Baitshop Survey Report 2008

With a focus on the supply and demand for bait-worms in South Australia

Professional bait-worm digger Lee Kelly at work

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Executive summary

Recreational fishing is an increasingly popular hobby both locally and globally. This rise in popularity has increased the world-wide demand for bait and has resulted in a higher demand for bait-worms than can be supplied. Bait-worms are a highly valued resource with a price tag, which is often higher per kg than that of human food. Evidence from overseas indicates that recently three main avenues have been adopted to fill this deficit 1) the culture of bait-worms, 2) the importation of live or preserved bait-worms or 3) by increasing the intensity of wild harvest (which has led to the development of a black market in Europe). None of these avenues has thus far proven sufficient to meet the current bait-worm deficit. Australia is currently mirroring the worldwide bait-worm situation, but to a much lesser extent, so is in the enviable position of being able to address the issue before it becomes dire, as has occurred in many parts of Europe and the USA.

Of the three main avenues attempted overseas, only two realistic options are available for Australia and indeed South Australia, due to our strict quarantine laws precluding the option of live bait-worm importation. The two remaining options are to increase the intensity of wild harvest and/or to culture bait-worms. There appears little chance of increasing commercial wild harvest for various reasons discussed later in this report, so the development of a culture industry may be the most viable means of addressing the bait-worm deficit.

Before considering the development of such an industry, it is imperative, and pertinent, to assess the current and potential markets for both live and preserved bait-worms within South Australia to assess the need for the end product. To this end, a survey was developed, distributed and the findings reported here. This survey was distributed to 92 retailers and 25 (27%) surveys were returned.

This survey has identified that:

- there is likely to be a market for aquaculture derived worms: 64% of baitshop owners would use a regular source of live worms with 17% of shop owners preferring cultured worms to wild harvested

- approximately 73% of anglers buy their worms from baitshops - which could equate to approximately 225,000 South Australian recreational anglers based on the 2000 - 2001 SA regional version of the National Recreational and Indigenous Fisheries Survey and ~$100 million of funds for fishing related expenses

- the responding baitshop owners estimated potential sales of live worms was approximately 1.25 tonnes in the first year. The survey respondent's sales accounted for only 15% of the total wild harvested bait–worms in the year surveyed, so the above estimate is probably conservative. The potential sales for preserved bait-worms was not assessed.

Statement of Purpose

The purpose of this survey was to both quantify and qualify the state of the South Australian recreational fishing bait market and to assess the current reliability/satisfaction of the supply chain from harvesters to baitshops. The intention was to use the information gained from the survey to determine if there is a place in the bait market for cultured bait-worms. Culturing worms will assist South Australia to meet its current bait-worm deficit, will increase product availability without increasing pressure on wild bait-worm stock and will avoid/minimise the importation of expensive and potentially environmentally damaging worms from overseas or interstate. The purpose of this report is to disseminate the findings of the Baitshop Survey to stakeholders and other interested parties in the bait-worm industry.

Scope of the survey

The survey targeted all South Australian baitshops identified from telephone directory listings and web-searches. Directory list sampling would not provide details of shops without telephone access or listed as a private number but this is unlikely for a business so it is believed that the survey was sent to the vast majority of registered retailers of baits to recreational anglers.

The survey is still available to any interested baitshop owners and the findings from newly returned surveys will be integrated into later versions of this report.

Introduction

What are polychaete worms?

Polychaete worms, or marine worms belong to the phylum Annelida or segmented worms, and are often the dominant type of organism in benthic (bottom) marine environments (Stoner and Acevedo, 1990). In their natural environment polychaetes perform many important environmental services such as sediment bio-turbation (Scaps, 2002), decomposition of organic matter, breaking down toxic ammonia based compounds in the sediment (Kristensen *et al*., 1985), release of nutrients back to the environment (Scaps, 2002, Batista *et al.*, 2003) and aeration of the sediment (Beesley *et al*., 2000). Polychaetes form a vital component of most marine food-chains and are regular food items for higher organisms such as finfish, crustaceans and birds (Navedo and Masero, 2007). Polychaetes vary in size from minute forms which live between sand grains, to individuals over three metres in length (Edgar, 2001, Thompson and Alam, 2005) and may live from several weeks to several years. Australia has representatives of approximately 80% of the extant (i.e. living) polychaete families from which more than 1000 species have been described (Beesley *et al*., 2000). It is expected that species suitable for culture are likely to be present within South Australian coastal waters.

