and upper values in the ranges. These points represent minimum and maximum distances, respectively.

Overall, the data indicate a trend of increasing minimum and maximum distances travelled on the water over the period surveyed (Fig. 4.9). This trend is most apparent for maximum distances. The average on water travel range for when fishers commenced fishing was 0.3 to 1.6 km. Thirteen fishers commenced fishing from the shoreline, in which case their minimum value was 0km. In their most recent fishing season, the average distance range of respondents was reported as being between 2.4 and 6.3 km. The results are likely due to the combined effects of having greater access

to more powerful vessels and a decrease in Bastard Trumpeter abundance in more accessible areas.

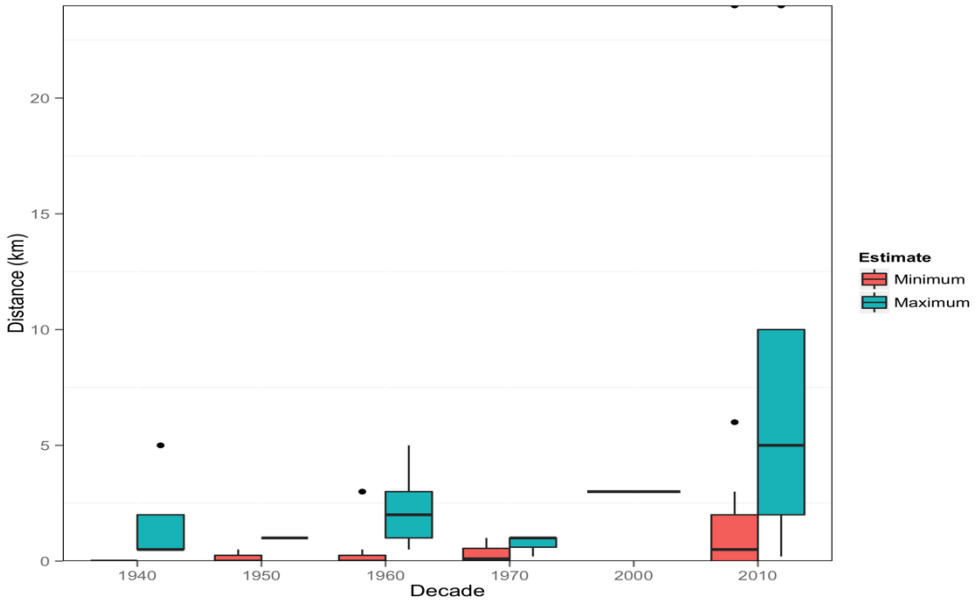

Fig. 4.9. Estimated maximum and minimum distances travelled on the water to go Bastard Trumpeter fishing over time (box and whisker plots shown). The upper and lower "hinges" within each box correspond to the first and third quartiles (the 25th and 75th percentiles). The upper and lower whiskers extend from the hinge to the highest and lowest values within 1.5* the distance between the first and third quartiles, respectively. Data points beyond the end of the whiskers are outliers.

4.4 DISCUSSION

This synthesis suggests that since British settlement of Tasmania, intensive fishing activity has resulted in a series of localised depletions starting with the shallow reefs closest to Hobart. Since the latter half of the 19th century, serial depletions of areas closest to population centres, fuelled by the popularity of the fish among consumers, led to considerably reduced catches on the commonly fished reefs of the south-east, east and north coasts. By the early 1900s, this widespread depletion resulted in fewer numbers of progressively smaller fish being brought to market despite boats working out further within their operating ranges. By 1918, only 3 tonnes of Bastard Trumpeter were sold at the Hobart Fish Market – a large decline from an average of 54 tonnes in the preceding 15 years.

From the 1920s, catches again rose due to the apparent impacts of an expansion of the fishery into largely unfished grounds, particularly off the west and south-west coasts, and improvements in fishing vessel capacity. Natural changes in recruitment may also have been implicated. As a result, over 100 tonnes of Bastard Trumpeter were landed, on average, each year during the 1930s. From the 1940s to the mid-1980s, however, catches followed a downward trend despite a large increase in the number of scale-fishing boats and numerous technological advancements pertaining to transit times, refrigeration and communications. During the 1960s and 1970s, catches averaged 12 tonnes per year and the abundance of legal-sized Bastard Trumpeter appeared to have been substantially reduced. Abundance and catches rose from the mid-1980s, presumably due to high recruitment then declined from the mid-1990s.

Since 2000, the species has become less targeted by commercial fishers with catches falling from 28 to 8 tonnes per year. The recreational fishery now accounts for the majority of the state-wide catch of the species.

The general consensus among fishers interviewed for this study was that, over time in the south-east and east regions, fishers caught fewer and smaller fish whilst travelling further distances to catch them. Between 1940 and the present day, the average estimated number of Bastard Trumpeter caught in a 50 m net-set dropped from 18 to two fish. Providing support for these estimations, memorable large catches were mostly made during fishers 'early years' and fishers nostalgically recounted times when net soak times had to be minimised to avoid catching too many fish. As for fish sizes, the reported weight of individual fish decreased by about 25% between when fishers commenced fishing and their most recent fishing season. Furthermore, a recurring observation among interviewees was the gradual decline over time in the numbers of the larger 'whitefish' relative to the smaller 'redfish', and progressively less variation in Bastard Trumpeter sizes.

The scarcity of Bastard Trumpeter has provoked concern from industry and recreational fishing representatives in recent years (Hartmann and Lyle, 2011) and is likely due to fishing pressure coupled with prolonged poor recent recruitment. The status of the stock is uncertain and no biomass estimates are available. However, insights into former stock abundance may be gained by examining historical accounts of catch and effort. The information presented in this report suggests that current Bastard Trumpeter stocks are a fraction of prior abundances. To use 1888 catches as an example, approximately 42 tonnes of fish were caught from a small number of sailboats equipped with low numbers of short nets that were fished within an area where Bastard Trumpeter were considered to be depleted from decades of fishing. In 1932, the second highest annual catch on record, it appears that the estimated 174 tonnes of fish caught were largely done so by fishing the west and south-west coasts.

Bastard Trumpeter fishing effort has been considerably reduced for the commercial fishery since the mid-1990s and since at least 2003 for the recreational fishery. This however, has not necessarily translated to increased fish abundances as inferred from commercial and recreational catches, interview data provided in this study and a recent assessment of Tasmania's rocky reef faunal communities (Stuart-Smith *et al*., 2008). While the availability of Bastard Trumpeter is dependent on highly variable recruitment pulses, the success of these events is clearly dependent on a sufficient number of fish growing to a reproductive age. It follows that the degree of inter-annual recruitment variability will increase with a lower biomass of reproductively viable fish. Although recent declines in fishing effort may well have reduced the pressure on the stocks of Bastard Trumpeter, there is considerable capacity in both recreational and commercial sectors for increased effort should fish become more available. This relationship between fishing success and effort is particularly likely for fishing activities of a primarily consumptive nature such as recreational netting.

5 BLUE WAREHOU

5.1 INTRODUCTION

Blue Warehou (*Seriolella brama*) occur seasonally in Tasmanian inshore waters where they have historically provided important commercial and recreational fisheries. Their occurrence in waters off Tasmania, the southernmost extent of the species, is characterised by considerable inter-annual variability. This is thought to be due to prevailing oceanographic conditions and the availability of pelagic tunicates, the main prey species of adult fish (Bulman *et al*., 2001).

The Blue Warehou fishery is managed by the Commonwealth and a Memorandum of Understanding is in place to cover Tasmanian state waters, with State catches managed within historic levels. The fishery in south-eastern Australia is thought to comprise two distinct stocks, delineated by Bass Strait (Bruce *et al*., 2001). It is likely that fish caught on Tasmania's east coast represent the eastern stock whilst fish caught on Tasmania's west and north-west coasts are from the western stock. Since the early 2000s, catches from the east and south-east coasts have dominated Tasmanian commercial catches (Hartmann and Lyle, 2011).

Trawling is the main capture method in Commonwealth waters, whereas in Tasmania almost all catches (commercial and recreational) are made using gillnets, with line fishing accounting for small quantities. Over recent years, Blue Warehou stocks have faced considerable sustainability challenges. After record high catches in the 1980s and 1990s, both catches and CPUE declined precipitously. This had led to significant quota reductions and the Commonwealth fishery is now classified as overfished as biomass indicators for both stocks remain lower than limit reference points. At this point, the ability of reduced quota to enable stock rebuilding is uncertain (Woodhams *et al*., 2012).

In Tasmania, commercial catches of Blue Warehou date back to the first records of fish sales for the fledgling Hobart colony. The species was also one of the first to be exported to Victoria, before the turn of the 19th century. As a recreational fish species, Blue Warehou (often referred to as "snotty trevally" or "snotties" by fishers) have long been popular among both net fishers and more recently anglers and are generally caught in inshore coastal and estuarine waters. They have a reputation for being dogged fighters when hooked and excellent table fare. As such, seasonal "snotty runs" attract many recreational fishers, usually on the north-west and south-east coasts. However, the pattern of decline observed for the commercial fishery has had corresponding impacts for the recreational fishery. While Blue Warehou represented 26% of the retained recreational gillnet catch (by numbers) in 1997, catch proportions in 2000/01, 2007/08 and 2010 were 7%, 12%, and 20% respectively (Lyle and Tracey, 2012a).

5.2 HISTORICAL RESEARCH

The first reference to Blue Warehou in a Tasmanian newspaper (*The Mercury,* 20 September 1869) alludes to high inter-annual variability in their availability – a theme that pervades accounts of this species in Tasmanian waters to the present day. Little information on the species appears to have been published until the Report of the Royal Commission on Fisheries in 1882 (Tasmania, Parliament, 1882). The following passage of the report provides information relating to availability, size, seasonality and mode of capture.

> *The snotgall trevalley (*Neptonemus brama*), although inferior in quality to the silver and mackerel trevalley, from its greater abundance and size is of much greater importance as regards the general market supply. The young enter the upper waters of the Derwent, and are caught by rod and line from the jetties and wharves about Hobart in considerable numbers during the months of March and April. The snotgall is better flavoured when it is under one pound in weight. The larger individuals are coarser, and are found toward the mouths of estuaries in deep water. They are frequently found from two to two foot six inches long, and at this size would average 12 to 14 pounds in weight. They are caught with hook and line, without a sinker, and are thus caught sometimes in very large quantities.*

Transcripts of interviews conducted for the Royal Commission further suggest that, in southern Tasmania, larger Blue Warehou were once prevalent around Wedge Island, but by 1882 the bulk of catches were made at the Hippolytes and the Pillar, on the south-east coast. Sporadic schools of much smaller fish provided sport for recreational fishers in the Derwent estuary. Two interviewees also noted that schools of Blue Warehou were generally associated with swarms of planktonic crustaceans referred to as "brit", which along with Blue Warehou occurred on an irregular basis. Some reports also suggest that, when Blue Warehou were abundant, so too were other schooling species such as Jack Mackerel, Mullet and Barracouta. A recreational angler interviewed for the Royal Commission boasted catching 29 dozen (348) fish – a mixture of Blue Warehou, Mullet and Jack Mackerel – in one session with a fishing companion from a wharf in Hobart.

While fish up to 6.3 kg were reported in the south-east, larger fish did not appear to frequent northern waters that were fished at the time. One Royal Commission interviewee observed that, in the Tamar estuary, schools of Blue Warehou were inter-annually inconsistent and the size of individual fish averaged between 0.25 and 0.5 kg. An article in *The Launceston Examiner* (26 June 1889) published a few years later concurred with the observations about the size of Blue Warehou caught from the Tamar by stating "the winter bream (or snotgall), which attains several pounds in weight in southern waters, is represented here by specimens two or three ounces in weight".

At the time, most fishing to provide seafood for Launceston and surrounding districts occurred either in the Tamar estuary or within a short distance from Tamar Heads owing to the limitations of the fishing boats. However, boats of an increased size and capacity, and road and rail developments, soon enabled fishing operations to spread along the north coast where Blue Warehou also gained popularity as a recreational

fishing species. The following quote appeared in a regular angling report in *The Launceston Examiner* (27 April, 1897):

> *Several large trevalley are being caught nearly every day. One landed weighed 12 lb; two others turned the scale at 9 lb and several others weight over 7 lb. The fish are very game and are great sport. It requires good tackle and some skill to land a large trevalley, as they fight hard, and having a delicate mouth require careful playing.*

From the 1870s, Blue Warehou, along with Southern Rock Lobster, Barracouta, Gemfish and Jackass Morwong were species commonly exported to Melbourne "where the larger fish appear to be in greater favour than in the local market" (Johnson, 1882). In an unpublished scale of the eating qualities of Tasmanian fish produced for the Royal Commission, Blue Warehou were rated "class 3" on a descending scale from 1 to 4. However, the inconsistency of supply affected both export and local markets. Newspaper articles and reports from the Commissioners of Fisheries provide numerous accounts of the irregular occurrence of Blue Warehou in Tasmanian waters from the 1890s to the 1940s. Three articles reported on the great abundance of fish from 1894 to 1897. In one article, the idea of developing a canning industry based on Blue Warehou was flagged by the Hobart Unemployed Committee to provide local jobs and to address the problem of market oversupply of seasonal schooling fish (*The Mercury*, 2 November 1894). According to the article, there were "thousands of tonnes of trevalley" schooling near Port Arthur. Interestingly, an article in *The Clipper* (18 December 1897) reported numerous large Blue Warehou being caught in the Derwent River and from the Sorell Causeway – unusual locations for large specimens of the species.

From 1914 to 1921 however, there were numerous references to the scarcity of Blue Warehou, at a time for which many Tasmanian fish species were reportedly scarce. *The Mercury* (20 July 1914) reported:

> *The kingfish and the trevalley are not to be got now …. The trevalley used to work down the east coast from the north, beginning after Easter, and continuing into the winter, but they do not come now.*

The scarcity was also discussed in the 1914/15 Report of the Commissioners of Fisheries (Tasmania Parliament, 1915), though they noted a gradual recovery in Blue Warehou captures:

> *It will be noticed from the Hobart market returns that a slight recovery has taken place in the supply of trevalley. For some years previously, a slight falling-off took place which was a matter of considerable concern to our fishermen, as trevalley used to be so abundant every season on the east coast that, together with real trumpeter, barracouta and crayfish they made up our chief exports. The theory advanced by our fishermen to account for their gradual disappearance was that the use of immense seine nets in Bass Straits, by fishing vessels from Victoria, had driven away fish from our coasts. Whether this be true reason or not, it is well known that trevalley have disappeared in Victoria from netted waters, and their gradual recovery*

> *here now coincides with the going out of business of the Victorian vessels which carried the nets mentioned.*

The recovery mentioned by the Commissioners was also reflected in the sales of Blue Warehou at the Hobart Fish Market for 1913 (Tasmania Parliament, 1913), which had more than doubled from the previous year (Fig. 5.1). However, sales for 1913 were still considerably less than the sales between 1907 and 1909. The overall pattern of depressed Blue Warehou sales (and by inference, abundance) continued until 1922 in southern Tasmania, and for the years 1917 to 1919 catches were either non-existent or negligible. The 1919 annual report of the Commissioners of Fisheries reported "mackerel and trevalley, once numerous, now seem to have almost disappeared from our waters".

While one newspaper article supported the theory that Victorian fishers were to blame (*The Mercury*, 20 July 1917), others suggested that predatory fish such as barracouta (*The Mercury*, 22 May 1915) or seals (*The Launceston Examiner*, 18 August 1915) were responsible. Of the latter, the Northern Tasmania Association implored the Commissioners of Fisheries, by means of a petition, to eradicate seals around Barren Joey Island off Tamar Heads as each year they reportedly "consumed tons of fish, worth thousands of pounds in value". The petition was dismissed by the Commissioners (Tasmania Parliament, 1921).

From 1925, state-wide catches of all commercially targeted species were reported more accurately. Between 1925 and 1977, inter-annual catches remained highly variable and fluctuated between 1 and 30 tonnes per year. Newspaper articles commenting on both the abundance (*The Mercury*, 23 May 1934) and scarcity (*The Mercury*, 15 September 1941) of Blue Warehou over this period suggest that catch variability was due to the fluctuating occurrences of the species in Tasmanian waters. Catch statistics from 1941/42, which reported catches by number and total weights, suggest an average weight of 0.96 kg (Tasmania Parliament, 1942).

From 1978 to 1989, catches rose to an average of 40 tonnes per year with a peak of 118 tonnes in 1987. At that time, the fishery biomass was considered to approximate a near virgin state (Bruce *et al*., 2002). During the 1990s, reported catches in Tasmania increased dramatically with an annual average of 208 tonnes and a peak of 275 tonnes in 1998. Catches for the whole fishery (including Commonwealth waters and waters off NSW and Victoria) followed a similar trajectory as landings in 1990 and 1991 eclipsed 2000 tonnes. From 2000 however, catches fell as sharply as they rose ten years earlier and since 2003, the average Tasmanian commercial catch has been around 20 tonnes. The dramatic decline prompted an equally dramatic quota reduction for the Commonwealth managed fishery, from a total fishery quota of over 2000 tonnes in the late 1990s, the quota for 2013/14 has been set at 118 tonnes – all of which must come from non-targeted catches. The 2012 Tasmanian commercial catch was only 2.3 tonnes and appears to be affected by the low abundance.

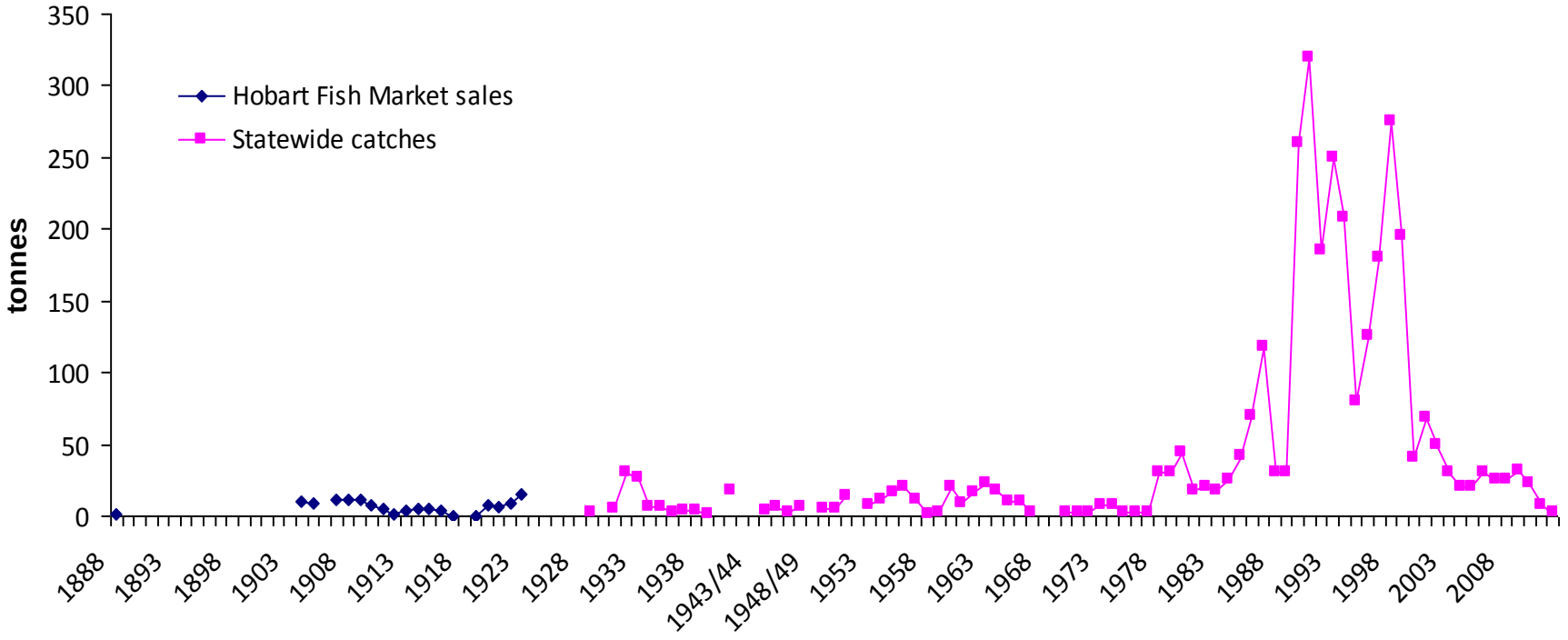

Fig. 5.1. History of Blue Warehou commercial catches in Tasmania since 1888. Hobart Fish Market data (1904-1923) also includes volume sold at the Launceston Fish Market from 1919 to 1923. Fish exports prior to 1929 are not shown.

5.3 FISHER INTERVIEWS

Ten interviewees provided information on Blue Warehou (south-east – 4: north-east – 2: Macquarie Harbour – 2: east coast – 1: north-west – 1). All ten fishers targeted the species with gillnets, though only five continue to do so at locations consistent with earlier efforts. Of the five whom no longer actively target Blue Warehou at such locations, two have continued gillnetting elsewhere in Tasmania, one still targets the species as an angler, one has discontinued gillnetting due to poor catches and one has discontinued fishing altogether due to poor health. The earliest 'starting time' among fishers interviewed was in the early 1950s and the mean year of commencement was 1966. An additional three interviewees provided qualitative information on Blue Warehou, and this information has also been used. In such cases, information was provided incidentally during discussions about gillnetting for Bastard Trumpeter.

5.3.1 Abundance

Quantitative Interview Data

Measures of abundance were expressed as the estimated average number of Blue Warehou caught per 50 m net-set. Reported catch estimates from nets longer or shorter than 50 m have been scaled down or up, respectively.

Seven interviewees reported declining Blue Warehou catch rates over time while three fishers who discontinued fishing by 1990 or earlier reported static catch rates until their discontinuation. Overall, the magnitude of catch declines over respondent's fishing careers was substantial. Catches between 1950 and 1985 were similar and ranged between 15 and 21 fish per targeted net-set while the current reported average was less than one fish per net-set (Fig. 5.2). A gradual increase in catch rates from the 1965 to 1985 is apparent, followed by a sharp decline in the 1990s to very low levels by 2000.

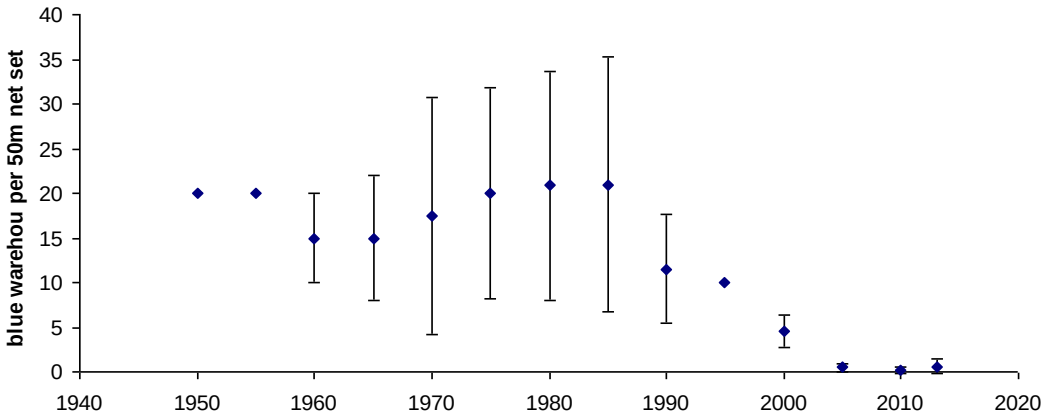

Fig. 5.2. Reported average number of Blue Warehou (+/- SD) per 50 m net-set, from 1950 to 2013.

Qualitative Accounts of Abundance

Due to the low number of respondents, qualitative accounts of abundance may provide additional insights into the availability of Blue Warehou stocks to recreational fishers since 1950. Regardless of region from which reports were based, there was a general consensus that the fish were more abundant at particular times of the year but in recent years they had become increasingly inconsistent and, when found, tended to be caught in lower numbers. While some fishers acknowledged that the ban on night netting had adversely affected catch rates of Blue Warehou, most said that they were still able to fish at the optimal times by setting nets around dawn and dusk. The following series of quotes from different interviewees epitomises reports provided during the study:

> *At the right time of the year, they were just constant. Then suddenly they got much fewer and quite small. We used to put a net in off Half Moon (Bay)…..and if you set it in the right place and you can tell when snotties are running, its full moon and there's all this crap in the water, slimy stuff that they eat. And we'd set that, and we'd have a net full, absolutely chockers of big snotties.*

> *One of the huge things in the 40s, 50s, and 60s, would be the snotty trevally runs. One of the things I can remember as a kid was being down at the Burnie Wharf when the snotty trevally were running. The wharf, Jones Pier, would not be more than 100m long, and there would not be more than half a metre between rods – there would be just rod after rod over the edge waiting for the run. The funny part was that the snotties would run in sequences, they'd run for half an hour then they would run again. So guys would put their rod over the wharf and you would see the run coming, then rods would be going over the wharf……I haven't really caught snotty trevally like that since them days.*

> *At the time, I didn't really realise that there was fewer of them, I just thought I was setting the nets in the wrong area. It wasn't until the 90s or so that I realised there wasn't many left. I just thought that I was fishing the wrong spot till I realised that every spot was the wrong spot.*

While for some regions, dramatically reduced numbers of Blue Warehou were reported in more recent years, three avid fishers suggested that the species had become completely absent from regions where they were formerly seasonally abundant –Macquarie Harbour, Southport and D'Entrecasteaux Channel. Of the latter, one recreational and ex-commercial netter provided the following:

> *This is how good it was….when my children were 7 or 8 years of age* [approx.. 50 years ago], *they would go and fill 2 or 3 bins up off the wharf at Woodbridge, snotty trevalley. They would catch loads of them in the wintertime. I never seen them since. I don't know what's happened to them, whether they were caught up and don't now get here…..its been 50 years since I've seen them in the Channel. For some reason they have disappeared from the Channel. Had they been around, I would have netted them. Back then we got bins full of them. We could have got a tonne if we wanted to.*

Numerous stories were recounted about the vast numbers of Blue Warehou caught in nets at particular times of the year. Some fishers mentioned that, when they knew the fish were around in large numbers, they would only leave their nets in the water for a short period to avoid catching too many.

> *We used to catch up to 10 dozen in 2 nets. We'd fill 2 garbage bins just setting one net for a couple of hours in places like Long Bay or up here in Carnarvon Bay….we'd get nets full of 'em. We used to have to give them away, you'd get too many. Most of them would be dead in the net 'cos you'd have the net in overnight. Sometimes we only put the net in for a couple of hours. And I've caught them way down to Remarkable Cave. I've been there in the boat and seem them in the water. We'd just chuck the net in and in about half an hour you'd have 40 or 50. Never seen that these days, never ever.*

Respondents were asked to comment on the period of time in which the greatest declines in Blue Warehou numbers were observed. However, the question was not asked of three fishers as, during their time of involvement with a particular fishing location (1970-1990), they reported steady catch rates. Of the seven fishers that were 'qualified' to respond, the times are as follows: around 2000 (3); 1980 (1); late 1990's (1); mid-1980's (1); and "not sure" (1).

Interviewees were also asked to recount their largest catches of Blue Warehou from a single net-set. Only three respondents were able to provide a definitive figure due to the high number of large hauls made and even then, the figures provided were approximations. Typically, respondents reported that, during times of high fish abundance, fish were not counted, though on numerous occasions they were thought to exceed 100 fish.

5.4 DISCUSSION

Unlike some species investigated in this study, fishing activities by Tasmanians did not appear to have significant impacts on the stock size of Blue Warehou until relatively recently. This is largely owing to the ecological characteristics of the species. As a schooling fish with a wide depth range, fishing methods used before the widespread use of deep water trawlers and offshore netting in Commonwealth waters accounted for relatively small catches. It is further likely that the characteristic inter-annual variability and unpredictability of the species in Tasmanian coastal waters would have made targeting them difficult, particularly before more recent advances enabled the stock to be better understood and schools targeted more effectively. The fishery is currently classified as overfished and the ability of quota reductions to rebuild stocks remains uncertain (Woodhams *et al*., 2012).

The low number of interviewees and the high degree of inter-annual variability in stock available to recreational fishers invokes caution when interpreting recalled CPUE data for this species. In this case, inferences to coarse-scale trends provided through qualitative data may be more instructive. Nonetheless, the general consensus from both qualitative and quantitative information provided through interviews pertaining to abundance trends were largely consistent with the prevailing understanding of relatively recent changes in the broader fishery. The assertion by

Bruce *et al* (2002) that total fishery biomass approximated a near virgin state in the mid-1980s accorded with fishers recollections of catch rates – overall, respondent's catch rates remained somewhat static between 1950 and 1985 and declined sharply thereafter.

Prior to the introduction of large-scale commercial fishing for Blue Warehou during the 1980s, this species appears to have provided excellent fishing opportunities for Tasmanian recreational fishers over periods of time that were characterised by declines in abundance of other target species. Notwithstanding the unpredictable availability of the species in Tasmanian waters, the quality of recreational fishing up to the mid-1980s may have been roughly comparable to fishing 100 years earlier. Relative to other gillnet target species such as Bastard Trumpeter, and Long-snouted Boarfish, the life history characteristics of Blue Warehou also afforded fishers large catches without the same degree of population level impacts on residential species. Unfortunately, poor catch rates in recent years have the potential for decreasing satisfaction values of recreational fishers which are underpinned by the reasonable likelihood of catching fish (Arlinghaus, 2006; Beardmore *et al*., 2011). Recent declines in gillnetting participation may reflect this but are also likely affected by activity restrictions imposed since the early 2000s, especially the ban on night netting. A further potential consequence is 'species-shifting' whereby the absence of one species transfers fishing pressure to other species: possible candidate species include Bastard Trumpeter and escapee Atlantic Salmon (Lyle and Tracey, 2012a). Also, due to the presumed existence of two separate Blue Warehou stocks, additional fisher interviews could provide more detailed information on the relative impacts of abundance declines on both the east and west coasts of Tasmania.

6 GREENBACK FLOUNDER

6.1 INTRODUCTION

Twelve species of flounder are found in Tasmanian waters, though the only species of commercial and recreational significance are the Greenback Flounder (*Rhombosolea taparinia*) and the Long-snouted Flounder (*Ammotretis rostratus*). While the species are not distinguished in commercial catch returns, Greenback Flounder are understood to comprise the bulk of catches. As for the recreational fishery, creel surveys undertaken in 1997/98 (Lyle and Campbell, 1999) showed that Greenback Flounder represented almost 99% of total flounder catch numbers.

Greenback Flounder inhabit waters from southern Western Australia to southern New South Wales and are also found in New Zealand (Last *et al*., 1983). They inhabit shallow inshore and estuarine waters and feed by digging for polychaete worms and small crustaceans in sandy and muddy substrates. Spawning occurs offshore in water depths of around 20 m during times of extended colder water temperatures in June-October (Crawford, 1984). Greenback Flounder can reach a maximum size of around 40 cm (0.6 kg) at 3-4 years of age (Last *et al*., 1993). However, the average size of flounder caught in Tasmania by recreational fishers tends to be around 27 cm and 0.3 kg (Lyle and Campbell, 1999).

Flounder were one of the first species to have been exploited commercially in Tasmania owing to the close proximity of productive flounder fishing grounds to Hobart and Launceston. While early catches were primarily made using seine nets, the majority of commercial catches are now taken by hand spear, followed by gillnets. Flounder spearing is undertaken using lights at night in shallow inshore or estuarine waters, either by wading or from a boat. While historical state-wide flounder catches have been as high as 45 tonnes, commercial catches have declined sharply from 33 tonnes in 1995 to 3 tonnes in 2012.

Spearing is also the most common method of catching flounder among recreational fishers although some fishers target flounder using large mesh gillnets. As a recreational fishing activity, flounder spearing gained popularity in Tasmania in the early 1900s. From the most recent assessment of recreational fishing in Tasmania, spearing accounted for 93% of the flounder numbers caught in 2007/08 (Lyle *et al*., 2009). Prior to the cessation of overnight gillnetting in 2004, net-caught flounder comprised around 15% of the recreational gillnet catch by number of fish harvested. Available data suggests that the bulk of flounder catches have historically been made by the commercial sector. However, the recreational sector currently has a larger impact on flounder stocks due to the recent declines in commercial catches. In 2007/08, recreational fishers accounted for approximately 56% of state-wide catches (Lyle *et al*., 2009), and that proportion is likely to have increased since then as commercial catches have continued to fall. It is further estimated that over 80% of recreational flounder catches in Tasmania are made in the south-east, particularly around the South Arm, Pittwater and Frederick Henry Bay areas (Lyle *et al*., 2009).

6.2 HISTORICAL RESEARCH

6.2.1 The Early Explorers

Seine netting on shallow sandy beaches was a fishing method commonly practised by early explorers. As such, flounder feature prominently in early descriptions of fish caught. There are at least eight instances where flounder are either alluded to or referred to directly in journals of early explorers' travels to Tasmania. While it is not the intention to provide a detailed historical narrative in this report, journal accounts are presented below in chronological order with sufficient narrative to provide context.

The first reference to flounder caught in Tasmanian waters was during the French expedition led by Marc-Joseph Marion du Fresne in 1772. Whilst anchored off the inside of Maria Island, numerous attempts were made to catch fish, with varying degrees of success. The following quote, which has been translated by Edward Duyker (1992), refers to a fishing effort in which flounder were apparently caught:

> *The middle of the lake is nothing more than a sandbank on which the smallest boat would ground at high tide. We collected a good catch of shellfish and flatfish.*

The second reference was made by William Anderson, the ship's surgeon on James Cook's 1777 voyage on the *HMS Resolution*. After a five day anchorage at Adventure Bay, Anderson summarised the fish caught over the period. The following quote has been extracted from a detailed summary:

> *Several large rays, nurses and small leather jackets were caught and a few soles and flounders.* (Cook *et al*., 1821)

A year later, the *HMS Bounty*, captained by William Bligh was also anchored off Adventure Bay. The results of a seine netting operation are described as follows:

> *We had very little success in hauling the seine; about twenty small flounders, and flat headed fish called foxes were all that were taken.* (Bligh, 2005)

In 1792, two French ships, commanded by Joseph-Antoine Bruni d'Entrecasteaux anchored within the sheltered waters of Recherche Bay. In summarising his observations of the local fish supply, d'Auribeau, one of the ship's captains, wrote:

> *When the duties on board allowed us to send a boat with the seine outside the basin and close to the bay in the south-west, it always returned with a very large catch which included many different species. The majority, however, were plaice or a species of sole, sea crayfish, conger eels and so on.* (Plomey *et al*., 1993)

D'Auribeau's fellow captain, Jean Michael Huon de Kermadec, also made detailed notes on the catches made by his crew at Recherche Bay:

> *Above all, we caught many small cod in the bay, a species of mackerel whose flesh I thought even more delicate, elephant fish, scads, large mullet, trout, rays, small soles, excellent crayfish and others.* (Plomey *et al*., 1993)

In 1802, a year before Hobart was first settled by the British, two French vessels commandeered by Nicholas Baudin spent two months exploring south east Tasmania. During their stay, three references to flounder were made relating to catches using seine nets. As to flounder abundance, the most informative of these was made by the naturalist Francois Peron, who commented on the small number of flounder caught near Maria Island after spending time anchored in the D'Entrecasteaux Channel:

> *The genus of rays and that of pleuronects, whose species were so numerous in the Channel, seem excessively rare here. The reason for this is simple: two genera equally fond of soft muddy bottoms could not be on rocks or a bottom bristling with shellfish.* (Peron, 1809)

6.2.2 1803 to 1887

Flounder, most probably Greenback Flounder was an important source of seafood for the fledgling colonies of Hobart and Launceston. The susceptibility of flounder to fishing methods used at the time, principally seine netting, coupled with the close proximity of fishing grounds to both colonies meant that the species was a staple food item. Furthermore, unlike many fish species that frequented fishing grounds on a seasonal basis, flounder were available all year round. However, due to intensive fishing effort in the Derwent and Tamar Rivers, there were widespread reports of abundance declines, particularly in the latter half of the 19th century. The fact that a large proportion of fish to supply Hobart were caught in the Derwent, and almost all locally caught fish used to supply Launceston were caught in the Tamar, made this an issue of particular concern. The earliest published report of this nature was in the Hobart newspaper *The Colonial Times* in 1849 (30 January) which reported "rock cod and guard fish are scarce, but flounders particularly so". At around the same time, overfishing of the Tamar estuary also had apparent impacts on the availability and size of flounder. The Launceston newspaper of the time, *The Cornwall Chronicle* (10 March 1849) reported "today we understand there was scarcely any of the finny tribe for disposal, except small flounders as big as your finger."

Fifteen years later, the newly appointed Salmon Commissioners, who were responsible for fisheries management in Tasmania at the time, closed the Derwent to seine netting upstream from Hobart under powers vested under the *Salmon Act* 1865. Despite vocal opposition from some local fishers, this measure was implemented amid concerns that smolts of the newly introduced Atlantic salmon may be caught whilst migrating to and from coastal waters coupled with concerns about diminishing supplies of fish in the Derwent estuary. Of the latter, it was recognised that that the Derwent estuary was an important nursery for young fish and declines in the number of marketable fish were linked to intensive seining operations, many of which were performed from the shore. The impacts of seine netting on juvenile fish were apparent from piles of dead juvenile fish left along the shoreline after fishers emptied their nets and removed the larger fish for sale. However, it was also assumed that fish eggs adhered to the substrate, in which case they were also likely to be destroyed by the seine net. In a paper describing the impacts of the river closure by one of the Salmon

Commissioners (Allport, 1869), populations of numerous fish species were thought to have responded well to the measure. Of these, flounder were seen to be the most valuable. In the same paper, the abundance of flounder near Hobart around 1830 was recalled:

> *Forty years ago, the bays near Hobart Town swarmed with fish during the summer months, and flounders and soles could be caught in any quantity on all the beaches at Sandy Bay.*

In 1870, the Launceston Council discussed concerns over the impact of intensive seine-net fishing on flounder stocks in the Tamar estuary (*The Cornwall Chronicle,* 9 March 1870). Of particular concern was the sale of progressively smaller flounder and in progressively lower numbers. To address this, the implications of imposing size limits and the closure of areas of the Tamar to seine netting were discussed and referred to the Parliamentary Committee. The Committee, in considering the proposed bill, described its urgency as follows:

> *Whereas great destruction and waste of the fish called the flounder is occasioned by reason of such fish being caught and taken from the River Tamar and elsewhere by nets and otherwise, and sold and disposed of before they are of sufficient growth or age, to the danger of the extirpation of such fish.* (*The Cornwall Chronicle,* 27 August 1870)

Later that year, the *Flounders Protection Act* 1870 was enacted to prohibit the sale of flounder less than 9 inches (*The Cornwall Chronicle*, 14 October 1870). However, netting closures of areas within the estuary were not implemented. The size restrictions were immediately unpopular among fishers, who were yet to expand their fishing operations beyond the Tamar Heads. Three years later, Tamar fishers lobbied to reduce the size limit of flounder to 8 inches to improve catches, which had reportedly not improved. They argued that only small flounder were present in the Tamar as the larger ones migrated seaward. As such, they argued the size restriction was unreasonable and was depriving fishers of earning a liveable income:

> *At present they cannot make a living, as sometimes two men work all night with boat and nets and only catch about two dozen flounders of the authorised size.* (*The Cornwall Chronicle,* 1 December 1873)

Despite their lobbying efforts, the size restriction remained unchanged. However, it appears that the legislation was poorly enforced and undersized fish were routinely sold in Launceston and surrounding areas. The lack of enforcement coupled with the continued use of seine nets further depleted flounder stocks in the Tamar. Nine years later, an article in *The Launceston Examiner* (21 December, 1882) brought the matter to public attention and signalled renewed efforts of the police to pursue the legislation more effectively:

> *Perhaps there is scarcely a householder in Launceston who could not testify that small flounders – mere dabs, four or five inches long – have been habitually and boldly-taken to his door for sale. From time to time attention has been called to the fact through the press, but only within the last few weeks have the police taken the matter in hand; and hence the outcry. When*

> *it becomes understood that the law will be enforced we have no doubt that more care will be exercised in bringing to market only fish of the proper size….The public are interested in the protection of the flounder. If it is wantonly and indiscriminately destroyed it will soon be exterminated as our oysters have been. Far better that the price of these fish should be enhanced for a time if that will eventually increase their numbers, rather than that for mere present selfish indulgence all restrictions should be removed. But it must be remembered that laws – especially those intended for the protection of animals, cannot be administered successfully without the sympathy and co-operation of the community.*

At around the same time, the *Report of the Royal Commission on the Fisheries of Tasmania* was released. An adjunct to the Report – *General and Critical Observations of the Fishes of Tasmania* (Johnson, 1882) – indicated that the minimum legal-size of flounder was also poorly enforced in southern Tasmania. It also appeared that the banning of seine net operations in the Derwent estuary had expanded flounder fishing efforts to the neighbouring waters of Frederick Henry Bay, Norfolk Bay, Port Arthur, the D'Entrecasteaux Channel and the Derwent estuary below Hobart. According to the Royal Commission Report, these waters had become "seriously injured by over-netting". Despite this, Johnson (1882) conceded that there were no alternative methods of catching flounder (or garfish and mullet) in commercial quantities, and therefore did not propose a cessation of the practice. He did however recommend that alternative means of capturing flounder be investigated as a matter of priority:

> *It is perhaps difficult to devise a better mode for the capture of certain fish now principally obtained by seine-nets, but it is undoubtedly a barbarous engine of destruction, and it would be of the greatest service if some improvement could be devised which would have the effect of rendering it less destructive to the young fry on the nursery grounds.*

In light of the prevailing lack of alternative fishing methods for flounder (and other species) and localised overfishing effects, it was recommended in Johnson's report and the Royal Commission report to reserve further areas for seine net protection. With regard to the Tamar however, protected zones were deemed unnecessary. This assessment was based on testimonials provided by a Tamar-based fisher, a fish hawker and the Launceston town clerk who suggested that submerged snags along the shore of the Tamar provided a natural refuge from seining activities. The Royal Commission Report also flagged the possibility of introducing spawning season closures for flounder fishing, though they conceded that more information about the timing and duration of the spawning season was required before a move of that nature could be considered. The matter was investigated and seven years later a closed season for flounder spanning August and September was implemented.