Polychaetes as a resource

In most areas of the world polychaete worms are a valuable natural resource harvested from estuaries and beaches for two main markets: the bait market (Olive, 1993, Olive, 1994) and the aquaculture brood-stock maturation diet market (Lytle *et al.*, 1990, Olive, 1993, Gambi *et al.*, 1994, Olive, 1994). Polychaete worms have always been regarded as excellent fishing bait and over the past century, demand for worms has increased in response to both the rising popularity of recreational fishing and the advancement of the prawn and finfish aquaculture industries (Gambi *et al*., 1994, Olive, 1994, Olive, 1999, Henry and Lyle, 2003).

The Australian National Recreational and Indigenous Fishing Survey conducted in 2001 estimated that there were over 3 million recreational anglers (Henry and Lyle, 2003) equating to approximately 18% of the population at the time (Australian Bureau of Statistics, 2008). In 2001, South Australia had approximately 300,000 recreational anglers spending an average of $452 each per annum on their hobby. This equates to $135 million of funds to spend on recreational angling pursuits in South Australia each year. Recreational anglers noted three main reasons for their hobby, these were to get outdoors, to relax and unwind and for sport (Jones and Doonan, 2005). The rise in popularity of angling in Australia has mirrored the world-wide upsurge. In Europe and USA, demand for large live bait-worms has increased (Hutchings and Karageorgopoulos, 2003).

Traditionally, bait-worms were collected from local estuaries by anglers in sufficient quantities for their own use only (Brown and Wilson, 1997, Dernie *et al*., 2003, Griffiths *et al*., 2006, Navedo and Masero, 2007) and this subsistence level of harvest is believed to have had little impact on the environment. However, the relatively recent upsurge of recreational angling and the facts that recreational anglers often have insufficient time to harvest their bait, or would prefer to pay someone else to 'do the dirty work', have stimulated the development of a lucrative retail market

for bait-worms both overseas and in Australia (Gambi *et al.*, 1994, Fowler, 1999, Scaps, 2002). The growing commercial bait market, along with the relatively recent aquaculture brood-stock diet market, have substantially increased the demand for polychaete products (Scaps, 2002) both locally and globally. This situation is exemplified in both Europe and the USA where the demand for polychaetes far outweighs the supply (Fowler, 1999, Fidalgo E Costa *et al.*, 2006) and indeed has resulted in the establishment of a black market for bait-worms (Olive, 1999).

Quantification of the current deficit is difficult as little data exist in terms of volumes collected or volumes traded between countries (Gambi *et al.*, 1994, Fowler, 1999, Sherfy and Thompson, 2001). Rather, various estimates of the European and US bait-worm market have been made in terms of US dollars rather than as weights or numbers (Sherfy and Thompson, 2001). In the early 1990s the European bait-worm market had an estimated value of more than US$300 million which is expected to have increased since then (Olive, 1993). The US market reported US$22.7 million worth of live bait-worm imports into the USA in 2000 (Thompson and Alam, 2005). A second related survey reported approximately US$5.5 million of live marine bait-worms were imported into the USA in the early to mid 2000s, with approximately 1-2 million dollars worth coming from each of Belgium, France, the Netherlands and the UK (Sherfy and Thompson, 2001, 2005). It must be noted that these figures are both likely to be underestimates of the true value of the US bait-worm market as the eastern seaboard has had a large and very active bait-worm harvest industry since the 1950s (Cohen *et al.*, 2001). Likewise in the late 1990s, the UK market was estimated at between US$35-40 million but as the figures included crustacean and molluscs it is difficult to assess the true value (Fowler, 1999). In the USA, UK and Europe bait-worms command a high market price which is often higher per kg, than human food (Gambi *et al.*, 1994, Olive, 1994, Dagli *et al.*, 2005). The variance of reporting methods, and the discrepancy in the above figures, highlight the limitations in regard to quantifying the bait-worms market. Indeed, the true value of the global bait-worm industry will probably never be known unless strict reporting methods are introduced and adhered to.

The combination of high retail value and high demand has stimulated attempts to meet the market deficit. The initial response was to increase wild harvest, a practise which comes with associated environmental consequences discussed later in the report, followed by the development of small-scale polychaete aquaculture industries and the establishment of lucrative import/export markets for both live and preserved worms. These measures have indeed, increased production to some extent but on a global basis there is still insufficient product, whether wild harvested or farmed (Gambi *et al.*, 1994, Olive, 1994, Fowler, 1999, Sherfy and Thompson, 2001, Scaps, 2002, Thompson and Alam, 2005). Overseas research has shown that increasing the wild harvest intensity of commonly used bait-worm species has resulted in their overexploitation (Britz *et al.*, 2001, Lewis, 2005a) so the initiation of this practise, as a means to meet the market deficit, must be viewed with caution. Australia is in the enviable position of being able to learn from the rest of the world by addressing the bait-worm deficit issue before it becomes a significant problem. The above facts allude to the high value of bait-worms and the potential value of a culture industry and appear to suggest that culturing bait-worms would be a viable industry for South Australia.