6.2.3 1888 to present

The first annual recorded catch estimate was provided by Johnson (1890) in relation to sales at the Hobart Fish Market. In 1888, 13,500 flounder were sold. At 6 shillings for a dozen fish, flounder were one of the most expensive fish, particularly when

assessed according to likely average weights of all species sold (which were not recorded).

Market sales figures were not published again until 1904. From then till 1923, annual sales fluctuated between one and 17 tonnes[5] (Fig. 6.1). Over the last four years of that period, sales figures were also available for the Launceston Fish Market which ranged between three and six tonnes. It is noted, however, that fish market sales did not provide an exhaustive account of state-wide sales as fish were also landed and sold at other ports and also sold by hawkers in the two major towns. During this period, little information is available regarding the viability of flounder stocks. An exception was provided by an article in *The Mercury* (22 July 1916) commenting on evidence presented for the 1916 Royal Commission in which case a Government statistician was quoted as saying "there was no depletion in the supply of flounders upon the banks and beaches". Based on the rapid geographical expansion of fisheries at this time, it is assumed that flounder fisheries expanded far beyond the regions mentioned in the 1882 Royal Commission report. It is not clear whether the seine net remained the principal fishing method for flounder but it is likely that spear fishing was also used as numerous newspaper articles described the uptake of this pastime among Hobart recreational fishers from the early 1900s.

From 1929, annual state-wide catches of flounder have been recorded as weights. From then to 2012, annual catches have fluctuated widely between 2.6 tonnes in 1962 to 45 tonnes in 1988. At this stage, the reasons for the fluctuations are not clear but are particularly curious in light of the year round availability of flounder. However, the reason for the most recent large downturn in flounder catches appears to be a large reduction in effort which appears to be driven by changing preferences of seafood consumers. From 1995 to 2012, annual state-wide flounder catches have fallen from 33 to 3 tonnes. However, catch rates for the two main fishing modes, hand spearing and gillnetting, have remained relatively stable over this period (Fig. 6.2), suggesting steady stock levels. Effort reductions are particularly marked for gillnetting (Fig. 6.3).

[5] While sales data were recorded as fish numbers, not by weight, weight estimates were made using the first available record of average flounder weight – 0.24kg in 1941

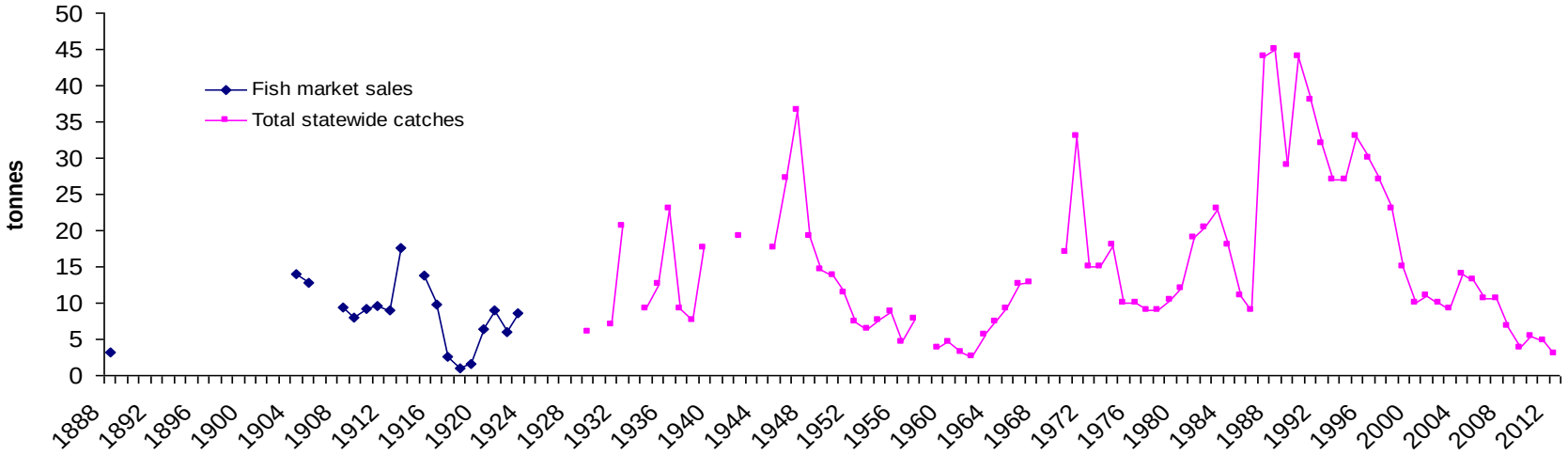

Fig. 6.1. Flounder sales data for the Hobart (1888-1923) and Launceston Fish Market (1920-1923) and state-wide catch data (1929-2012). Data also include Long-snouted Flounder though they are understood to represent a small proportion of total sales and catches.

Table 6.1. Summary of particulars for interviewees

	Waters fished	Status	Career duration	Abundance changes	Reason for change	Timing of Change	Catch rate (early)	Catch rate (late)	Size changes
Fisher 1	South Arm / Pittwater	Comm/Rec	early 1940s - present (comm fisher from 2002-2009)	no change	N/A	N/A	20-30 p/h	20-30 p/h	No
Fisher 2	South arm / Pittwater	Comm/Rec	1948 - present (comm fisher from the 50s to early 70s)	decreased	commercial trawlers, water quality, tractors used on oyster leases	2000-2002	40-50 p/h	20-30 p/h	No
Fisher 3	Denmans Bay	Rec	1960s - 2009	decreased dramatically	unsure	unsure	5-15 p/h	0 p/h	No
Fisher 4	Bruny Island	Rec	1950s - present	little change, large catches less common	N/A	N/A	25 p/h	11-14 p/h	No
Fisher 5	Prosser River/ Triabunna Bay	Rec	1960 - present	decreased	scallop trawlers, pesticide effluent	early-mid 1980s	10-13 p/h	2 p/h	No
Fisher 6	Tamar/Bell Bay	Comm/Rec	1987 - 2004 (comm fisher from 1987 to 1990s)	decreased	commercial flounder netting		50 p/h	25 p/h	No
Fisher 7	Tamar River	Rec	1960s – 2002	decreased	Unsure	gradual	10-20 p/h	5-10 p/h	No

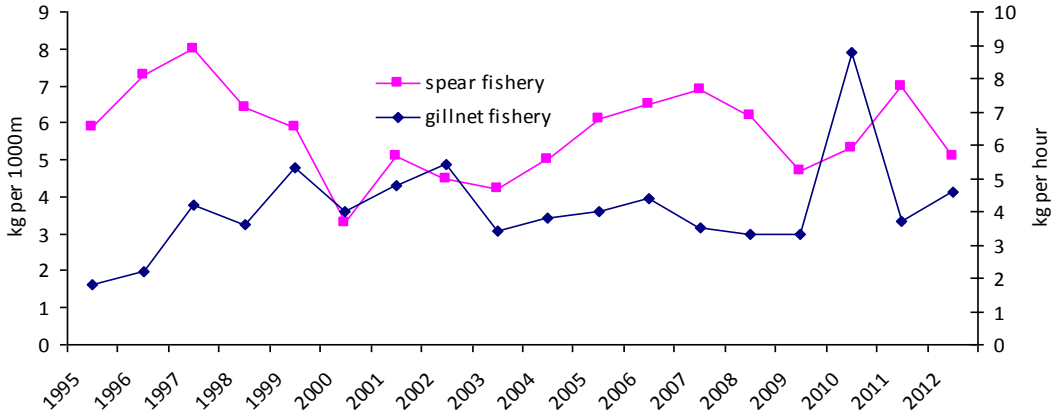

Fig. 6.2. CPUE values for the Tasmanian commercial flounder fishery from 1995 to 2012. Values presented for the gillnet fishery are expressed as weight of flounder (kg) per 1000 of net, while for the spear fishery CPUE is expressed as weight (kg) per hour of fishing.

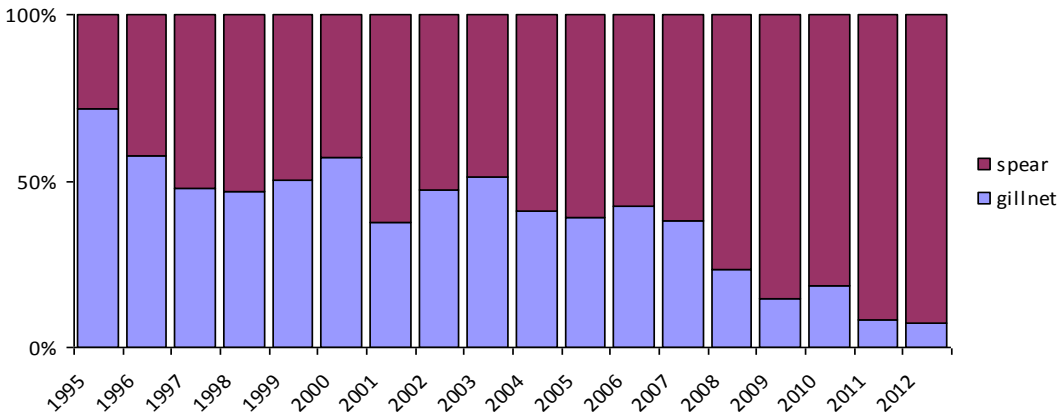

Fig. 6.3. Relative proportions of flounder caught using gillnet and spear methods for the Tasmanian flounder fishery, from 1995 to 2012.

6.3 FISHER INTERVIEWS

Seven interviewees provided information on flounder, three of whom were current or former commercial flounder fishers. All fishers interviewed, commercial and recreational, fished for flounder using spears only. The south east of the state was more highly represented than other regions, though two fishers provided information regarding the Tamar estuary. Due to the small number of interviewees, data were not analysed quantitatively; an abbreviated account of information and data is provided in Table 6.1. A further three fishers contributed 'incidental' comments relating to flounder whilst discussing other species.

6.3.1 Abundance

Six of seven fishers interviewed reported a decline in catch rates over their period of involvement, though the degree of reported declines varied widely (see Table 6.1). The regions with the greatest reported declines were Denman's Bay, the Prosser River and Triabunna Bay; however, the fishers reporting these declines were less avid than the other fishers interviewed. The two respondents who fished the South Arm and Pittwater areas since the 1940s described how their intimate knowledge of these areas had enabled them to target fish more effectively with respect to locations, seasons, tides and lunar phases. However, they varied in their perceptions of decline: one suggested that catch rates had not changed since he commenced fishing while the other perceived catch rates to have decreased in the last 10-12 years. The two interviewees who fished the Tamar River were quite consistent with their perceptions of decline (i.e. catch rates decreased by about 50%), though one had fished the area 20 years longer than the other.

Of the three additional fishers who provided 'incidental' comments on flounder abundance, two fished in Norfolk Bay and one fished in Georges Bay. All three reported large declines in flounder numbers though catch rates were not solicited. The following comments are in relation to Norfolk Bay:

> *They're just not there. They're just not there to target, well around our area anyway, down on the Peninsula side of it (Norfolk Bay)….. I used to go out to spear half a dozen in front of home there, but you just don't see them anymore. You don't even see the small ones.*

The following quote was provided with regard to Georges Bay:

> *Sadly, the flounder stocks everywhere are nowhere near what they used to be …..the one species that hasn't returned in number is the flounder. Whether the flounder have got to a point where they just can't replenish themselves, I just don't know. I don't see a lot of what we call the 'pennies'* (juvenile flounder) *at night. When you don't see the little fellas around, something is not quite right.*

6.4 DISCUSSION

The early history of flounder fishing in Tasmania involves intensive fishing with basic equipment that led to local depletion of sites near markets. Until late in the 19th century, flounder fishing grounds close to Hobart and Launceston had been impacted by a combination of intensive and unregulated fishing, the capture and discarding of small and immature fish, and the use of non-selective fishing gear that also damaged inshore habitats. Eventually however, the status of the flounder fisheries in affected areas appeared to have been improved by a combination of expansion to new and relatively unfished areas, the introduction of size limits, some localised area closures and a transition to more selective fishing practices.

The earliest indication of flounder catches was made available in 1888. At the time, six years after the first Royal Commission into Tasmania's fisheries, the Derwent estuary had been closed to netting for 23 years and problems identified through the

Royal Commission were being addressed. There is little information from this time although trends in flounder abundance are suggested by historical catch data. Interviews with enduring fishers can partly alleviate this information paucity, though due to the small number of interviews undertaken in this study, further research is required to gain a more comprehensive understanding. Nonetheless, the manner in which flounder are most often targeted imparts rigour to collected data. Unlike some modes of fishing where 'technology creep' can mask fishery trends inferred though catch rates, the gear used to spear flounder – for both the commercial and recreational fishery – has not changed significantly over many decades. As such, evaluating catch rates from long-term data should provide a good indication of trends in fishery health.

While no changes to the average size of flounder were reported during interviews, catch rate declines of 40% or more were reported by six of the seven interviewees; albeit on differing timescales and across different regions. Information provided from two long-term commercial fishers of the South Arm/Pittwater area is particularly noteworthy in light of the length and intensity of their involvement and the importance of that region to the overall fishery, both commercial and recreational sectors. Of particular note is the discrepancy in their assessment of recent trends in abundance: one fisher suggested that catch rates hadn't changed since the 1940s whilst the other fisher suggested that they had dropped by around 40% from around 2000. The assessment provided by the former appears more consistent with state-wide catch rate trends for the commercial fishery since the mid-1990s and highlights the need for further research to investigate claims of abundance declines at localised scales.

7 SOUTHERN ROCK LOBSTER

7.1 INTRODUCTION

Southern Rock Lobster (*Jasus edwardsii*) have long been an important source of food for coastal Aboriginal populations. Soon after the colonisation of Tasmania by British settlers, a commercial fishery for the species was established. The early fishery was primarily based on the collection of Rock Lobster using hoop nets. It was not until 1925, after the legalisation of the lobster pot and the development of an interstate market, that large volumes of Rock Lobster were caught (by modern standards) by the commercial fishery.

Currently, 1100 tonnes of Southern Rock Lobster are harvested annually by the commercial fishery (Hartmann *et al*., 2012). In addition, around 100 tonnes of Rock Lobster are caught by recreational fishers each year. While this represents less than 10% of the combined catch, the proportion of catch taken by recreational fishers in inshore waters along the east and south-east coasts is more significant; for instance the recreational catch represented between 22 and 35% of the shallow water east coast catch in 2010/11 (Lyle and Tracey, 2012b). The distribution of the catch and average sizes of harvested Rock Lobster are largely determined by differences in biological and physical factors affecting different regions of Tasmania's coastline.

In this chapter, data and information have been sourced primarily from historical documents and through interviews with long-term fishers. Commercial fishing records have also been sourced and interpreted to contextualise the results. As it is the aim to examine historical information on Rock Lobster abundance and size, administrative and managerial developments have not been discussed in detail unless they provide necessary context for understanding notable resource-based trends. However, these aspects of the fishery have been thoroughly addressed by other authors (Winstanley, 1973; Harrison, 1986). The reader is also encouraged to refer to historical information relating to Tasmania's population in Appendix 1 for additional context.

7.2 HISTORICAL RESEARCH

7.2.1 Pre-1803

Unlike scalefish, shellfish and crustaceans were important dietary items for the Aboriginal population, which was estimated to have numbered between 3000 and 15000 before British settlement (Macneil and Neil, 2003). Customarily, the task of collecting Rock Lobsters and other seafood was reserved for women. Numerous observations of Aboriginal women diving for Rock Lobster were made in the journals of early explorers and in publications of early settlers. In most accounts, the skill and ease in which the women collected Rock Lobster from shallow waters was described.

Some of the early explorers also recorded their own attempts at catching Rock Lobster. While numerous Rock Lobster were caught by the crew of fleets commandeered by Du Fresne and Baudin, the most informative journal entries pertaining to the species abundance and their capture were provided by Pilot Raoul,

an officer under the command of "D'Entrecasteaux". Whilst anchored in Recherche Bay in 1793, Raoul described the effectiveness of an innovative method of capture:

> *At one place about a hundred Rock Lobsters were taken by means of a kind of net made up of three circles and some rods, the whole thing being in the form of a barrel. The fish entered the two ends, and by this method they could be captured and later removed.* (Plomey and Piard-Bernier, 1993)

In the next passage, Raoul describes catching Rock Lobster by line fishing, apparently for finfish species:

> *We set baited lines to take other kinds of fish, as many as twenty and sometimes more of the larger quantity that are bottom dwellers; but they are found only near a rocky bottom and associated with or among the large seaweed which a part of these bays are filled. From the moment our fishermen began to catch these Rock Lobsters with their lines, they had no chance of catching all other species of fish, for they hadn't time to take the bait.* (Plomey and Piard-Bernier, 1993)

From this quote, it appears that, while baited lines were intended for catching finish, the abundance and voracity of Rock Lobster made it difficult to catch other species.

7.2.2 1803-1925

Southern Rock Lobster were amongst the first species to have been exploited commercially in Tasmania due to the proximity of productive fishing grounds and their ability to be transported alive in an era before refrigeration. While commercial fishing for the species is thought to have commenced around 1830 (Ford, 2001), a few references to subsistence or recreational fishing prior to that time provide valuable insights into their abundance and size. The first apparent record was made by Reverend Robert Knopwood in 1805 who described an account of catching a Rock Lobster near his cottage at Risdon Cove:

> *I went out a-fishing and caught a very large crayfish, the first that was taken in this colony.* (Knopwood, 1977)

It is not apparent whether hoop nets ('cray rings') had been developed at this time. However, based on some accounts of Rock Lobster caught by hand when wading in shallow waters, it was quite likely caught in such a manner. While the size of the "very large crayfish" was not recorded, the size of two Rock Lobster caught by Knopwood 12 days later – "6 lb and 7 lb" – suggests that large individuals were common.

Ten years later, on a government sponsored geological expedition of the west coast, immense quantities of Rock Lobster collected by Aborigines were witnessed by James Kelly and his crew at the mouth of a creek near Low Rocky Point:

> *This was named Crawfish Creek in consequence of the immense number of crawfish that lay at the water's edge. There were above three tons in one*

> *heap. They appeared to have been gathered the day previous, which must have been done by the natives.* (*The Courier*, 3 April, 1854)

This curious account has been frequently misreported by various sources who claim that the Rock Lobster were quickly gathered by Aborigines who traded them for two black swans shot by Kelly's crew. Regardless of the circumstances, this account is particularly questionable in view of enormous volume of Rock Lobster reportedly collected and the collection of far more than required for immediate consumption. Possible explanations are that a large number had been collected for ceremonial purposes, or the volume was overestimated, or midden had been misinterpreted as a harvest of the previous day. Nonetheless, the report provides an indication of the abundance of Rock Lobster available in shallow water and alludes to their ease of capture.

An article in the *Hobart Town Courier* in 1830 (30 January) gives the reader an idea of the ease of capture (and size), this time in the State's south-east:

> *In half an hour the other day, I and two companions caught 17 cray-fish, weighing from two to four pounds each, equal in flavour to English Rock Lobster.*

It was not stated how the Rock Lobster were caught, but they were likely caught by hand whilst wading or with hoop nets. Alternatively, some early accounts of recreational fishing for Rock Lobster describe the use of handlines or meat stuffed inside a stocking, presumably the legs of the Rock Lobsters would become entangled in the stocking material.

Although commercial Rock Lobster fishing for the Hobart market commenced around 1830, very few references to supply (or demand) are available prior to the Royal Commission in 1882 (Tasmania Parliament, 1882). One exception comes from an article describing Tasmania's exploitable natural resources published in *The Cornwall Chronicle* in 1861 (6 July):

> *The seas surrounding Tasmania abound with a great variety of fishes, many of which being firm of flesh and delicate in flavour make choice dishes for the table. The trumpeter, the perch, the flounder, the rock cod, the mullet, the garfish etc are all in estimations; shell-fish, oysters, mussels, periwinkles etc are plentiful. The Hobart Fish Market is plentifully supplied with the best crayfish.*

At the time, the fishery was primarily based on the use of hoop nets in the south-east region, and it appears that the supply from this limited area was sufficient to meet local demand. However, an article published 14 years later suggests that Rock Lobster were not highly regard as a food item (*Cornwall Chronicle*, 8 August 1875).

> *In time perhaps, as our population increases, our fishing grounds will become more frequented and their produce be oftener seen in our markets. Crustaceans such as crabs, shrimps and crayfish are found along our coast in great abundance, but as luxuries, they are almost as unfashionable in Tasmania as in Belgravia, and few fortunes are gathered from their source.*

The apparent lack of regard for Rock Lobster suggested by the above passage is consistent with an unpublished scale of the edible qualities of Tasmania's fish accompanying the 1882 Royal Commission report. On a descending scale from 1 to 4, Rock Lobster received a rating of three, together with Jack Mackerel and Australian Salmon. The 1882 Royal Commission Report also states that "the mature crayfish weigh 6 to 7 lb."

The first published account of fish prices at the Hobart Fish Market (Johnson, 1890) report that Rock Lobster, with an average weight of 4 lb, sold for an average of 5 shillings per score (24)[6]. At that price, based on fish numbers (not weight), the species were less expensive than Gurnard and Jackass Morwong. In fact, the only species that were cheaper than Rock Lobster were flathead, mullet, Jack Mackerel, Garfish, Rock Cod and Sand Whiting. When the average sizes of these fish are compared with the average size of Rock Lobster sold at the time (1.8 kg), it becomes apparent that the luxury status afforded to Southern Rock Lobster in more recent times was far from being realised. Furthermore, they were often caught as bait for Striped Trumpeter and shark and were also used to feed Striped Trumpeter held in cauffs prior to sale.

Interestingly, however, the poor market prices attained at the Hobart Fish Market were not consistent with the description provided in the report of the Royal Commission (Tasmania, Parliament, 1882):

> *….the crayfish* (P. edwardsii) *is, perhaps, one of the most important of our marine products, being not only esteemed for its quality, but for its great commercial value from its wonderful abundance, especially around our eastern coasts.*

Whilst this reference to the "quality" of Rock Lobster is not reflected in the poor table rating given to the species by the same author, a closer examination of the prices and volumes of fish sold at the Hobart Fish Market (Johnson, 1890) suggest that the low prices paid for the species may be largely attributed to consistent over-supply. At the time, sales of Rock Lobster comprised 22% of all fish sold by numbers (probably higher by volume). When prices attained are compared with other species with an equal or lower table rating, it seems that price was very much determined by supply. For example, Gemfish and Conger Eels, with low table ratings of 3 and 4 respectively, attained an average price of 60 and 11 shillings per dozen in a year when very few were brought to market (1 dozen and 70 dozen, respectively).

Whilst some of the evidence concerning the supply, demand and popularity of Southern Rock Lobster during this period is contradictory, the low prices attained in Tasmania stimulated the development of more lucrative interstate markets. The prices attained at the Melbourne Fish Market were considerably higher and the species was attaining a reputation as a highly esteemed food item in mainland states. A commercial fishery for the same species existed in Victoria. However, due to differences in water temperature between the two States, Tasmanian fishers were able to supply the Victorian market when their local Rock Lobsters were moulting (while

[6] While the term 'score' unusually denotes a number of 20, it was commonly accepted to mean 24 at the time when applied to Rock Lobster. This was due to an allowance of 4 extra Rock Lobsters to allow for "breakages" (Winstanley, 1973)

it was not illegal to take soft shelled Rock Lobster, they did not survive well during transit to the Melbourne market). Also, Tasmanian fish commanded a premium price on the Victorian market. It is possible therefore, that the references to "quality" and "great commercial value" in the report of the Royal Commission may have been strategic advertisements to markets further afield in view of the fledgling export trade.

It is thought that the export of Tasmanian Rock Lobster to Victoria commenced around 1870. From the Minutes of Evidence collected by the Royal Commission, one trader exported an average of 26,300 Rock Lobster annually between 1872 and 1881, with an average weight of 4 lb (1.8 kg). This number was higher than the total number of all other fish exported, including Striped Trumpeter, Barracouta, Gemfish and Blue Warehou. It is not clear whether there was only one exporter in the seminal years of the export market. If so, exports at the time comprised a quarter of local production as total annual sales of Tasmanian Southern Rock Lobster in 1882 were estimated to be 209 tonnes (Tasmania Parliament, 1882). This figure does not, however, include considerable volumes of fish taken illegally by Victorian boats fishing in Tasmanian waters in the Bass Strait. While this was a source of escalating consternation among Tasmanian fishers over many years, the volumes of Rock Lobster taken by these boats were apparently not recorded.

Although the 1883 Royal Commission report was partly driven by concerns about the impacts of injurious fishing practices on commercially important species, much of this focus was on species impacted by seine netting. Nonetheless, one paragraph outlined concern about the sustainability of the Rock Lobster fishery:

> *The destruction of crayfish is stated to be carried on at a rate exceeding the natural increase. This seems to be so serious in some localities as to threaten extermination at no distant date. It is recommended that the sale or possession of crayfish under a length of 10 inches, and all spawn carrying female fish, should be prohibited.*

The Minutes of Evidence accompanying the report provides consensus among almost all Rock Lobster fishers interviewed that the species was being heavily depleted, and that the depletion was due to intensive fishing. Some interviewees also reported that the market was being increasingly supplied with smaller fish and females carrying eggs.

At the time, the south east region had been fished commercially for almost 50 years without regulation, though fishing efforts were confined to areas sufficiently shallow to use hoop nets. Due to the concentration of fishing effort within 80 km of Hobart, it is inferred that stocks further afield were lightly exploited. Nonetheless, when compared with modern stock assessments, the yields obtained from a small fleet of 50 boats (9 m ex-whaleboats and small sailing boats fitted with perforated wells) are quite remarkable. Based on an average of 12 rings per boat (Harrison, 1986), the mean annual yield per ring was 350 kg, considerably greater than the current annual catch limit per commercial pot (105kg). Considering most Rock Lobster fishers also targeted scalefish and the area fished was experiencing marked catch declines during that time, the indications of abundance are even more remarkable.

Owing to the results of the Royal Commission, the *Act for the Protection of Crayfish* was enacted in 1885. The Act imposed a minimum overall length of ten inches and prohibited the sale or possession of soft shelled and female Rock Lobster carrying eggs. In the same year, a Board of Commissioners was appointed to manage the fishery. Under their administration, little information on catches was made available until fish sales at the Hobart Fish Market were published in annual reports from 1905. Before then, however, limited information from newspaper articles suggests that the fishery was steadily expanding along Tasmania's coastline. Northern fishers, previously limited to a short stretch of coastline near the Tamar Heads, were expanding operations to the north-west coast and the Bass Strait Islands. Of the latter, an article in *The Launceston Examiner* (16 June 1888) described the abundance of Rock Lobster off western King Island:

> *Under New Years Island, any number of crayfish can be caught, and at any time one can catch a score or so in a few minutes.*

Contrary to this indication of great abundance around New Years Island, a testimony provided a few years earlier for the Royal Commission by the Clerk of the Hobart Fish Market suggested that Rock Lobster numbers had declined appreciably around the wider King Island region due to fishing by Victorian boats:

> *I think it is to be attributed to the use of these pots that King's Island and other parts of the coast are now denuded of crayfish.*

The discrepancy between these two assessments may simply imply that the impacts of intensive fishing in the King Island region were highly variable on a fine spatial scale. The fact that the area around the New Years Island is difficult to navigate boats owing to numerous bommies underscores this assertion. It is also possible that the comment was intended to persuade the Government to address growing concerns about Victorian fishers and their use of craypots in waters off Tasmania – a topic of considerable angst among Tasmanian fishers. Nonetheless, reports of Rock Lobster declines attributed to Victorian boats were not limited to King Island. The following quote describes the apparent impacts of incursions by Victorian fishers on a fishing trip to the north-west coast in 1897 (*The Launceston Examiner,* 25 October 1897):

> *Although successful in obtaining a few fine trumpeter, perch and crayfish, they report that the usual fishing grounds are well nigh exhausted, owing to the frequent visits from the boats of the Victorian waters, and one or two steamers are now employed in the trade. Crayfish, especially are very scarce.*

While the west coast had yet to be commercially fished on a regular basis, a few early reconnaissance missions provided accounts of great abundance, with a view to imminent fishery expansion. On one trip in 1893, the abundance and size of Rock Lobsters are emphatically endorsed:

> *There are any quantities of crayfish too, and if taken aboard, they would bring 'grist to the mill'….Some of the west coast crayfish attain great dimensions….The prospects for establishing an industry on the west coast are really first-class* (*The Mercury,* 20 May 1893).

During the administration of the Commissioners of Fisheries from 1885 to 1925, total state-wide catches were not recorded. However, records of sales for both the Hobart and Launceston Fish markets for the respective periods of 1904-1923 and 1920-1923 were published (see Fig. 7.1). Combined, an average of 94 tonnes was sold annually over that period. This was less than the volume sold at the Hobart Fish Market in 1888 – 138 tonnes – despite considerable population growth and fishery expansion since then. This lack of growth in local fish sales may be attributed to at least two factors. The importance of these factors in characterising prevailing issues and shaping future developments in the fishery are such that they will be discussed at length in the following paragraphs.

First, it appears that a decreasing proportion of local catches were being sold through traditional markets. The sales data reported by the Commission do not include Rock Lobster landed in Tasmanian ports other than Hobart, and from 1920, the port of Launceston. Whilst this was also true for the 1888 data, the subsequent expansion of the fishery and proliferation of regional population centres meant that fish were being landed in an increasing number of ports, especially on the south-east and east coasts. Also, a rapidly increasing proportion of Tasmanian catches were being exported to Victoria and New South Wales, the volumes of which were not officially recorded. While some newspaper articles described this expansion of exports, only one provides an estimate of volume: in 1920, approximately 227 tonnes were exported (*The Mercury*, 13 July 1921). This represented 82% of total local production – an increase from 25% in 1888 – and signified a shift in focus from supplying local markets to supplying interstate markets, where demand was less limiting.

The second factor was an apparent decline in Rock Lobster availability in many of the traditional fishing grounds, particularly from 1911. As stock declines appear to have been particularly pronounced closer to Hobart (Tasmania Parliament, 1913), smaller fishing operations supplying the local markets from these waters were likely to have been disproportionately affected. Abundance declines were also well documented for other fisheries and led to a decrease in the quantity of fish sold in local markets and increases in retail prices (and were eventually instrumental in precipitating a second Royal Commission into Tasmania's fisheries in 1916). The apparent increasing scarcity of Rock Lobster in south eastern, eastern and northern waters from around 1911 both reflected and advanced a series of controversies and events that eventually led to the legalisation of pots in 1925, and heralded a new era for the fishery. These controversies and events are chronologically described below.

In addition to the south east, more widespread depletions were being blamed on the impacts of Victorian fishers in Bass Strait and increasingly the north-east and east coasts. Some reports suggest that Victorian fishers were operating as far south as Dunalley. In former years, Victorian vessels were said to frequent Tasmanian waters when Victorian Rock Lobster were moulting; however, by this time it was widely understood by Tasmanian fishers that the visitations were due to lower catch rates in Victorian waters. Despite this, there was considerable pressure on Tasmania from the Victorian Government to allow interstate pot fishing in local waters. The following excerpt from *The Launceston Examiner* (22 May 1911) reported on comments made by R W Knight, Commission Secretary, in light of calls to relax (largely ineffective) restrictions on Victorian fishers:

> *He declared that the crayfish grounds adjacent to the Victorian coast had been fished out, and the Tasmanian crayfish industry would also be in danger of extinction in a few years if the Victorian pots were allowed to be used.*

As the issue was controversial among Tasmanian fishers, some of whom wanted the government to permit the use of lobster pots, there were numerous references to the impact of pots on the fishery in publications at the time. However, from the following quote from the 1912/13 annual report of the Commissioners (Tasmania Parliament, 1913), it appears that fishing grounds unexploited by Victorian fishers were also facing sustainability challenges:

> *Owing to the enormous demand for this splendid crustacean, both locally and on the mainland, the fishermen are concentrating their efforts more each year toward the capture of this valuable marine product. For some reason at present unknown, the natural increase of this crustacean in Tasmanian waters, does not keep pace with the limited depletion of the crayfish areas by the use of hoop nets.*

While less fish were being caught in traditional fishing grounds, the fishery was rapidly expanding with regard to areas fished, the fishing capacity of boats and the number of Rock Lobster fishers. Many scalefishers were abandoning their trade due to increasing prices obtained for Rock Lobster, especially in interstate markets. An abrupt decline in the seasonal abundance of barracouta and gemfish was also a factor. These developments, and their impacts on the supply of fish coming into Hobart, were described by W. Bowtell, fishmonger and owner of several Hobart-based fishing smacks:

> *The quantity of fish which came into the market was growing less, although bigger and better boats and better gear was used. Very many of the boats too had oil engines, so that one would expect them to make much quicker trips than when they had to depend on sails alone.* (*The Mercury*, 20 July 1914)

While numerous theories were proffered to explain the decline in migratory fish like Barracouta and Gemfish, it was widely understood that little could be done to address the problem. With regard to Rock Lobster, however, various theories and solutions were offered by parties involved in the fishery. One report advocated a re-direction of fishing effort to the west and south-west coasts, where abundances were known to be much greater (*The Mercury*, 26 July 1917). However, a second Royal Commission into Tasmania's fisheries in 1916 favoured a more revolutionary change to the fishery – the legalisation of lobster pots – a recommendation consistent with others intended to modernise and develop Tasmania's fisheries. The same conclusion about lobster pots was also reached by two separate inquiries conducted a couple of years earlier into the issue: one by a Select Committee chaired by Joseph Lyons and another by the Commonwealth Director of Fisheries, H. C. Dannevig.

The Dannevig investigation suggested that two thirds of Tasmania's Rock Lobster stocks remained completely unexploited. Presumably Dannevig was referring to stocks on the west coast and in waters too deep to operate hoop nets. Dannevig's views were repeated later by reports on the fishery in the lead up to the Second World War (Winstanley, 1973) and implies that egg production in the fishery were at very

high levels relative to unfished stocks because of the large areas of the fishery yet to be harvested. Given this, it seems implausible that recruitment overfishing could have occurred and thus the various reports of localised depletions described up to this time appear to be economic overfishing: that is, a depletion of stocks in some areas decreasing profitability, rather than a decline in overall stock productivity.

Support for legalisation of lobster pots as recommended by the Royal Commission came from many Tasmanian fishers who were constrained by decreasing catch rates and were aware of the large catches made by Victorian pot fishers. Nonetheless, the Commission stood firm and resisted any pressures to legalise pots, which they repeatedly referred to as "engines of destruction". For a few years, social and economic conditions associated with Australia's involvement in the First World War diverted attention and resources from fisheries related issues. However, the pot issue flared up again in 1920 when the Victorian ketch the *Myrtle Burgess* was apprehended fishing illegally at Binalong Bay. The seized vessel logbook showed that, between 1913 and 1920, 250,200 Rock Lobster were taken (Harrison, 1986), effectively providing the first available catch data using pots. The *Myrtle Burgess* log also showed that 40% of the catch was made in waters where pot fishing was not illegal while the remaining 60% was caught in an area for which numerous reports of Rock Lobster declines were attributed to illegal incursions from Victorian fishers.

Public disclosure of the vessel's catch seemed to reinforce fisher's appreciation of the efficiency advantages offered by pots as a fishing gear. This appeared to polarise the fishing community and petitions and counter-petitions over the legalisation of pots were undertaken. However, accounts of stock depletions only strengthened the resolve of the Commissioners who were convinced of the capacity for pots to exhaust the fishery. As such, they resisted any moves to change the manner in which Rock Lobster were caught. Comments provided by Commissioner and fisher, William Gates, during this vexatious period summarised the Commission's position on the matter:

> *There was no quicker way of exterminating a body of fish than to permit the use of pots, which constantly went adrift and continued their work of trapping. The depletion resulting from the use of crayfish rings was bad enough, but with pots it was increased a hundredfold….The only result of the legalization of the use of pots, if ever permitted, would be the extinction of a valuable industry.* (*The Mercury,* 13 July 1921)

Though the Commission was primarily concerned about the efficiency of lobster pots as a fishing gear, the quote also shows that they were concerned about the capacity for pots to continue 'ghost-fishing' when lost. We know today that these claims were unfounded as Southern Rock Lobster are readily able to exit pots when the bait is exhausted (Green, 2002).

7.2.3 1925 to 1938

It wasn't until 1925, when the Commission was replaced by the Sea Fisheries Board that the use of lobster pots was legalised in Tasmanian waters. Soon afterwards, catches rose dramatically due to the increased efficiency of pots compared with hoop nets, especially in deeper waters which were previously unexploited by Tasmanian

vessels along many parts of the Tasmanian coastline. The lobster pot also enabled fishers to fish more effectively within kelp beds and in areas exposed to currents and tidal flows. Despite the advantages, Tasmanian fishers converted to pot fishing at a slow pace and many continued to use hoop nets: the percentage of boats used for Rock Lobster fishing that were licensed to use pots rose from 15% in 1925 to 37% in 1939 (Winstanley, 1973). Even though a large proportion of fishers continued to use hoop nets, the majority of these also targeted scalefish and provided relatively small quantities of Rock Lobster to local markets. The reasons for the slow transition are likely to have been a combination of high pot licence fees, suspicion about the 'new' technology and a lack of deckspace (Winstanley, 1973). Despite the slow transition, the rapid growth in state-wide catches from 1925 suggests that the fishers who did make the transition were having a major impact.

Factors other than the legalisation of pots also increased the efficiency of fishing efforts during this time including a rapid growth in the use of engines. Whilst boats retained their sails, the option of auxiliary power enabled faster transit times for some fishers and reduced instances where live fish perished while being transported to ports and markets. At a time when
unfished waters were available at the periphery of the traditional fishing grounds, such developments affecting travelling capacity would have provided fishers access to virgin stocks, in terms of both depth and geography. At the time, approximately 95% of all Rock Lobster were caught off the east coast between South Cape and Bridport (Winstanley, 1973). Therefore, the west and south west coasts, to this point in time, remained essentially untapped resources. While few Tasmanian fishers worked the north-west coast and Bass Strait islands, approximately 275 tonnes per year were being caught by Victorian fishers in these areas (Winstanley, 1973).

Another important development affecting efficiency was the introduction of regular steamer services to both Melbourne and Sydney by which Rock Lobster and other seafood products were transported under refrigeration. Previously, many fishers sailed across Bass Strait to access the more lucrative Melbourne markets which effectively meant large periods of 'dead' time for fishers (and also considerable stock losses during periods of unfavourable conditions). With the advent of the steamer services, fishers 'merely' transported their catch to fishing co-operatives (in Hobart, Launceston, Dunalley or St Helens).

Despite the slow uptake in pot use, annual catches rose from 39 tonnes in 1925 to 1080 tonnes in 1939. Unlike the previous administration, who did not regulate or record the number of fishing units (hoop nets), the Sea Fisheries Board introduced a pot registration system by which the number of pots per registered vessel was allocated according to the weight of the vessel. For example, smallest vessels (<5 tons) were allowed 10 pots while the largest vessels (>30 tons) were allowed 30 pots. Recording the effort potential for the fishery provided the first opportunity for Rock Lobster abundance within fished areas to be inferred through catch rates. While catch rates measuring the weight of legal-sized biomass per pot-lift is the most appropriate measure for which to infer the abundance of legal-sized Rock Lobster, data of this nature were not recorded until 1947. Up to this time, therefore, legal-sized biomass per pot/year represents an alternative measure. Nonetheless, incomplete historical data and inconsistencies between sources make this process difficult. In Fig. 7.1, two sources of data have been used to estimate the mean annual catch per pot for subsets

of time between 1927 and 1931. These two data series, and an additional data source not presented, are described below:

1. The first source (Series A) is based on total annual landings of Southern Rock Lobster and the number and type of registered boats that used lobster pots; both of which are outlined in annual reports of the Sea Fisheries Board. Of the latter, the number of pots has been calculated based on the maximum number of pots boats could carry, depending on their weight class (Tasmanian Government Gazette, Jan-June, 1926). Data pertaining to the number of boats licensed to carry pots were available from 1927 to 1938; however, boat weight class data were only available from 1927 to 1932. To estimate pot numbers for the following years (1933 to 1938) boats (and therefore the number of pots) were allocated into classes based on the average relative proportions of different boat classes for the preceding period. Using this approach, catch rates for the 1927 to 1938 period ranged from 0.3 to 0.98 tonnes per pot, with a mean of 0.7.
2. For the second source (Series B), total landings data were also taken from annual reports of the Sea Fisheries Board. However, data for the annual number of pots were estimated from a line-graph published by Winstanley (1973). Using this approach for the 1930 to 1938 period, mean annual catch rates ranged from 0.3 to 0.87 tonnes per pot, with a mean of 0.66.
3. A third source of catch rate data for this period comes from an early CSIRO report (CSIRO, 1962). In the report, both pot numbers and annual total fishery harvest were presented on a scatterplot for the years 1931 and 1938. The primary source of the data was not disclosed and figures for both pot numbers and total harvest were considerable greater than for Series A and B, provoking obvious questions about the provenance of the data. The years from 1931 to 1938 were not differentiated and therefore, catch rate values are not displayed in Fig. 7.1. Nonetheless, catch rates for the period ranged from 0.34 to 0.59 tonnes per pot year, with a mean of 0.42.