The 2008 Baitshop Survey (Appendix 1) was developed to assess the retail bait market within South Australia in terms of quantity, preferred species, potential future sales and the reliability/satisfaction

with the current supply chain in South Australia. Other potential markets such as brood-stock diets and export markets are therefore not covered in this report.

The next section will consider the South Australian bait-worm deficit, how we stand currently in terms of supply and demand and our future options to fill the supply gap.

Professional Bait Harvesting in South Australia

Licenses

South Australia has five bait-diggers exclusively licensed to harvest and on-sell both live and preserved worms. These licenses are non-transferrable so as each digger retires their license will be lost from circulation. Two other licenses currently allow the collection and on selling of bait-worms, these are marine scale fishery (~340) and rock lobster licenses (~250). The extent of this harvest is believed to be small due to the labour intensive nature of bait-worm harvesting compared to the primary licensed activity (B. Walkley, Pers. Comm. 2009). The controlling body Primary Industries and Resources South Australia (PIRSA) has decided not to issue any new bait-collection licenses, based on the large number of licenses currently allowing worm harvesting and following the 'Precautionary Principle' (A. Montoya, Pers. Comm. 2009). Consequently, the number of people licensed to collect and sell bait-worms within South Australia is likely to remain constant or decline.

Production

PIRSA records show that the commercial wild bait-worm harvest decreased from ~14 tonnes in 2000 to the current static level of approximately 7 tonnes (Figure 1) (A, Sullivan Pers. Comm. 2006 and 2008) due to the retirement of some licensed harvesters (A. Montoya, Pers. Comm. 2009). The SA version of the National Recreational and Indigenous Fishing Survey reported harvest by recreational diggers in 2001 at approximately 0.6 tonnes (Jones and Doonan, 2005) but as there is no requirement to report their harvest, this figure is likely to be an underestimate. The current harvest data suggests no increase in future production levels. As such, it is unlikely that SA can expect wild harvest alone to meet either current or future demand for bait-worms, this fact is especially poignant when the static license situation is considered. As no new licenses will be issued the only way to increase wild harvest will be to increase the number of hours spent in the field by the current licensed diggers. Figure 1 suggests the diggers are working to their maximum capacity as figures have been static for the last six years. The question then is: '*how will South Australia meet the expected increase in demand for bait-worms?*'

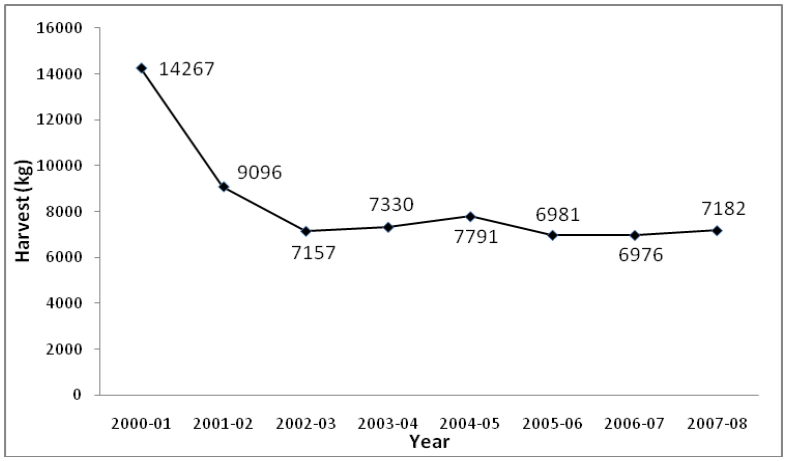

Figure 1. Wild polychaete harvest by licensed and recreational bait-diggers in South Australia from 2000 to 2008 (numbers equal the total reported catch in kg for each season)