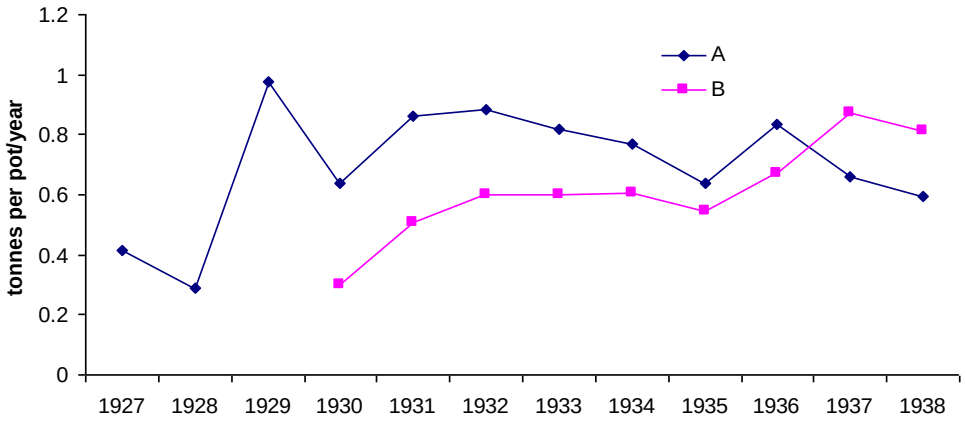

Fig. 7.1. Rock Lobster catch rates expressed as tonnes per pot per year, from 1927 to 1938. Catch rates have been derived from two sources of data relating to the number of pots in use and total Rock Lobster harvest weights. See preceding text for an explanation of the data used to construct Series A and B.

At this stage, the causes of data inconsistencies between the three series are unclear. The inherent difficulties in constructing and interpreting historical catch rates for this period are furthermore compounded by the high likelihood that total annual catches used to develop Series A and B also included catches made by ring net fishers. It is not clear what proportion of the catch was made by these fishers but it was likely to have decreased over time. While a large proportion (63%) of Rock Lobster fishers had not converted to using pots by 1939 (Winstanley, 1973), ring fishers generally also fished for other species and fished for Rock Lobster in shallow areas that had been worked for decades. A comparison between catches made before and after the legalisation of pots suggests that the overall contribution of ring net fishers to total annual catches was small. On the face of it, it seems that the relatively lower catch rates provided in the CSIRO report may suggest that only catch data from the pot fishery was used. However, catch values presented (CSIRO, 1962) for the 1931-38 period were on average 46% greater than official annual harvest data presented in the Sea Fisheries Board annual reports, making interpretation of catch rates difficult.

In the years following the legalisation of the lobster pot, its effectiveness as a fishing gear has also been documented in some semi-quantitative descriptions:

> *At the time of legalisation of pots, it was common for a boat with 20-30 pots to catch 72 dozen a day in the vicinity of (the) Lanterns and this from three daylight hauls only.* (Bridge, 2009)

At 20 and 30 pots, this equates to 9.6 and 14.4 Rock Lobster per pot-lift, respectively. Another description was provided by E. Andrews, Senior Fisheries Inspector (Andrews, 1957).

> *The fleet increased with the legalisation of crayfish pots, and by 1929 there were 48 boats engaged. These boats caught little or no fish, except for bait, and in 1930 produced a total of 2¼ million lbs of crayfish, the average catch per boat being 48,000 lbs.*

This account is questionable as the estimated total annual harvest (1020 tonnes) is considerably greater than that provided through the Sea Fisheries Board annual reports. If accurate, this would equal almost 1.5 tonnes per pot per year. It is possible that, as the Senior Fisheries Inspector, E. Andrews had access to fisheries statistics that aren't currently publicly available. However, in its absence, these figures must be viewed cautiously due to their inconsistency with catch rate data in Figure 7.1.

7.2.4 1939 to 1945: The War Years

With the onset of the Second World War, commercial production dropped by around 25% from the level in 1939. According to annual reports of the Fisheries Division (Department of Agriculture), there was a decline in crew numbers available and some boats were requisitioned for military service. In quantifying the reduction in effort during the war years, there are inconsistencies in the numbers of lobster pot boats registered for the years 1941-42 based on Fisheries Division reports and later data from the Department of Sea Fisheries,. Notwithstanding this, it appears that a reduction in effort mainly affected the number of pots used in the fishery rather than

the number of vessels, which remained relatively stable. As there was a sliding scale for pot allocation based on boat tonnage, it follows that some of the larger boats (and their pots) were probably temporarily removed from the fishery. Catch rates between 1939 and 1944 averaged 0.8 tonnes per pot per year (Fig 7.2), marginally higher than for the preceding years taking into account the uncertainties surrounding the calculation of catch rates between 1926 and 1938 (Fig. 7.1). It is likely that the rapidly advancing efficiency developments described in the previous section were at least partly responsible for this.

7.2.5 The Post-War Years

From the end of the war in 1945 until 1948, state-wide catches rose sharply due to a large increase in the number of registered boats and pots (Fig. 7.2). Over this period, the number of Rock Lobster boats rose from 94 to 225 while the number of pots rose from 1306 to 2787. Despite increases in annual catches, the average weight of catch per pot declined from around 0.8 tonnes during the war period to 0.36 tonnes in 1949 – a decline greater that 50% in just five years (Fig. 7.2). Given that the downturn in fishing effort during the Second World War was relatively modest, it appears that the declining catch rates after the war signalled that the fishery could no longer sustain such high catch rates given the rapidly increasing effort levels. Even though all Tasmanian coasts were fished, the bulk of fishing effort at this time was still focussed on traditional fishing grounds off the south-east, east and north coasts. The effects of this concentration of fishing effort on shallow inshore stocks prompted a study examining the impacts of re-populating areas near Adventure Bay with large Rock Lobster from deeper water (Winstanley, 1973).

The decline in catch rates during the post-war years needs to be viewed within the context of significant technological advancements at this time. These included the widespread transition to diesel engines as the primary source of boat propulsion, the use of mechanised pot haulers, on-board refrigeration units, two-way radio communications and lights. Furthermore, the increasing use of frozen baits absolved the need for fishers to catch their own bait and the introduction of tanks and water pumps alleviated the problem of Rock Lobster deaths from low salinity water (previously, low salinities were responsible for many deaths when water was provided via perforations in boat wells). Together, these developments would have increased fishing power and therefore the magnitude of change in Rock Lobster abundance as inferred by the decline in catch rates, may have been underestimated.

For a brief period after 1949, declining catch rates appeared to discourage new participants: effort remained somewhat static whilst annual catches fell by 31%, reflecting a decrease in catch rates. The decline in catches was, however, short lived as newcomers entered the fishery and the number of registered pots again rose sharply until the mid-1960s (Fig.7.2). Between 1951 and 1966, total catches doubled whilst the amount of fish caught per pot halved. It was also during this period that an export market for tinned Rock Lobster tails to the United States was forged. This not only increased overall demand for the resource but increased prices paid in Australian markets, providing additional incentive for growth in catch and effort. It has been suggested that an unfortunate side-effect of the US export market was the landing of many undersized fish: as the legal minimum length applied to the portion of the Rock

Lobster that was discarded (i.e. the carapace), the chances of being apprehended were greatly reduced (Bridge, 2009).

While total annual catches in post-war years, as a general trend, increased until a peak in 1985, the weight of Rock Lobster per pot trended downwards, albeit at a slower rate after 1949 (Fig. 7.2). There were many mediating factors complicating the interpretation of these trends, which include changes in season length and in the number of pots operated per vessel. Numerous technological developments also occurred and there was an expansion of catches in unfished or lightly fished grounds off the west and south west coasts. Annual catches rose steadily in these areas, while catches in more traditional areas off the east and south east coasts remained static, despite a threefold increase in fishing effort between 1946 and 1970 (Winstanley, 1973). By the early 1960s, the CSIRO determined that "there are probably very few grounds yet to be discovered and practically all stocks within the fished area have now been brought under exploitation" (CSIRO, 1962). The widespread adoption of depth sounding technology at this time was likely to be integral in the discovery of previously unfished Rock Lobster habitat. The expansion of effort into deeper water and slow growth areas off the west and south west coasts from 1957 to 1966 led to greater landings of smaller Rock Lobster. This was reflected in changes in the average size of Rock Lobster, which shifted from around 1 kg to between 0.8 to 0.9 kg as per current values (Fig. 7.3).

By the mid-1960s, sustainability challenges facing the fishery prompted a restriction on the number of fishing licences issued. From that point, the number of registered pots has remained similar to the number used today. The impact on annual catches was dramatic: from 1967 to 1974, annual catches fell by 35%. The fishery then stabilised and for the next eleven years, both catches and catch rates rose jointly. It was not since the late 1920s that both measures increased concurrently for more than one year in succession. Further sustainability challenges faced after catch rates ceased rising in the mid-1980s eventually led to the introduction of output controls in the form of Individual Transferrable Quotas in 1995. Commercial production levels since then have been limited by a total allowable catch that is reviewed annually.

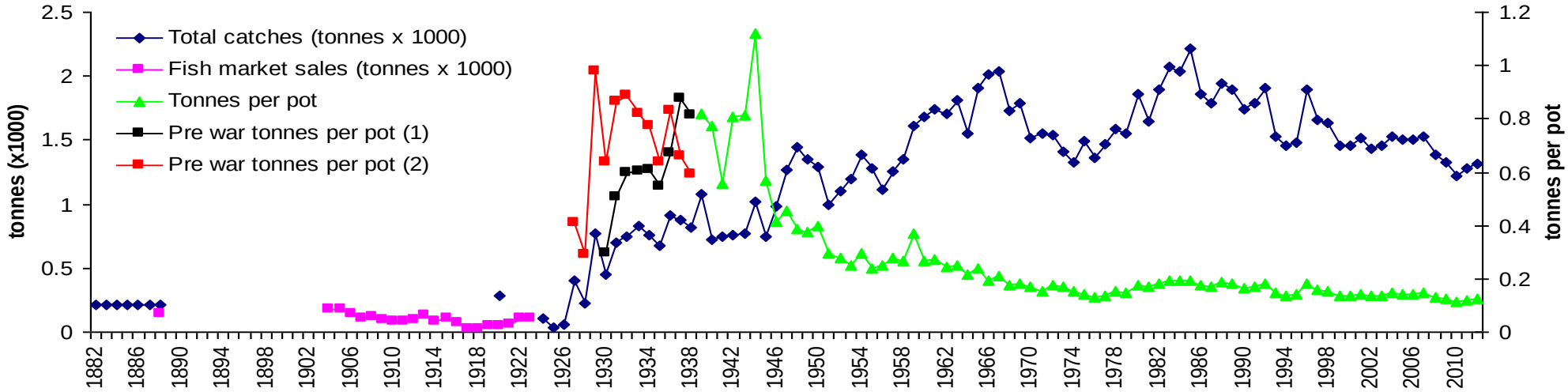

Fig. 7.2. Total catches, fish market sales and average catch per pot for the Tasmanian Rock Lobster fishery. Fish market sales encompass sales for the Hobart Fish Market from 1904-1923 and the Launceston Fish Market from 1920-1923.Pre war tonnes per set (1) and Pre war tonnes per pot (2) are based on data series A and series B, respectively, reported in Section 7.2.3.

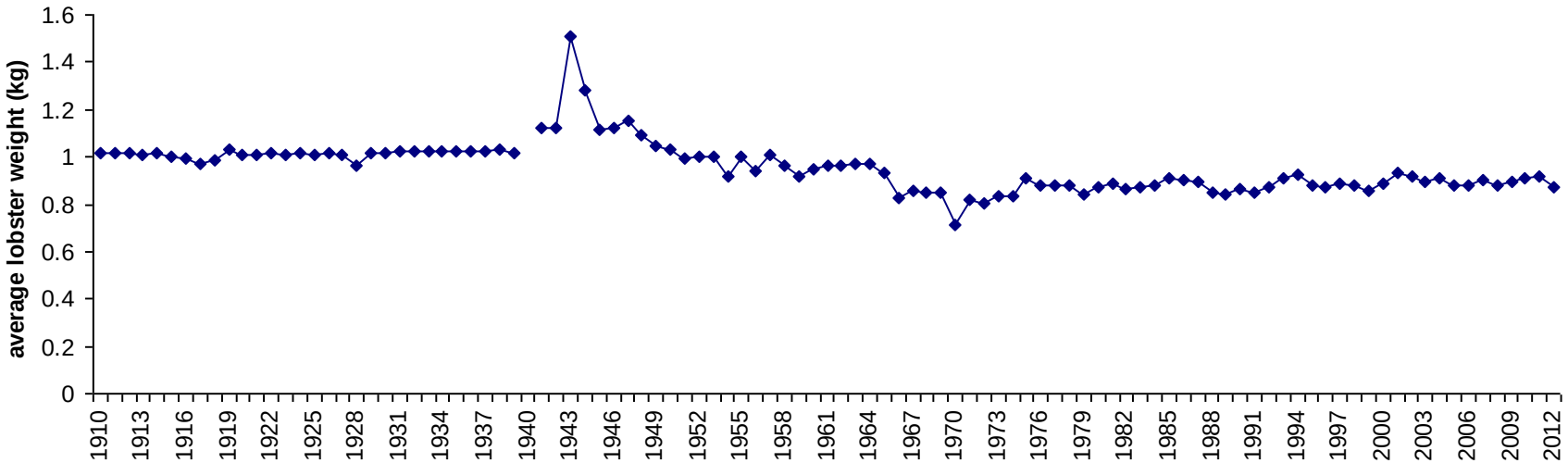

Fig. 7.3. Average Rock Lobster weight (kg) for the Tasmanian Rock Lobster fishery from 1910 to 2012.

7.3 FISHER INTERVIEWS

Twenty-seven respondents were interviewed about Rock Lobster. One fisher provided information pertaining to four regions while another provided information for two regions. As this study focuses on species caught within defined regions over long time scales, multiple contributions by these two fishers were treated as discrete data entries. As such, 31 'entries' were collected and reported. A further two fishers, who were not specifically interviewed about Rock Lobster, also provided unsolicited qualitative accounts relating to early Rock Lobster abundance. These accounts were also used in this chapter.

The earliest recollection of Rock Lobster captures was 1942 and the average commencement year of Rock Lobster fishing was 1961. Though many interviewees commenced fishing with 'cray rings' (hoop nets), almost all fishers used lobster pots during their fishing careers and it is this experience that quantitative analyses are based.

Table 7.1 provides a summary of each entry including regions fished, period of involvement, gear type and sector. The east and south east regions were disproportionately represented in geographical terms, though the pattern is consistent with the distribution of Rock Lobster fishing effort around Tasmania. Some fishers provided information relating to commercial fishing; however, as all commercial fishers interviewed have now retired, this was generally limited to earlier stages of their overall period of participation. All ex-commercial fishers interviewed still participated as recreational fishers at the time of interviews. As the same mode of capture (i.e. lobster pots) is used by both commercial and recreational fishers, data collected pertaining to catch rates and average sizes were deemed comparable across sectors. However, in recognition of the greater capacity of commercial vessels to fish further from shore and in greater depths, interview data from former commercial fishers was restricted to Rock Lobster caught in less than about 20 metres of water.

7.3.1 Abundance

Semi-Quantitative Interview Data

Abundance data was collected as the average number of legal-sized Rock Lobster caught per pot-lift. This method of assessing abundance excluded two fishers: one fisher only used rings whilst another predominantly dived for Rock Lobster and did not use pots often enough to provide confident average catch data.

All fishers reported a decrease in catch rates since they commenced Rock Lobster fishing. Furthermore, all reported current catch rates to be either at, or equal to the lowest point over their entire period of participation. Only two fishers we able to estimate catch rates prior to 1950. Since then, recollections of catches decreased from around seven legal-sized fish per pot to a current average of 0.7 fish per pot (Fig. 7.4). The current average catch rate is in fact comparable to that reported in the most recent survey (2010-11) of the recreational Rock Lobster fishery (Lyle and Tracey, 2012b).

Table 7.1. Summary of particulars for Rock Lobster interviewees

	Region 1	Region 2[1]	Started	Finished[2]	Comm / Rec	Mode[3]
Fisher 1	E	Maria Island	1983	Current	Comm / Rec	P
Fisher 2	E		1942	2000	Rec	P
Fisher 3	E	Swansea	1962	Current	Rec	P
Fisher 4	E	Swansea	1969	Current	Rec	P
Fisher 5	E	Orford	1960	Current	Rec	P
Fisher 6	E	Orford	1960	Current	Rec	P
Fisher 7	E	Marion Bay	1955	Current	Rec	P
Fisher 8	E		1948	Current	Comm / Rec	P
Fisher 9	E		1962	Current	Rec	P
Fisher 10	NE	Flinders Island	1946	Current	Comm / Rec	P
Fisher 1	NE	Musselroe Bay	1965	Current	Comm / Rec	P
Fisher 11	NE	Musselroe Bay	1975	2003	Rec	P
Fisher 12	NE		1955	Current	Rec	P
Fisher 10	SE		1953	1966	Comm	P
Fisher 13	SE		1975	Current	Rec	P
Fisher 14	SE	Eaglehawk Neck	1972	Current	Rec	P
Fisher 15	SE	Port Arthur	1960	Current	Rec	P
Fisher 16	SE	Tasman Peninsula	1974	Current	Comm / Rec	P,D
Fisher 17	SE	Great Taylor Bay	1970	2010	Rec	R
Fisher 18	SE	Port Arthur	1968	Current	Rec	P
Fisher 19	SE	Eaglehawk Neck	1975	Current	Comm / Rec	P
Fisher 20	SE	Port Arthur	1968	Current	Rec	P
Fisher 21	SE	Eaglehawk Neck	1965	Current	Rec	P
Fisher 22	SE	Southport	1950	Current	Rec	P
Fisher 23	SE	Southport	1950	2000	Rec	P,R
Fisher 10	W	Strahan to SW Cape	1956	1978	Comm	P
Fisher 10	W	Strahan to Sandy Cape	1966	1978	Comm	P
Fisher 24	W		1955	Current	Comm / Rec	P
Fisher 25	NW		1940s	Current	Rec	P,R
Fisher 26	NW		1940s	Current	Rec	P,R,D
Fisher 27	NW		1955	Current	Rec	P,R

[1] Specific locations have been provided only when reported Rock Lobster fishing pertains to such. If no entry is provided, respondent reported fishing at various locations within Region 1 over the duration of their fishing career

[2] All respondent with a commercial fishing status are no longer currently working as commercial Rock Lobster fishers. If their present status is indicated as "current", this refers to recreational fishing

[3] P, R and D refer to Pot, Ring and Dive, respectively

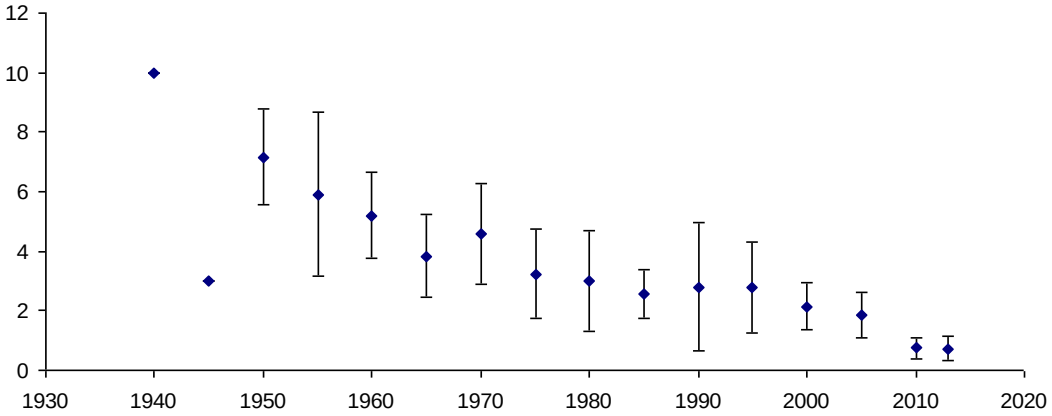

Fig. 7.4. Reported Rock Lobster catch rates between 1940 and 2013, expressed as the average number of legal-sized Rock Lobster (+/- SD) caught per pot-lift

Historical catch rates based on fisher interviews were considerably higher than those for the commercial sector for the corresponding period and suggest that catch rate estimates recalled by interviewees have been exaggerated (Figure 7.5). From the 1950s to 2012, the average number of Rock Lobster per pot-lift for the commercial fishery declined from 2.6 to 0.9, corresponding catch rates provided through interviews were 5.9 and 0.7 legal-sized Rock Lobster per pot-lift. While catch rates follow similar overall trends and converge for contemporary observations, interview based estimates are roughly double those based on commercial data for the years prior to1995.

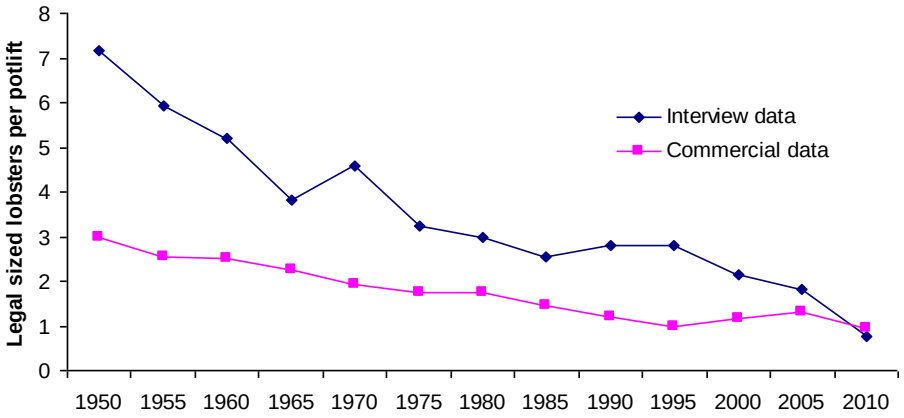

Fig. 7.5. A comparison of reported Rock Lobster catch rates from interviews with commercial whole of fishery catch rates, expressed as the mean number of legal-sized Rock Lobster caught per pot-lift. Data were aggregated into blocks of five years.