Options to meet South Australia's demand for bait-worms

South Australia could potentially meet its bait-worm deficit by increasing the intensity of wild harvest locally, increasing the number of licensees or increasing the fishing effort by each licensee but, as discussed above, none of these options are likely to occur in the near future. In addition, any increase in wild harvest is likely to have negative environmental implications, both for the bait-worms and other associated sedimentary organisms as demonstrated by overseas studies (Mclusky *et al.*, 1983, Olive, 1993, Brown and Wilson, 1997). The harvesting of any organism from the wild has a maximum sustainable limit (MSL) in terms of the quantities which can be harvested before the remaining population is affected in a negative way (Pauly *et al*., 2002). The concept of an MSL for polychaete worms has been demonstrated in South Africa where increased harvest intensity, in response to increased demand, led to the overexploitation of at least two of the three targeted bait-worm species (Britz *et al*., 2001, Lewis, 2005b). The potential follow-on effects of this overexploitation, and the likelihood of recovery, are difficult to predict as little is known about bait-worm reproductive biology (Lewis, 2005b). So the above case should be used as a precautionary example with conservatism being the best management option. As such, it is unlikely that wild harvest will be able to meet SA's bait-worm demand.

The next option to meet SA's deficit would be to import live and/or preserved worms from interstate or overseas as has occurred in the USA and several European countries. Most of the worms imported into these countries are intensively harvested from the wild in developing Asian countries where there is no obligation to consider the environmental implications of their activities (Olive, 1994). As such, the imported product whilst partially filling the gap in the importing country has been shown to have negative environmental impact in both the exporting and receiving countries (Gambi *et al.*, 1994, Dernie *et al.*, 2003, Thompson and Alam, 2005, Griffiths *et al.*, 2006). In the USA and Europe, live imported bait-worms have escaped from anglers' hooks becoming established in the local environment where they could potentially become 'invasive species' (Sherfy and Thompson, 2001, Thompson and Alam, 2005) or even responsible for the introduction of novel pathogenic organisms which may be present on their bodies or in the packaging materials (Cohen *et al*., 2001). The

implications of novel pathogen introduction into local ecosystems or aquaculture industries are unknown but are likely to be negative (Gambi *et al.*, 1994, Olive, 1994, Fowler, 1999, Thompson and Alam, 2005, Fidalgo E Costa *et al.*, 2006). The risks associated with live imported bait-worms such as escape could be reduced by killing and preserving/treating the worms prior to export/import but unless irradiated the potential for the transfer exotic pathogens still remains (Cohen *et al*., 2001). Realistically, the importation of bait-worms is at best a bandaid solution to an ongoing problem and the practise cannot be expected to sustainably keep up with the growing demand.

The importation of live bait-worms is not currently (or foreseeably) an option for South Australia due to strict quarantine laws. However, it is currently possible to import preserved worms following irradiation treatment to destroy pathogens but no quantitative data are collected (D. Leelawardana AQIS 2006 Pers. Comm.). As such, there is currently no possibility of meeting the South Australian (or Australian) bait-worm deficit by importing live bait-worms from overseas but there are a couple of alternative options such as importing irradiated worms from overseas or importing both live and/or preserved worms from interstate. These options do however have drawbacks, which require consideration to assess their sustainability and suitability for the SA market. Importation of wild harvested preserved (irradiated) worms would partially fill our local market deficit but there are negative environmental implication for the producing country, as discussed earlier. Trials of imported irradiated worms during the mid 1990s found the product to be 'soft and unusable' (B. Walkley. Pers. Comm. 2009) so this product is neither sustainable or suitable for the SA market. As such, importation of live or preserved bait-worms from overseas cannot realistically, or ethically, be considered as an option to meet SA's bait-worm deficit.

The importation of preserved worms from interstate could possibly meet some of our market but few SA bait-shops (~15%) currently choose to purchase this product despite its ready availability. However, importing live bait-worms from interstate should be considered with caution due to the combined risks of escape/establishment in the local ecosystem and/or the introduction of novel pathogens from the eastern states. A final consideration for interstate importation is the associated extra costs in terms of transport, packaging, irradiation treatment and lower end-product quality compared to locally sourced bait-worms as identified in the survey responses (comment 9).

The third option to meet SA's bait-worm demand would be to culture one or more local species of bait-worm as has occurred in Europe, USA, Asia (Gambi *et al*., 1994) and interstate in NSW (Safarik *et al*., 2006). It appears that the most sustainable way to meet both current and future bait-worm demand in South Australia, Australia and possibly the world, will be to culture local bait-worms at the source of the demand, in aquaculture facilities as suggested by Scaps *et al* in 2002. The establishment of such an industry within South Australia could potentially meet, or at least partially meet, the demand for live and preserved bait-worms with the potential to extend into brood-stock diet and export markets at a later date.