As most respondents to this study fished in shallow waters on the east and south-east coasts, it is more relevant to compare catch rates with commercial data for corresponding areas and depths. However, commercial regional data for shallow waters are only available from 1983, and the manner in which interviews were conducted in this study means that data for more recent decades is limited. Regardless, commercial data indicate that between 1983 and 2012 catch rates for

these areas (Fig. 7.6) follows a similar pattern to that for the whole of fishery (Fig. 7.5), although the extent of the decline in these areas was greater (73 and 58% on the east and south-east coasts, respectively) compared with the state-wide decline (40%) in commercial catch rates for the period.

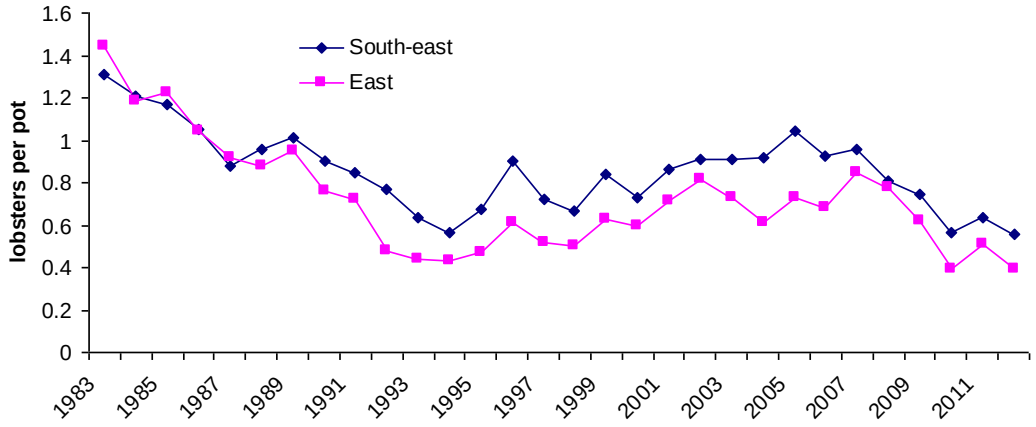

Fig. 7.6. Commercial catch rates, expressed as the average number of legal-sized Rock Lobster per pot-lift, for shallow water (<10m) in the east and south east regions between 1983 and 2012

Separate recollections of historical catch rates were attempted for four regions – south east, north east, east and west, although due to the relatively low numbers of participants providing data for the latter two regions the determination of catch rates for individual time periods (in 5 year blocks) was performed differently to that described in the General Methods section (Fig. 7.7). Specifically, when a participant suggested that catch rates had declined steadily between two points in time, catch rates were interpolated for the intervening time periods between the two 'book-end' catch rates based on a linear trend.

The results suggest that recreational catch rates over time have been similar for the east, west and south east coasts and followed similar trajectories over time. Catch rates on the north east coast were considerably lower than for the other three areas up until recently. In 1955, the first year block when all four zones were represented, the average numbers of legal-size fish reported per pot-lift were as follows: north east, 3.7; east, 8.2; south east; 6.3; and west, 6.3. For the same regions, current catch rates were reported as 0.4, 0.9, 0.6 and 1.1, respectively. Interestingly, catch rates derived from the 2010/11 recreational fishery survey for the same regions averaged 0.6, 0.8, 0.6 and 1.1 Rock Lobster per pot day, respectively (Lyle and Tracey, 2012b), implying confidence in the accuracy of the most recent estimates.

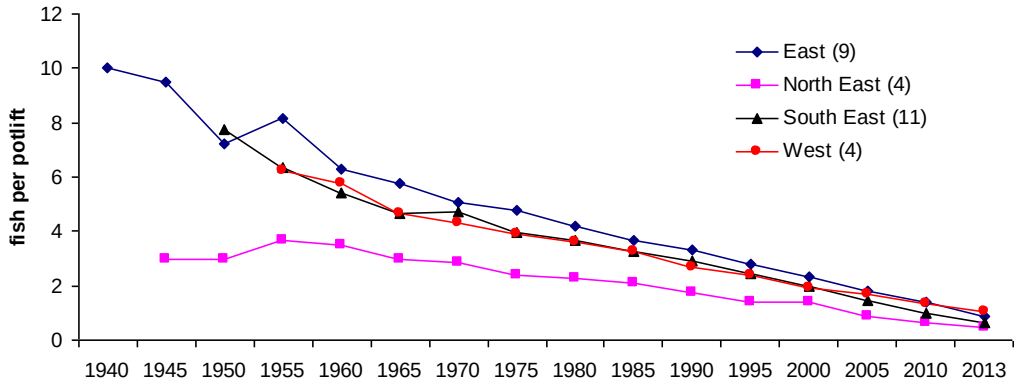

Fig. 7.7. Reported Rock Lobster catch rates over time for four regions, expressed as the average number of legal-sized Rock Lobster caught per pot-lift (numbers represent the number of respondents)

Two respondents who fished commercially on the west coast in the 1950s also provided catch data for areas which they perceived to have been largely unfished in historical terms. The catch rates are summarised in point form and may provide insight to virgin biomass for those areas:

- *Low Rocky Point*. Retained catches averaged 40-50 'score' per day. At 50 score, an average of 30 Rock Lobster per pot per day was kept. However, as pots were retrieved four times in a day, the average was 7.5 Rock Lobster per pot-lift.
- *Scud Rock* (near Pedra Blanca). An average of two tonnes per day was caught. Using 40 pots provides an average of 50 kg per pot per day.
- *South West Cape.* Up to 60 score (1440) were retained per day. Using 40 pots represents up to 36 Rock Lobster per pot per day.
- *Point Hobbs.* Catches were up to 24 legal-sized fish per pot per day across three day shots.
- *King Island.* At an unfished reef south of King Island, 900 Rock Lobster were caught per day, averaging 1.2 kg, with three day shots using 30 pots. This equates to 10 Rock Lobster per pot-lift or 12 kg per pot-lift.

These reports also suggest that temporal comparisons using unstandardised pot-lift data may underestimate the degree of catch rate change through time. For instance, recreational and commercial Rock Lobster fishers now rarely fish during the day due to the reasonable likelihood of negligible catches. The transition (particularly for the commercial fishery) from multiple day shots to a single night shot occurred more recently on the west and south west coasts than in other areas. As such, pot-lift values for the west coast reported in Fig. 7.7 may underestimate the relative abundance of Rock Lobster in comparison to other areas as the data provided for west coast was from former commercial fishers.

Fishers were further asked to recall the largest number of legal-sized Rock Lobster they had caught in a single pot haul during their fishing careers. These values were plotted according to year of capture and region and ranged between 4 and 69 (Fig. 7.8). Consistent with catch rate data, the largest individual catches reported for the north east were substantially lower than those reported for all other regions.

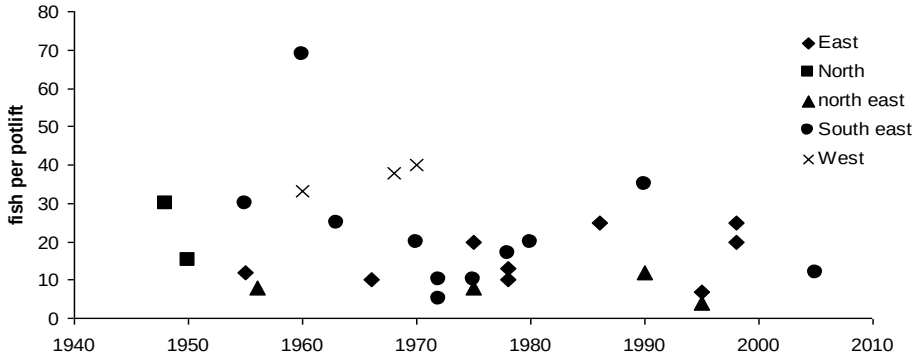

Fig. 7.8. Highest ever reported number of legal-sized Rock Lobster in a single pot-lift

An assessment of when fisher's largest catches, within the context of their fishing careers, was also undertaken. To do this, each respondent's period of involvement was divided into three equal time periods representing 'early career', 'mid-career' and 'late career'. The proportion of fishers who recalled taking their largest catch within those periods was 63%, 23% and 13%, respectively (Fig. 7.9).

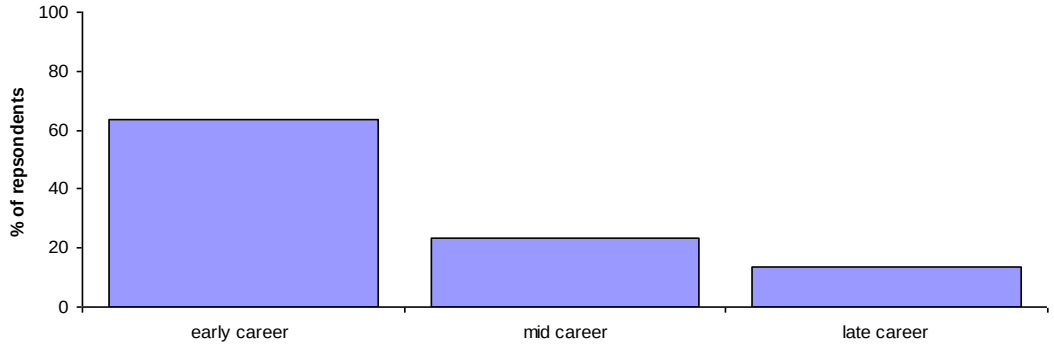

Fig. 7.9. Timing of largest pot-lift values relative to respondent's fishing career 'stage'

Qualitative accounts of abundance

Comments from fishers regarding the availability of Rock Lobster over time were consistent with the pattern of estimated catch rates, i.e. they suggest a considerable and steady decrease in density of legal-sized Rock Lobster during each respondent's fishing career.

Additional comments were provided by respondents who weren't specifically interviewed regarding Rock Lobster but were avid Rock Lobster fishers nonetheless. Most interviewees commenced fishing for Rock Lobster using rings before progressing to using pots, despite having access to boats from a young age. Some mentioned that the progression was necessary in light of a decreasing availability of Rock Lobster, particularly in shallow waters. In describing declines in density of legal-sized Rock Lobster, many fishers provided detailed anecdotes of the abundance of legal-sized fish early in their fishing careers. Some of these are provided in Table 7.2 according to different coastal regions. Broadly speaking, in all coastal regions of

Tasmania, scenarios depicted by recollections of legal-sized Rock Lobster abundance would be unrecognisable to fishers today.

Most fishers also provided an account of the current state of the fishery within the areas for which they had a long-term involvement in Rock Lobster fishing. Some of these accounts are presented in Table 7.3; in some cases, a comparison of previous legal-sized Rock Lobster abundance to present abundance is provided. Most fishers also provided detailed explanations of factors thought to reduce catch rates. Some of these responses are provided in Appendix 2.

Interviewees were also asked to comment on when they perceived the decline in legal-sized Rock Lobster abundance to be most noticeable. When responses were grouped into decadal blocks, there was no consistent pattern from the 1960s to the present (Fig. 7.10). Four respondents suggested that declines in catch rates were steady over their period of involvement. All fishers who suggested that the most noticeable declines occurred after 2000 fished the south-east coast.

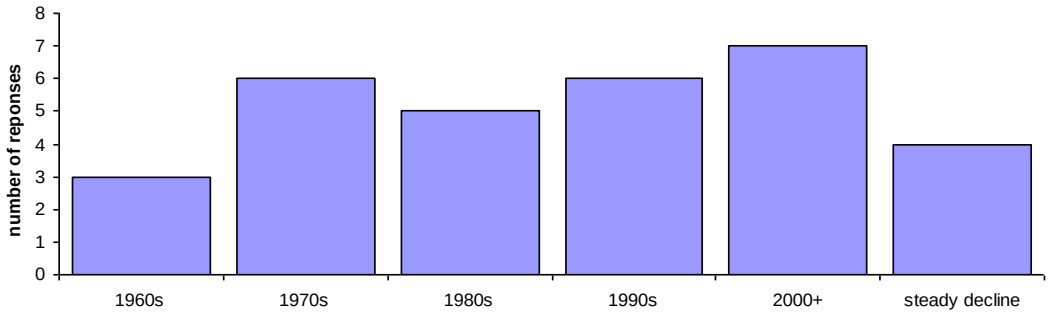

Fig. 7.10. Reported timing of the greatest period of Rock Lobster declines, by decade

Table 7.2 Qualitative accounts of legal-sized Rock Lobster abundance. Information in the margin relates to location, time period and fisher number (corresponding to fisher numbers in Table 7.1). Quotes without fisher numbers relate to information provided by fishers not specifically interviewed about Rock Lobster.

East Coast c. 1960	*We'd drive to the southern corner of Friendly Beaches and we'd camp there the night. We'd set our nets and then we'd walk up over this big cliff. And there was this big rock there, about as big as the house. And between the rock and the shoreline there was this little canal going through it. We'd throw our rings in on the full moon and get as many crays as we wanted.*
1960s	*I remember in the 60s, on New Year's Day, we'd take 3 or 4 land rovers and we used to go into Friendly Beaches track and drive along the beach right up until bottom end corner of Friendly Beaches. We'd take a couple of tinnies and you'd get 200 crays, just with rings - 200 crays in a couple of hours just with rings.*
Fisher 25 1958	*With the east coast…..I went there on my honeymoon……55 years ago. And I walked out to a little place there and you could see the crayfish running around on the bottom and every day you went I saw them. So in the end I got a chaff bag, four bits of tea tree stick, tied the corners, tied a stone on each corner, cut some holes in it so it didn't balloon too much, dropped it on the bottom with a bit of bait and caught all the cray I wanted. But before that, me and others, we'd just drop a line with a bit of bait on and bring it slowly up and you'd bring it up with a crayfish on it.*
Fisher 8 1950s	*You nearly didn't have to worry about measuring anything in those times 'cos they'd take all the best fish out of the pot and then anything that looked like being close to undersize they'd throw it back in. That was the quantity of fish that were around in those times.*
South East Fisher 15 Early 1950s	*We used to go out to Blackmans Bay in the very early 50s and it was nothing to get 100 crays in a day in a ring. We used to go down, put the dinghy in the water and row around to the island. There's a little island just below there and four or five of us would go with four or five rings. And normally if you put a ring down now, you gotta leave it in the dark if you even get anything in it. But this was in the daytime in 10 foot of water and you could look down and see them walking in it. We used to go there once every 3 or 4 months and if you didn't get 50 or 60, you was going bad.*
Fisher 6 c. 1950	*Out of Crabtree Quarries was quite a good strand of* Macrocystis pyrifera*. We'd go out with four rings and get two chaff bags full in three hours.*
North East Fisher 17 1961/62	*I went up to Anson's bay again, the same place and never had no rings so I found some wire netting. You had a 2 mile walk down there and there was some old cray pots smashed up on the rocks so I just put the wire netting around the cray pots and I walked in the water up to here (points to his waist), it was low tide and just dropped the cray pots off there. I mean its illegal and they weren't registered or anything like that but I used to get some beautiful big crays in there and lots of 'em too. In water that deep* [points to his waist].
Fisher 1 1960s	*When we first got into pots, we only had one pot for the whole family. But that was enough 'cos we always got 2 or 3 big crays whenever we wanted.*
Fisher 26 1949/50	*That's what it was like at Boat Harbour in 1949, 1950. Every tiny nook and cranny, didn't matter how big or small it was, had crayfish.*
West Coast Fisher 26 c. 1900 1940s	*My grandfather used to go down the coast shooting at the turn of the century…..and they'd row down Macquarie Harbour and into Birches Inlet and walk down to the Spiro, way down. They reckon then that you could actually wade out into the water and pick 'em up.* *There was just no end to the amount of crays around the place in those days.*
North-West Fisher 19 c. 1960	*When I was going to Burnie High School, there were a bunch of us who were fans of Jacques Cousteau and we bought the most primitive of wetsuits……we would go diving at Burnie High School in the lunch hour off Parsonage Point. Nobody knew. We used to snorkel for crays and after we'd been diving – this is on the weekends and holidays – we'd got to pubs in Burnie with a big sack full of crays and sell 'em in the pub.*

Table 7.3. Qualitative accounts of the current state of the recreational Rock Lobster fishery. Information in the margin relates to location, time period and fisher number (corresponding to fisher numbers in Table 7.1).

East Coast Fisher 14	*We put pots in at the crayfish season opening and the bait wasn't even touched. We asked around nobody caught anything, well somebody lied and said they caught five but nobody believed them. But nearly everybody who did fish caught nothing.*
Fisher 7	*I can still recall many a time my dad pulling up these pots, and these were big (commercial) fishermen's pots. And they were absolutely chocker block full of crayfish, and no kidding, at the last little bit as they were coming up you would see them hang off the side….This would be back in the 50s and 60s type of thing…..Going back along there, all the area along there was just crayfish plentiful. But the last dive I had through there which would have been seven or eight years ago, right in along those shorelines it was bare, barren. You would have to go out to about 20 or 30 metres of water before you would see anything that looked like crays.*
South East Fisher 22	*Dad, just prior to that, took this craypot to the Burial Grounds at Southport…..he carried the pot on his shoulder* [to be launched form shore]*, he chopped the roosters head off, wired it in the pot and staggered home the next day absolutely loaded with crays. And you won't get a cray there today, all along that shore there.*
Fisher 19	*For diving, it used to be like shopping at Coles out here* [Tasman Peninsula]*. You could just drop down, look under the ledge and go "right, now which crayfish am I gonna take? I'll have you and I'll have you". We'd get way more than we needed in the boat and then go "OK, I'll take that one, that one and that one and that one" sort of thing. And then put the others in a bag, take 'em back to the bottom and let 'em out. And those same ledges, no crays on 'em now. There's a lot said about the urchins and the kelp forests are all gone, but the crayfish just aren't there.*
Fisher 19	*I mean, people were used to getting half a score a pot and then happy if they get half a dozen fish because the price per kilo was going up, commercial fishermen were happy sort of thing. But now it's got to this, its crashed, it really has, it really has. There are people out there who are really good fishermen who can't make a living.*
Fisher 20	*If you don't land the pot right in their living room, you're not gonna get any. I don't know, the fish don't want to move or they're just not there.*
Fisher 15	*When I first went there* [Port Arthur] *in 1960, I built a shack down there, just in front of the shack, right along the shore, you'd put a couple of pots there and they'd be full the next morning. You wouldn't even get one rat in there now, you know.*
North-West Fisher 26	*I remember the first time we ever went to Boat Harbour* [in the 1940s]*. You could stand up to your knees anywhere and see crayfish everywhere. In every nook and cranny, crayfish from that big to that big* [gestures]*. If you've ever dived off Boat Harbour, there is shelf after shelf after shelf going out deeper and deeper and deeper. And they all used to be chocker block full, and I mean chocker block full of crayfish….now its just barren rocks, totally barren, I mean barren, its just rocks, bare rocks, everything's gone, the whole ecology has changed. The kelps gone too, it's all gone.*
Fisher 25	*There's a shallow area there, just below Cape Lodi, half a mile long and a mile wide and shallow water, just tumbled loose rocks. That was an absolute moving mass of crayfish. And now you go dive there, there's nothing. Absolute zero nothing, just barren, desert, just rocks, bare rocks.*
Fisher 26	*We used to probably get the same amount but we had to work a lot harder to get them. Whereas now, we still work hard but don't get any.*
South West Fisher 10	Extracted from an anecdote about a recent fishing trip to Cox's Bight from a former commercial fisher who used to fish in the same area *....I was surprised at how scarce the fish was, how much they've caught. You know the places where we put pots, in the middle of the Cox's Bight area, and beautiful bottom where it was always productive - we got nothing…..And I never ever did that when I was fishing. I never ever caught nothing. We used to get poor lifts sometimes and we used to get heaps of little ones, but now, nothing.*

7.3.2 Size

Fishers were asked to estimate the average carapace length of retained Rock Lobster caught both when they first started fishing and during their most recent season of fishing. This was done by soliciting the average length of fish "over the measure". As the legal minimum size differs between males (110 mm) and females (105 mm), estimated average sizes were recorded as the length "over the measure" plus 107.5mm – the mid-point distance between the two minimum legal-sizes.

One fisher indicated that the average length of Rock Lobster was currently larger than when he commenced fishing. Otherwise, all fishers indicated a decrease in average size over their fishing careers. On aggregate, average lengths of 'early' and 'late' Rock Lobster were 134 and 120 mm, respectively. When converted to weights, these correspond to 1.25 and 0.88 kg, respectively, or an average decline of 26%.

When data were grouped into regions, current reported average carapace lengths were as follows: south east and east, 115 mm; north-east, 142 mm; and west, 121 mm. Converted to weights, these sizes are generally consistent with those reported for commercial pot fishing in the most recent Rock Lobster fishery assessment (Hartmann *et al*., 2012). Regional declines (as a proportion of 'initial' sizes) were most pronounced for the south east and were least pronounced for west coast catches (Fig. 7.11 and 7.12). In terms of weight change, reported declines for these two regions averaged 31 and 11%, respectively. Fishers of the east and south east coasts frequently complained that nowadays, most legal-sized Rock Lobster are only a few millimetres "over the measure".

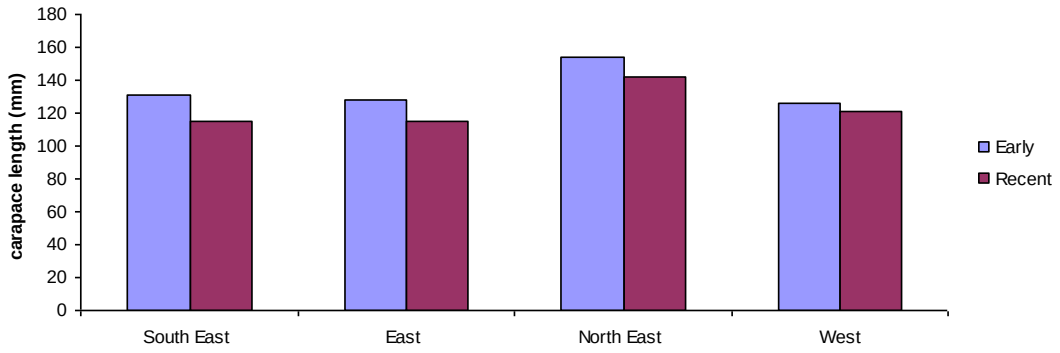

Fig. 7.11. Reported average carapace length of legal-sized Rock Lobster caught at the beginning of respondents fishing careers and during their most recent fishing season.

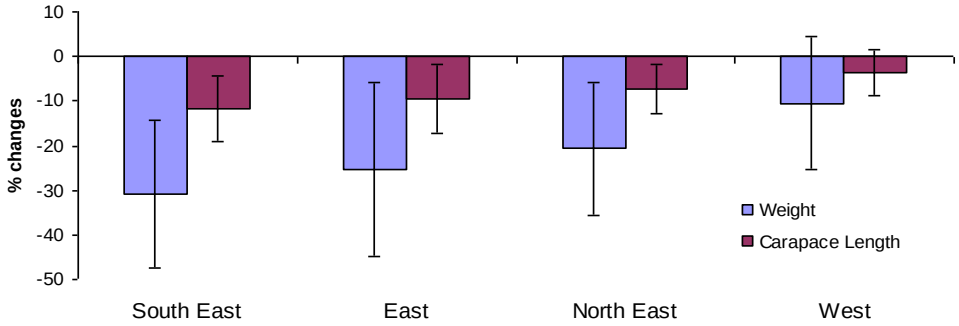

Fig. 7.12. Reported average weight decreases (+/- SD) of legal-sized Rock Lobster caught at the beginning of respondents fishing careers and during their most recent fishing season.

Reported historical and contemporary Rock Lobster weights were compared with commercial average weight data. Due to the high degree of spatial heterogeneity in the growth and size of Southern Rock Lobster in Tasmanian waters (Semmens *et al*., 2006), and the limited number of study participants, comparisons were limited to the region with the highest representation by study participants. The region, formerly known as "Zone A", which now comprises commercial reporting Areas 1 and 2, extends from Southport to Bicheno. Commercial weight data for this region is available from 1963 while for survey respondents, estimates of 'early career' average Rock Lobster weights extend from 1942 to 1983 (Fig. 7.13).

Both data sources converge at around 0.75 kg for contemporary catches. For historical catches however, the limited number of survey responses for the period of temporal overlap (between 1963 and 1983) limits robust comparisons. Nonetheless, seven of the nine data points provided through interviews were considerably greater than corresponding commercial Zone A averages. Prior to 1963, recollections of mean weights within Zone A averaged 0.95 kg (not including an outlier value for 1942). While region-based commercial data were not available for this period, the trend for the first few years of data collection (1963 to 1966) suggests that respondent's recollections were generally reliable. This suggestion is furthermore supported by average 'whole of fishery' commercial Rock Lobster weight data presented in Fig. 7.3, which shows that prior to the early 1960s, mean weights were close to 1 kg. However, given the low number of data points provided through this study, and the high degree of spatial and depth heterogeneity with respect to Rock Lobster size, inferences regarding the accuracy of respondent recall in this context are limited.

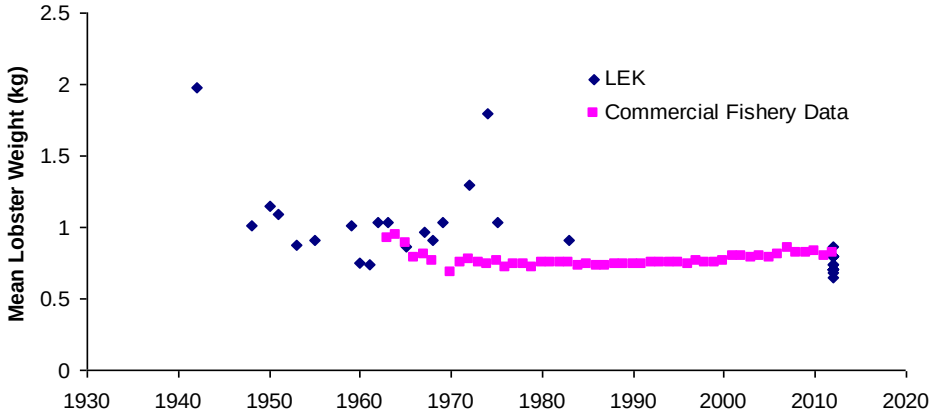

Fig. 7.13. A comparison between LEK average Rock Lobster weight data and commercial fishery data for the south east region (Areas 1 and 2), from 1942 to 2012. LEK data is represented as the estimated average weight at the commencement of fishers' 'careers' and for their most recent fishing season.

Fishers were also asked to recall the largest Rock Lobster they had ever caught, with all but two responding. Values were plotted according to year and region of capture (Fig. 7.14). The weights of largest Rock Lobster ranged from 1.3 to 6 kg, only one of these memorable captures was recorded after 1992. These data were also used to provide an assessment of when fisher's largest Rock Lobster were caught, within the context of their fishing careers. To do this, each respondent's period of involvement was divided into three equal time periods representing 'early career', 'mid-career' and 'late career'. The proportion of fishers who caught their largest Rock Lobster within those periods was 72%, 21% and 7%, respectively (Fig. 7.15).

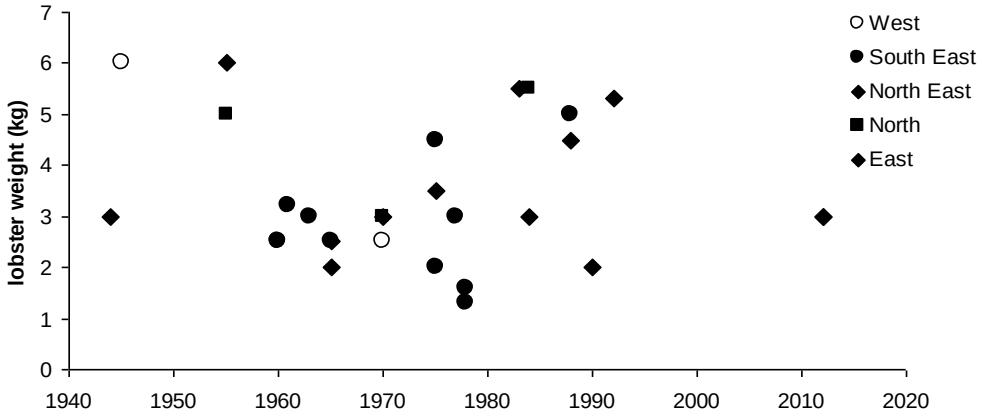

Fig. 7.14. Largest Rock Lobsters caught over the fishing careers of respondents

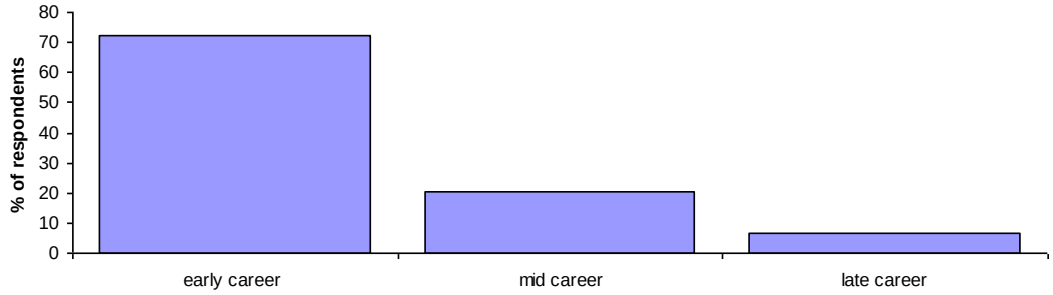

Fig. 7.15. Timing of the capture of respondent's largest Rock Lobster relative to fishing career 'stage'

7.3.3 Fisher Behaviour

Distances Travelled

Fishers were asked to estimate the average distance range they would normally travel on the water in order to set their pots; both when they commenced fishing and in their most recent year of fishing. As ranges rather than point estimates were provided by fishers, the data were analysed by assessing both the lower and the upper points of distance ranges. These points represent average minimum and maximum distances travelled, respectively. Interviewees who commenced Rock Lobster fishing as commercial fishers only provided data for the latter period. In total 22 fishers provided usable data.

Overall, the data demonstrate a trend of increasing minimum and maximum distances travelled on the water for fishers to set their pots over the period surveyed (Fig. 7.16). This is more apparent for maximum distances particularly since the 1950s, noting that the relatively high maximum value for the 1940s is based on just two respondents.

Interestingly, eighty percent of fishers who commenced fishing in the 1950s and 1960s provided a "zero" minimum travel distance as they often set cray rings or pots from the shoreline. Maximum distances travelled from the 1950s to the 1970s averaged 2.2 km, after the removal of outliers. This value is consistent with stories from fishers about setting pots and ring nets from unpowered or low powered dinghies. Average minimum and maximum distances travelled since 2010 were 3.2 and 12.1 kms, respectively. The combined effects of access to more powerful vessels and depletion of Rock Lobster abundances close to access points are likely to be contributing factors to this trend.

Depth Fished

Fishers were asked to estimate the average depth range in which they would normally set their pots; both when they commenced fishing and in their most recent year of fishing. Interviewees who commenced Rock Lobster fishing as commercial fishers only provided data for the latter period. In total 23 fishers were able to provide usable data.

Overall, the data demonstrate a trend of increasing minimum and maximum depths fished over the period surveyed, thought the relatively deep water fished during the

1940s is based on just two respondents (Fig. 7.17). The depth range in which respondents fished also increased over time. On average, the minimum depths fished in the 1950s, 1960s and 1970s ranged between about 2 and 7 metres, corresponding maximum depths ranged between 9 and 15 metres. Since 2010, reported average minimum and maximum depths fished for Rock Lobster have increased to 15 and 32 m, respectively. As for distances travelled (above), the progressive trend toward fishing in deeper waters over time is likely due to the combined effects of access to more powerful vessels and the greater depletion of Rock Lobsters in shallower waters relative to deep waters.

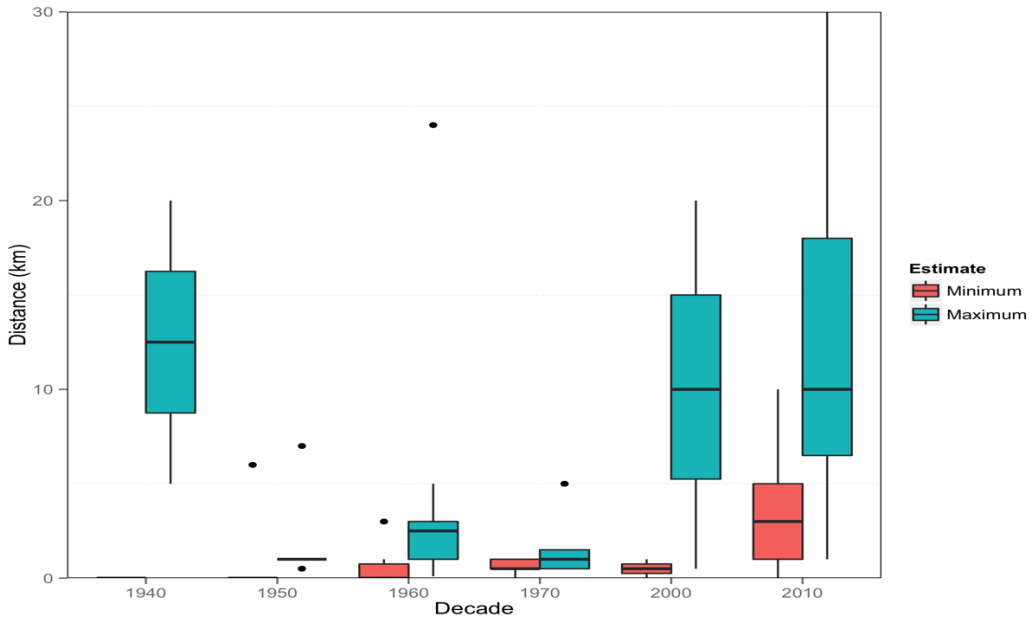

Fig. 7.16. Estimated maximum and minimum distances travelled by boat to access fishing grounds over time using box and whisker plots. The upper and lower "hinges" within each box correspond to the first and third quartiles (the 25th and 75th percentiles). The upper and lower whiskers extend from the hinge to the highest and lowest values within 1.5* the distance between the first and third quartiles, respectively. Data points beyond the end of the whiskers are outliers.

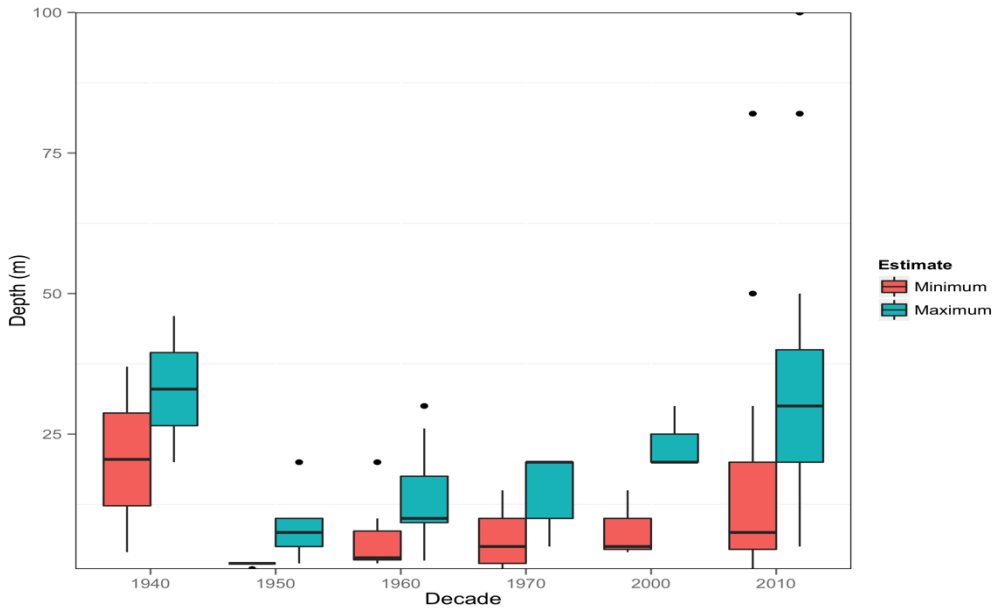

Fig. 7.17. Estimated maximum and minimum water depths over time using box and whisker plots. Refer Fig.7.16 for details.

7.4 DISCUSSION

The integration of multiple information and data sources to document the history of Southern Rock Lobster stocks has provided an expanded view from which to understand changes. While the history of the Tasmanian fishery is data rich from the 1940s, the use of archival information (and limited data) published before the systematic collection of detailed catch and effort data has provided an opportunity to understand fishery changes for this period and for more recent trends to be contextualised.

7.4.1 Historical research relating to Rock Lobster abundance

From a resource-based perspective, the history of the Tasmanian Rock Lobster fishery draws parallels with other documented fisheries, (e.g. Roberts 2007, Jackson *et al*., 2011), particularly before the intervention of input controls in the 1960s. The recent increase in research publications using historical information to better understand long term trends in the health of exploited fisheries generally converge around common themes. Themes that unite the current study with comparable research include the discovery of a fishery defined by 'incredible' abundance, initial unregulated exploitation and depletion of local areas followed by expansion of effort into unexploited areas coupled with technological advancements, which to some extent combine to mask fishery impacts.

Early accounts of incredible Rock Lobster abundance were soon followed by largely unregulated fishing, mainly through the use of hoop nets. While this was originally confined to easily accessible areas and depths, the expansion of sales saw the fishery expand further afield to supply local markets and later interstate markets. In the first quarter of the 20th century, the recognition of the development potential of the fishery precipitated the biggest revolution in the fishery – the legalisation of lobster pots in 1925. While lobster pots were not a new technology, fisheries administrators had

perceived that pots could collapse the fishery and repeatedly resisted pressure to overturn their prohibition.

After the legalisation of lobster pots, catches escalated dramatically. The use of pots expanded the fishery into deeper waters and allowed more effective fishing in areas unsuitable for hoop nets. The fishery experienced an unprecedented expansion of effort and rapidly evolving technologies enhanced efficiency. The increasing popularity of Rock Lobsters as food coupled with a rapidly growing Australian population provided a ready market and the appointment of steam-boat cargo services to Melbourne and Sydney streamlined the export trade. Furthermore, new fishing grounds were being sought and discovered along more remote regions of the coast.

While there is uncertainty surrounding catch and effort data during the early years after the introduction of pots, it appears that catch rates, expressed as tonnage per pot/year ranged between 0.3 and 0.8 before the Second World War. During the war years, effort decreased by around 25% and catch rates appeared to have risen to an average of around 0.8 tonnes per pot year. Immediately after the war, a rapid expansion of fishing effort saw annual production double between 1945 and 1948. However, during this time catch rates fell sharply to around 0.35 tonnes per pot year. It appears that the fishery, which was still largely centred on traditional fishing grounds, could not sustain such high catch rates with the extra fishing effort of a rapidly expanding fishery. It also appears that the decreased profitability associated with falling catch rates discouraged new entrants to the fishery from 1948 to 1951, when effort remained somewhat static. During this period, catch rates continued a downward trend.

In the early 1950s, effort again rose until the mid-1960s and total catches doubled between 1951 and 1966. Catch rates, however, declined by around 50% as deep-water and remote stocks that had previously not been fished were fished down. These trends were set against a backdrop of efficiency improvements including increasingly larger and faster boats and rapid advances in communications, navigation and depth sounders. The use of depth sounders was particularly noteworthy as echo-sounding technology enabled the rapid discovery of previously unfished habitat. By the 1960s, very few grounds were yet to be discovered (CSIRO, 1962).

By the mid-1960s, concerns about the economic performance of the fishery prompted a restriction on the number of commercial fishing licences issued. From that point, the number of registered pots has remained similar to that used today. The impact on catches was initially dramatic: from 1967 to 1974, annual catches fell by 35%. The fishery then stabilised and for the next 11 years, both catches and catch rates rose jointly. Catch rates finished rising in the mid-1980s then commenced a downward trend that eventually led to the introduction of output controls in the form of Individual Transferrable Quotas in 1998.

The use of tonnes of legal-sized catch per pot per year as the catch rate metric in the historical research component of this chapter has enabled Rock Lobster abundances to be inferred from the 1920s. While the weight of legal-sized catch per pot-lift is a more accurate and appropriate method, the necessary data were not collected until 1947. By this stage, available data and information suggests that legal-sized stocks had already decreased significantly within most areas apart from the west coast. Notwithstanding

the differing patterns of exploitation within regions and depths, comparing the annual catch per pot in the early 1940s (around 0.8 tonnes) with the current state-wide average of around 0.13 tonnes provides an indication of the magnitude of legal-sized biomass decline over that period. However, the catch rate used is particularly vulnerable to masking effects as technology improvements over time have conferred efficiency advantages relating to the balance between travelling and fishing time, the deployment and retrieval of pots, the location of suitable habitat, and the survival and storage of captured Rock Lobsters. The most remarkable developments in this regard appear to have occurred between the 1920s and 1950s. Therefore, when used to infer the abundance of Rock Lobsters, earlier catch rates will likely provide very conservative estimates when compared with later catch rates.

Another way of understanding species biomass approaching unfished levels is through biological surveys of Marine Protected Areas (MPAs). Information assessed in the current study appears somewhat consistent with Edgar *et al.* (2009) who assessed the relative biomass of Rock Lobsters both outside and inside the Maria Island MPA. In that study, there was an order of magnitude difference between areas protected from fishing for 16 years and fished areas. Low biomass of legal-sized Rock Lobsters off eastern Tasmania is thus of concern and the basis for recent management changes.

7.4.2 Social research relating to Rock Lobster abundance

Though some interviewees were former commercial fishers, collected data and information focussed on the recreational fishery, i.e. shallow water areas that are relatively accessible to trailer boats. Most respondents were long term fishers of the south east and east coasts, though other regions were represented.