The potential for a bait-worm culture industry in South Australia

Project Aims

The establishment of a bait-worm aquaculture industry in South Australia will be a lengthy process. Flinders University is investigating the key researchable constraints to the development of such an industry within South Australia. Thus, it is essential to first assess the current and future demand for bait-worms in South Australia by surveying bait retailers across the state.

The key researchable constraints to be investigated in relation to the establishment of a bait-worm aquaculture industry include:

- achieving captive year-round breeding for each species
- developing larval and juvenile rearing protocols for each species
- developing culture protocols for each species
- developing a sustainable and efficient diet for each species

Proposed research

As previously discussed, the development of an aquaculture industry for local bait-worm species may offer the only sustainable option for meeting the current demand for bait-worms (and aquaculture brood-stock feed) in South Australia. The use of local species in aquaculture is expected to minimise the likelihood of pest or pathogen introduction/transfer into local waters. The South Australian polychaete families targeted for evaluation in our research are presented in Table 1.

Table 1 Larger species of worms commonly used for bait

Family name	Common name/s	Used as bait in SA?	Studies
Arenicolidae	lugworms	**No but available**	(Olive, 1993, Fowler, 1999, Britz *et al.*, 2001, Lewis, 2005a)
Eunicidae	blood worm	**?/Yes** when found	((Oglesby *et al.*, 1982, Olive, 1993, Gambi *et al.*, 1994, Olive, 1994, Fidalgo E Costa, 1999, Fowler, 1999, Olive, 1999, Hutchings and Karageorgopoulos, 2003)
Glyceridae	blood worm	**Yes**	(Olive, 1993, Fowler, 1999)
Lumbrineridae		?	(Olive, 1993, Fowler, 1999)
Nereididae	centipede worms/ sand worms	**Yes** but only in aquatic reserve	(Olive, 1993, Olive *et al.*, 1998, Fowler, 1999, Scaps, 2002, Fidalgo E Costa *et al.*, 2006, Poltana *et al.*, 2007)
Oenonidae	?	**?/Yes** when found	(Okuda, 1933)
Onuphidae	tubeworms and bungum worms	**Yes** **Yes**	(Fowler, 1999, Fidalgo E Costa *et al.*, 2006, Safarik *et al.*, 2006)

Survey Methods

The survey (Appendix A) was designed to explore the current extent of live vs. preserved bait-worm sales, the level of satisfaction with the current supply chain, where baitshops source their worms, the potential demand for live cultured worms and any preference for wild vs. cultured product. The survey sought baitshop owners' opinions in regard to the environmental effects of bait-digging, allowed space for further comments and offered the opportunity to remain informed of research progress. The Survey complied with the Flinders University Social Ethics Policy and was approved by the appropriate committee (Social and Behavioural Ethics approval number 4022).

Survey packages were disseminated to 92 South Australian baitshops between March and August 2008. The names and addresses of recipient baitshops were generated from telephone directory listings and web-searches using the keywords 'baitshop, bait, tackle, fishing and South Australia'. Directory list sampling would not provide details of shops without telephone access or listed as a private number but this is unlikely for a business so it is believed that this survey was sent to the vast majority of registered retailers of baits. The survey package included a survey (Appendix A), a letter of introduction, duplicate consent forms (Appendix B): one for the participant's records and one for university records and a reply paid envelope.

Returned surveys were checked for appropriate consent and data were entered into a database. Information likely to identify participants was removed from each survey and an identification number allocated. Once processed, the surveys were stored in a secure facility at Flinders University. Data were analysed to identify any trends and to quantify the current and potential sales of live polychaete worms along with the most popular species. The findings were converted to percentages where possible so that direct comparisons could be made.

Results and Discussion

Demographics (Q1, 2, 3, 4 and 5)

Ninety two surveys (92) were distributed to baitshops and 25 completed surveys were returned giving a 27% rate of return. The responding baitshops represented metropolitan, remote rural and inland retailers with approximately half being from metropolitan Adelaide (12 surveys) and half (13 surveys) being from rural areas such as Yorke Peninsula, Naracoorte, Streaky Bay, Renmark, Clare, Port Lincoln and Port Pirie. Seventy percent of baitshops were located close to popular fishing spots and, on average, shop owners had been selling bait for approximately 14.2 years. As such, their answers, opinions and suggestions are likely to be based on practical industry experience.

Bait types (Q6)

The percentage of bait types sold by baitshops is presented in Figure 2. Cockles ranked first representing 51% of sales, whilst yabbies ranked last with 2.5%. It is difficult to interpret these figures because the low percentage of some bait types could be due to lack of availability rather than lack of popularity; this is thought to be the case for bait-worms. The fact that 64% of shops would utilise cultured worms suggests that the low percentages noted here might be due to a lack of availability rather than a lack of popularity.