Notwithstanding variability in responses between fishers and regions, overall trends suggest substantial decreases in catch rates over the past 50 years or so. Over time, respondents reported travelling increasingly greater distances on the water and setting their pots in deeper water. This is due to increasing access to boats with greater capacity as well as in response to the reduced abundance of inshore Rock Lobster stocks (poor catch rates) close ready access points. Over time, fishers recalled travelling further and fishing deeper whilst catching fewer and smaller Rock Lobsters.

Catch rates reported by fishers followed a similar overall trend for whole of fishery commercial data and converge for contemporary observations. However, the temporal decline reported by interviewees was considerably greater in scale, particularly before 1995. Between the 1950s and 1995, the catch rate differential between both sources was around 100%. From the 1950s to 2012, the average number of legal-sized Rock Lobsters per commercial pot has declined from 2.6 to 0.9 based on whole of fishery data. Corresponding catch rates recalled by fishers were 5.9 and 0.7 Rock Lobsters. Given that most of the data recalled for this study focussed on shallower, inshore waters, a comparison with commercial data from these waters would be more appropriate. However, commercial data differentiating catches based on water depth is only available from 1983. Due to the focus on ‘early career’ and contemporary catches during interviews, the limited data available for medium term decades did not allow for confident comparisons with shallow water commercial data.

Notwithstanding potential compatibility issues between whole of fishery commercial data and interview data collected in this study, the disparity in catch rates, particularly before 1995, suggests significant recall bias effects consistent with memory illusion (Matlin, 2004). The limited degree of data variability between interviewees further suggests that recall bias effects may have been fairly consistent and/or other factors other than memory illusion may be implicated. While the scale effects discussed above prevent recall bias from being quantified with any degree of confidence, the catch rate discrepancies should also be viewed in light of inter-sectoral fishing behaviour differences that may confound data comparisons.

Firstly, as recreational fishers are limited to one pot, they are likely to be particularly selective with their placement, whereas commercial fishers may tend to scatter pots less carefully over areas of suitable substrate. The effects of this may be inferred by comparing catch rates between commercial and recreational fishers who fish the same area. For the most recent recreational Rock Lobster fishery assessment for 2010/11, catch rates (kg of legal-sized biomass per pot-lift) in the east and south-east region were 28% and 42% greater than respective catch rates for shallow water commercial pot-lifts over the same period (recreational data supplied by J. Lyle). Secondly, during earlier periods, commercial fishers normally deployed pots multiple times within a 24 hour period in an effort to maximise catches; pots would therefore have a limited soak time, constraining potential catches on a pot-lift basis. The convergence of pot-lift catch rates in recent years may reflect a tendency for both sectors to do a single 'night-shot' with a 24 hour period. Information relating to the frequency at which recreational pots were pulled and deployed during fishers 'early careers' were not sought in this study. However, future work in this area should consider assessing this given the implications in comparing catch rates with commercial data, and therefore the magnitude of recall bias.

7.4.3 Rock Lobster size (historical and social research)

Anecdotal accounts during the 1800s indicate that very large Rock Lobsters were relatively common in south eastern waters. The first comprehensive historical record (based on market sales) of the average size of Rock Lobsters in the south east was 1.8 kg in 1890. It is possible that this reported average weight, from an area where the current average is 0.75 kg, may have already been influenced by the effects of prior fishing activities, which commenced in the early 1800s. Despite these uncertainties, it appears that the decline in state-wide average size of commercially caught Rock Lobsters from around 1 kg before 1957 to between 0.8 to 0.9 kg after 1966 is a result of fishing.

For all regions, most interviewees expressed that the average size of Rock Lobsters had declined over time. This was especially apparent in the east and south east where recreational fishing accounts for a large proportion of annual catch, particularly for inshore waters. For these areas, interviewees reported that over recent decades the majority of fish caught were only a few millimetres over legal-size. This suggests that catches are largely dependent on annual recruitment from undersized stocks and implies that either the exploitation rates are high or growth is slow. Declines in the average size of legal catch are consistent with increasing fishing pressure and a greater reliance on new recruits rather than changes in productivity or recruitment.

Across regions, the reported average weight of Rock Lobsters was suggested to have declined by about 25% over 50 years. The extent of the reported decline was in reasonably good agreement with state-wide 'whole of fishery' commercial data. When interview and commercial data were compared for the south east region (the region constituting the greatest representation by interviewed fishers), within the overlapping period, average reported Rock Lobster weights were considerably greater than for commercial data. However, the decline in mean commercial Rock Lobster weights prior to the mid-1960s demonstrated by limited south east data and by 'whole of fishery' data was reflected in fishers' recollections. Despite this, inferences regarding the accuracy of respondent recall in this context are limited given the low number of data points provided through this study and the high degree of spatial and depth heterogeneity with respect to Rock Lobster size.

8 GENERAL DISCUSSION

This study highlights the value of integrating different information and data sources to establish an understanding of historical stock trends for recreationally (and commercially) significant species. The use of archival information and data published before the systematic collection of catch and effort statistics provides an opportunity to better contextualise more recent trends, particularly those relating to changes in fish abundance and size. While fisher knowledge has provided valuable insights into relatively recent changes in the Southern Sand Flathead fishery, particularly in the absence of a significant commercial fishery and associated catch and effort data, the approach has also provided an alternative perspective with which to view trends in fisheries for which commercial catch data are available.

The results of this study also provide long-view insight into how much fishing effort different species can sustain. For species that were heavily fished soon after British colonisation, stock depletions occurred closest to population centres. In some cases the rate of stock reduction was rapid due to a combination of intensive and unregulated fishing and the use of non-selective fishing methods. In other cases effort was controlled by the introduction of fishing regulations. In time, developments to improve access and fishing capabilities enabled fishing in remote and previously unfished waters. By the 1940s, the entire coastline had become fully accessible.

This pattern of development for Tasmania's fisheries is common to fish species that were popular among consumers (in local and/or export markets), easy to catch with basic fishing gears, and locally abundant. This description is most relevant for Rock Lobster and Bastard Trumpeter, and to a lesser extent flounder. Rock Lobster and Bastard Trumpeter catches rose sharply in the 1920s and 1930s and then both catches and catch rates fell in the 1940s. It wasn't until the 1960s and 1990s that significant controls on catch and/or effort were implemented for the Rock Lobster and Bastard Trumpeter fisheries, respectively. While these controls appear to have been somewhat effective in arresting the pattern of decline, both species currently appear to be at close to historically low levels of legal-sized stock which has led to recent management changes. Declining abundances of Rock Lobster and Bastard Trumpeter were a source of great concern among fishers interviewed, some of whom have discontinued fishing for these species due to low catch rates.

The extent of the localised depletion of Greenback Flounder was a subject of great concern in the 1800s, especially in the Derwent and Tamar estuaries. However, depletions in these areas were addressed by the implementation of area closures, more selective fishing methods, the expansion of the fishery into neighbouring waters and the rising prominence of other fisheries. More recently, fisher knowledge suggests that Flounder stocks in some key local areas, particularly in the south-east, have not experienced declines of the same magnitude as other species investigated in this report. From a limited number of respondents however, more marked declines appear to have occurred within less prominent local flounder fisheries, which may warrant further investigation. Flounder currently have a low market value and are becoming less frequently pursued by commercial fishers.

Patterns of exploitation reported in this study were quite different for Southern Sand Flathead and Blue Warehou than they were for Southern Rock Lobster, Bastard Trumpeter and Greenback Flounder. Early community attitudes towards Flathead were negative, based largely on their appearance and reputation as a scavenger, and as such they were not heavily targeted as a commercial species. It has not been until relatively recently that they have been intensively fished, mainly by recreational fishers, and fishing accounts from the middle of the 20th century likely reflect the quality of fishing in a near pristine fishery. Since then, an apparent large decline in both catch rate and average size, as reported by fishers, suggests that fishing has reduced fish stocks, and within a comparatively short timeframe.

The Blue Warehou is unique among the species studied in that they are a schooling species that only frequent Tasmanian waters during seasonal migrations. Furthermore, high inter-annual variability in their local availability precluded large scale commercial fishing efforts until more recent times. While the species was caught by commercial and recreational fishers when available, catch volumes reported in historical data sources were unlikely to have had large stock-level impacts. The current depressed state of the stock in Tasmania is largely due to commercial overfishing by the Commonwealth sector during the 1980s and 1990s. Although a recovery plan has been implemented, this has not led to a demonstrable increase in stock in inshore waters as yet.

Four of the species investigated in this study were data-poor in terms of historical catch and effort. For Rock Lobster however, the ability to compare catch rate estimates of interviewees with long-term commercial catch rate data enables the accuracy of the former to be scrutinised, with implications for catch rate data collected for the other four species. Comparisons suggest that interviewees correctly identified the overall direction of abundance trends but the scale of the decline trend was exaggerated compared with commercial data, particularly before 1995. This suggests that data provided by fishers was affected by recall bias effects consistent with memory illusion (Matlin, 2004) rather than personal amnesia (Papworth *et al*., 2009). The manner in which the study was conducted and the overall agreement between fishers suggests that strategic or motivation biases, if present, were minimal.

However, other possible factors in the discrepancy between LEK and commercial data for the Rock Lobster fishery relate to fishery scale effects and differences in fishing behaviour between recreational and commercial fishers. As discussed in Chapter 7, ways to investigate the effects of these other potential bias effects should be considered in further research, with clear implications for understanding and quantifying recall bias. Also, the collection of logbooks or diaries from long-term fishers would provide supplementary information on abundance estimates that are not subject to recall bias effects. In the meantime however, CPUE estimates provided by interviewees in this study, and their inferences to species abundance patterns, should be viewed as indicate rather than absolute.

Overall, this study suggests that abundances of each of the species investigated have declined considerably over their period of exploitation. While this is expected, and is a natural consequence of fishing, the apparent scale and speed of the decline for some species, indicated by historical information and fishers recollections, is surprising. Pauly (1995) emphasised the need to avoid the "shifting baseline syndrome", whereby

successive generations accept progressively lower densities of fish as normal. The ability to estimate unfished biomass through the use of quantitative models may protect against this problem in some Tasmanian fisheries, including Southern Rock Lobster. However, population models are not available for other species and a better understanding of past states of fisheries can assist in setting management targets in these instances.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Fishwise Community Grants Scheme administered by the Department of Primary Industries, Parks, Water and Environment.

Special thanks are due to Tony Harrison and Ross Winstanley for providing documents and advice, Ingrid Van Putten for assistance with interview preparation and Julian Pepperell for accessing materials relating to early Tasmanian explorers. Also deserving of acknowledgements are Denise Garcia for providing access to commercial fishing data, Klaas Hartmann for assistance with data analysis and the staff at the CSIRO and Tasmanian State libraries for their generous assistance. Caleb Gardner and Colin Buxton provided many useful comments and valuable editorial input to this report.

Finally, this project would not have been possible without the willingness of numerous Tasmanian fishers who shared their valuable knowledge and insights.

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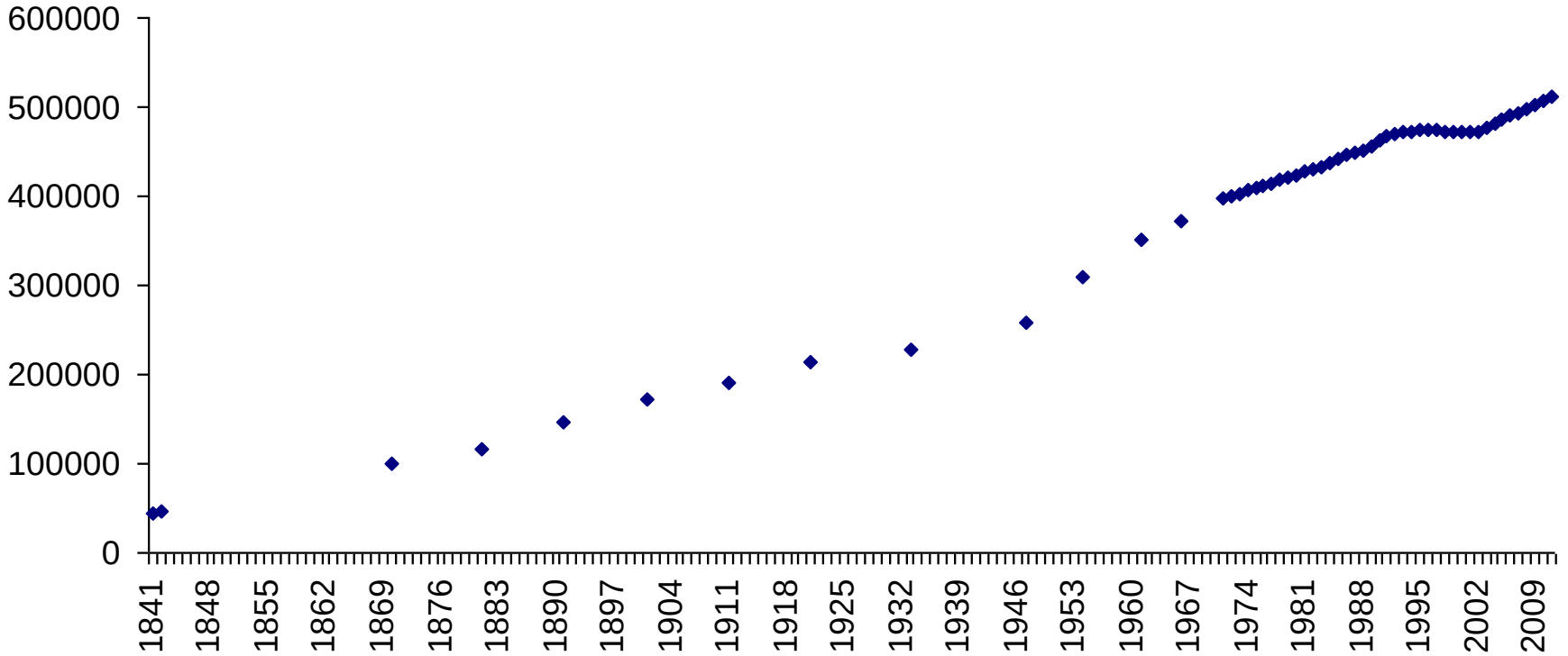
Appendix 1. Population (number of residents) of Tasmania – from 1841 to 2011



Appendix 2. Quotes from fishers regarding their views on factors responsible for decreased Rock Lobster catches.

Commercial Fishing	*When the weather is bad, the commercial fishers will hit these reefs* [inshore reefs between the gardens and Binalong Bay]. *I know the boys have gotta make a living, so I take that into consideration. What I don't take into consideration is how sometimes the commercial fishing is*
Fisher 27	*allowed to be done. I don't see why little areas or pockets of reef, and there's not a lot of them around the coastline, take Binalong for instance, get hammered……when you hit a little reef like that with 40 pots, you may as well forget about it – its all over*
Fisher 16	*Commercial fishermen, they've stopped working ledges like they used to and now shoot this boulder field stuff……they've wiped the ledges out, between them and the divers they've just about cleaned the ledges up.*
Fisher 16	*They're their own worst enemies, and I've had this argument with the boys at the neck all the time. I watched one commercial fisherman last week set 200 pots off the Blowhole Point. He's only got 50 pots on his boat but he did it for four days. For four days he did not move, all 50 pots working the same ledge for 4 days. And I said to him, "for Christ's sake S---n, how about leaving some for the rest of us"? And he said, "Oh M--k, Ive gotta make a living". So I said "yeah, I understand that mate but I got one and a half fish per pot there last night so I set the pots back there and I got ¾ of a fish the next night so I set the pots back there" sort of thing. I mean, he's making a living, he's got quota to catch, he's paid out a fortune for this quota. And I sympathise with him.*
Fisher 20	*Near the boat ramp, we've got Bother and Sister Island. I know a chap who used to row out there 'cos he hasn't got an outboard. Its only a hundred yards from the boat ramp and the professionals will come and put their 15 or 16 pots, that close, you know*
Fisher 18	*What they generally do at the beginning of the season is set their pots in the bay and clean the bay out, then they go further afield. That's been happening for years out here. If they get rough weather outside they set all their pots in the bay again. You might see 100 pots set in the bay which is more than the recreational pots*
Fisher 15	*The little bay at Port Arthur, there's four professional boats in there with cray pots. There's over 100 pots set in the bay when the season opens they bang straight in their pots where all the amateurs can go and clean the place up before they go outside.*
Recreational Fishing	*Nothings sacred out there no more, you know. If you've got a rock there, your favourite rock, where you could catch two of three crays, you'd have your markings or bearings. The guys will run past with their GPS, or put a buoy there and 'bang', there will be a net in there and next*
Fisher 11	*there will be a diver. It's a bit Raffertys rules now, it's a bit over the top. The poor ole fish aint got much chance.*
Fisher 14	*I think now, it's about putting a pot where there's been not one there before. Alright, blokes like myself, we used to go along, find a bit of kelp, oh yeah, here's a good place to put a pot. Now we got fish finders, bloody GPS's in boats, I've even got an old paper echo sounder in mine……Well, its like, you're all against the fish aren't ya? When I fished at Eaglehawk Neck first, I knew everybody who fished there. Now I don't know anybody hardly. The shackies weren't there, like they are now and its probably overfished too.*
Fisher 3	*There's that many people fishing now. Back in 69, there were no more than 4 or 5 blokes chasing them, maybe half a dozen, you know. And now, at Christmas time, you could damn near walk ashore on the buoys. There could be a hundred, you know the two ramps out there, between 75 and a hundred boats like. One day, last year they counted 75 trailers in Swansea*
General Overfishing	*You do get the bigger ones. But with intense fishing, where we'd work it once, and that was for they year, sorta, but now they're working it 20 times, so they do catch the bigger ones. So you're getting less oversize ones.* (Fisher 24)
Fisher 11	*The deep water Rock Lobsters have lots of natural fluctuations. In the inshore fish, it's not so much about fluctuations as it is about overfishing.*

Recreational Diving	*The divers find a place like that and they just keep going and going and going. They're actually depleting the stocks dramatically, the divers. They're diving into deep water, 10 to 15 fathoms they will dive* (Fisher 9)
Fisher 14	*There's a lot more divers around now. I mean back then, we were a rarity, divers. Now, you go out there of a weekend and there are hundreds of them. They've got the opportunity to get a lot more fish, they have the opportunity to bag out and the quite often do.*
Fisher 20	*You're always gonna get that element that don't give a stuff. They're just gonna be full on, it makes 'em look bad and it's the same with potters, just bad practices that they keep and they don't give a stuff.*
Fisher 26	*I still dive and I still love diving, just for diving's sake. And when I think of the beautiful bottom, one of the best dives you could do is at Boat Harbour and now it's a bloody dessert.*
Fisher 25	*To me, divers have done the most damage, because they've forced all the fish out into deeper water, and deeper and deeper water because of hookahs and lungs so kids go in the water and never see a crayfish (unless) they're very bloody lucky.*
Kelp Loss	*The scientists of the day said that if you cut the stems it would (re) grow, but it doesn't……were down to about 10 or 12% of what we had in 1946…..The only predator on the kelp is the large*
Fisher 5	*sea urchin….and the only predator for them (sea urchins) is large Rock Lobster. We've had a regime of taking the oldest ones and the biggest ones all the time so what we've done is knocked on the head, the only protection that it had.*
Fisher 8	*The kelp on the east coast has pretty much all gone. When you'd go out past Black Point, heading towards Little Swanport, there was big patches of kelp all the way up. D---k told me when the kelp was there, on a real hot day, you could go down with a dipnet and they'd (lobsters) would be laying just under the top of the kelp. Put a dipnet under and you'd get two or three crays…..Now you go back there and there's no kelp, there's nothing. I can guarantee you that there's no kelp all along that western shore, from Swansea to Triabunna,*
Sea Urchins	*When you clean the big crays out, then you got the sea urchins coming in. And because the sea urchins, they eat the kelp. When we used to go out….you had a job to set your nets, you sort of*
Fisher 17	*had to pick your way through the kelp. Now when you go down there, you don't see any kelp at all, its all gone.*
Fisher 27	*If you dive out here now, the damage that's been done by them (sea urchins) is massive, it really is sad. And everyone was saying that naturally because of the kelp and the food range of the cray has diminished so bad.*
Technological Advances	*In the 50s, it was all trial and error. You didn't have a 200 horsepower donk on the back of your boat, or even a 50 or 60 like mine. You would have to battle the elements and try to make it happen. Now you have GPS marks. I have reefs out there where I can drop my cray pot nearly down a crays mouth.* (Fisher 31)
Fisher 10	When asked about depth sounders improving catches*….Oh God yes! Yes it did because we could fish edges and go right to the outside edges and find little pieces of bottom that we didn't know about. It gave us more intense fishing and made it that much easier.*
Fisher 22	*We never had sounders back then. We just looked for a dark patch of reef and threw the pot in. These days yo got your sounders and underwater cameras to make sure the pot is jammed right in the crevice. The poor ole cray has got 'em coming after him from every direction.*
Fisher 26	*And I think your commercial fishers with GPSs and extra expertise and the rest of it are still getting their quota but that only because of their extra expertises*
Fisher 18	*Now with all the technology you got…..everyone can target where the rocky areas are and set your pots accordingly. Before, we used to rely on locating the kelp beds to set the pot next to the kelp beds*