Since the survey results were analysed feedback from a major SA bait retailer suggests that the local bait-market has seen a significant increase in cockle prices leading to a decrease in their popularity and a concomitant increase in the popularity of other forms of bait such as prawns and bait-worms (B. Walkley. Pers. Comm. 2009). These changes cannot however be qualified or quanitifed.

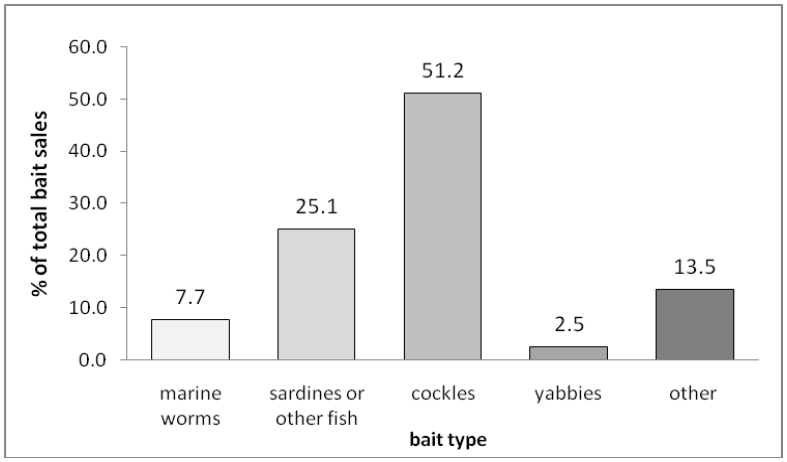

Figure 2. The distribution of bait types sold in South Australian baitshops in 2008 (n=25).

Sales of live versus preserved worms (Q7 and 8)

A comparison of retailers selling preserved vs. live worms showed that almost three times as many shops sell preserved worms as was the case for live worms (84% vs. 29% respectively). The supply chain feedback showed a similar trend with the supply of preserved worm being more reliable than that of live (76% vs. 24% respectively). Owners who responded to the survey sourced the majority of

their product locally irrespective of whether it was preserved or live (85% and 100% respectively) and only 15% of baitshops sourced a proportion of their preserved worms from interstate. These findings suggest that there is more opportunity to increase the sales of live worms than preserved worms as long as market confidence is achieved by ensuring a regular and reliable service.

The effect of wild harvest on the environment (Q11)

In response to the environmental impacts of bait harvesting, 21% of baitshop owners consider that wild bait harvesting is harmful whilst 33% think it is not. The remaining majority (46%) of owners were unsure (Figure 3 left hand column). The above facts combine to suggest that there may be a market for aquacultured product but baitshop owners may be undecided because of a lack of familiarity with the product.

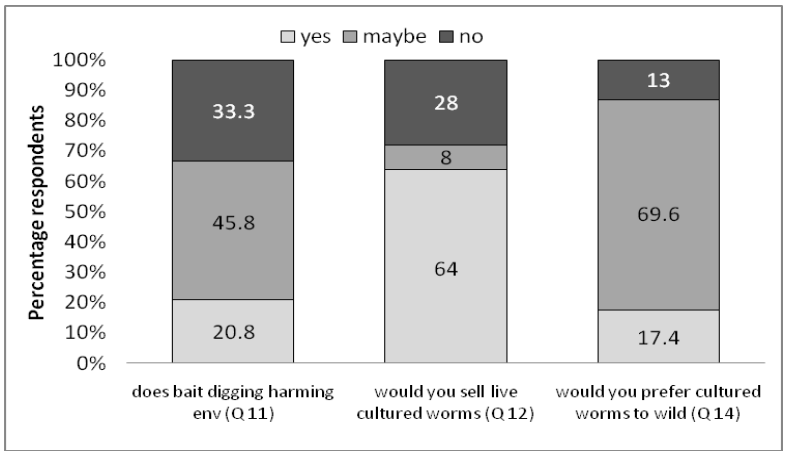

Figure 3. Responses to questions 11, 12 and 14 which relate to opinions re. the effects of wild harvest and the potential market for live cultured worms in South Australia (n=25).

Preferred species (Q9)

Shop owners were asked to rank the three most popular species they sold. Each species was given a score according to their place on the preference list i.e. if they were first on the list they scored 3 points, second = 2 points and third = 1 point. The most preferred species was tubeworms with 40 points, followed by bloodworms with 38 points and bungum worms with 24 points.

Potential markets and future demand (Q10, 11, 12, 13 and 14)

Sixty four percent of baitshop owners said they would sell live worms given regular supply (Figure 3 middle column) and approximately 20% of baitshops would prefer cultured worms to wild (Figure 3 right hand column). If the 'maybe' answers were combined with the 'yes' answers then there is potential for a swing towards cultured worms from ~20 to 87%. This indicates that there is a market for aquaculture derived bait-worms in South Australia.

According to the survey approximately 73% of anglers buy their worms from baitshops the rest harvest their own worms from the wild. This finding together with comments 2, 4, 5, 8 and 9 (below) suggest that the production of cultured live worms (and maybe preserved) would be welcomed and utilised by baitshop owners and anglers in South Australia. There also appears to be potential to

increase the sales of live marine bait-worms in both metropolitan and rural areas. The success of this venture would depend on the regularity and reliability of the supply chain. However, this aspect of increased sales may require further research to establish the extent of the natural range of each species in order to minimise/avoid negative environmental outcomes (species invasion).

Figure 4. The percentage of shops selling live vs. preserved marine worms for rural and metropolitan baitshops (n=25).

Figure 4 indicates that there is the potential to increase the sales of live bait-worms in both rural and metropolitan areas and to increase the sales of preserved worms in rural areas.

The fact that only metropolitan baitshops sell live marine worms is probably due to shorter shelf life and higher spoilage risk of live than preserved worms. It also appears that preserved worms are more regularly available than live (see also comments 2, 4, 5, 8, 9 below). The sale of preserved worms in both metropolitan and rural areas allows baitshops to 'stockpile' product for use during various fishing seasons or peak holiday periods. The general conclusion is that fewer stores stock live worms than preserved irrespective of their location (Figure 4).

Figure 5 shows a further breakdown of the rural/metropolitan data in terms of species and product type (live vs. preserved). The data suggest the possibility of increasing metropolitan sales of the three most popular species of bait-worms and also the possibility of introducing live bait-worms into rural areas. The data also suggest that there is potential to increase the sales of all three preferred species of preserved worms in both metropolitan and rural areas.

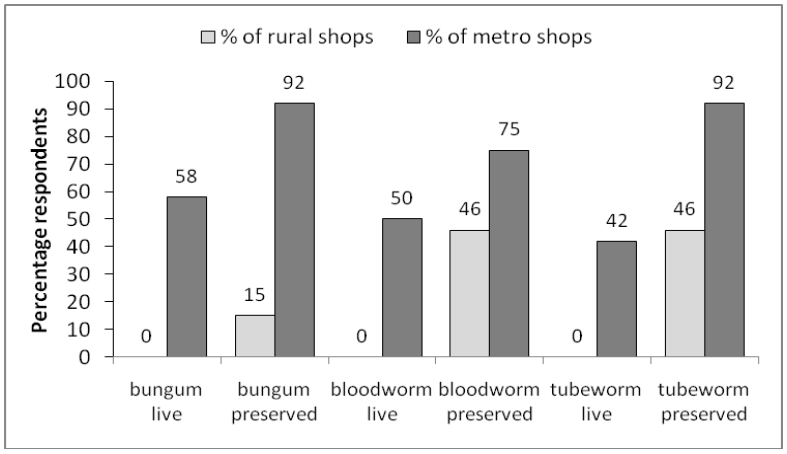

Figure 5. Breakdown of worm species and type to allow comparison between rural and metropolitan preferences (n=25).

Baitshop owners estimates of current annual sales of live and preserved worms were approximately 250kg and 780kg respectively, compared to the potential live worm sales of 1.25 tonnes/pa (Figure 6). These estimates were derived from baitshop owner's experience (average time spent selling bait is 14.2 yrs) and is considered to be an informed opinion of likely sales and anglers' preference.

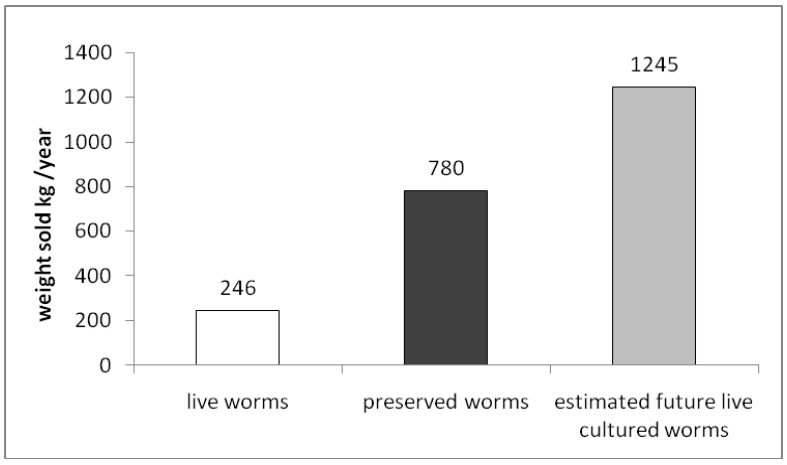

Figure 6. Current annual sales of live and preserved worms and the estimated future sales of live worms.

Wild harvest compared to current sales

According to PIRSA records approximately seven tonnes of bait-worms are professionally harvested in South Australia each year. The current sales of live worms, reported by respondents however, is only 250kg or approximately 3.5% of the annual SA harvest. Even when preserved worms are included in the total bait-worm sales the total sales still only account for 1.02 tonnes, or 15%, of the annual SA harvest. Given that the projected sales, are likely a conservative estimate it seems fair to estimate that more than 1.25 tonnes of cultured worms could be sold in SA each year.

Further information for consideration

Visit to the SA commercial bait-worm beds

An area of less than 0.5km^2 and has been extensively harvested (every day except Christmas) for 30+ years (L. Kelly, Pers. Comm. 2008). Observations from a visit to the commercial worm beds in September 2008 suggested that the current extent of commercial wild harvest of tubeworms (*Diopatra aciculata*) does not appear to be unsustainable. Research in the UK has shown that there are occasions where the wild bait-worm harvesting can be sustainable if environmental conditions are optimal and recruitment rates are adequate (Olive, 1993, Olive, 1994), this is possibly the situation in the SA commercial worm beds. The small number of active licensees and the time constraints imposed on their activities by the tides probably assists the situation. The current level of wild harvest in SA appears to have minimal negative impacts upon the environment but any claims of sustainable practices would require long-term research to confirm or refute.

The SA Bloodworm Run

Every year, in winter, during two consecutive months there is a South Australian polychaete event of massive proportions, which lasts for only a few days each month. The timing of this phenomenon known as the 'Bloodworm Run' can be predicted with great accuracy allowing local anglers to flock to 'the Run' in their hundreds. During 'the Run' the local glycerid worm *Glycera ovigera* swarms to the surface where they can be scooped from the water in their hundreds using buckets or nets allowing the potential for massive harvests by overzealous amateurs. Once caught these worms are either frozen or preserved for future use.

The effect of this activity upon the wild population is generally considered to be minimal as the event is generally considered to be a breeding event after which the worms will die. Research by Dr. Greg Rouse (ex SA Museum) over three consecutive years found no evidence of reproductive products in any of the hundreds of worms sampled (G. Rouse Pers. Comm. 2006 & 2009), a finding which coincides with those of Dean (1978) for a different species of Glycerid in a USA estuary. Dr. Rouse and Dean both suggest that bloodworm swarming is a migratory rather than reproductive event. If this hypothesis is correct, the annual SA harvest of bloodworms is removing massive numbers of pre-breeding worms from the wild population and reducing the number of worms entering the future breeding pool. It is perhaps time to reassess the current bloodworm harvest situation in SA and consider the possibility a quota system for their collection.

Comments

Comments made during the survey are presented below in their original form:

1. *I will not buy cultured worms whilst diggers are working*
2. *I feel we would sell more (live cultured worms) than 450kg/pa if the product were available*
3. *Amount sold (live cultured worms) would depend on the price*
4. *We would sell live worms if we could get them where we live (Yorke Peninsula)*
5. *We only sell 1kg live worms per year because the supplier is unreliable*
6. *The volume of live worms (sold) fluctuates due to fact that this is a seasonal market*
7. *Don't know what volume of worms I would sell; only been here for three months during the quiet time. Don't have figures prior to us (taking over the business)*
8. *Amount of live cultured worms would buy would depend on delivery problems and life of the worms and management to keep them alive (e.g. wastage)*
9. *I have tried NSW live worms but too expensive + transport + deaths + extra effort. Wild are packed and delivered pretty much daily, good and convenient*
10. *The order of worm preference doesn't reflect what is available daily; live bloodworms sell best in winter months, (live) beachworms in summer, (live) tubeworms all year round because they are available but not necessarily the most wanted by anglers.*
11. *No damage whatsoever from worm digging, bloodworms dabbing on a seasonal basis, tubeworm- fork holes that have been dug are covered in when tide comes in*
12. *Whether commercial digging harms the environment depends upon the worm type and the area dug*
13. *I believe there are more private diggers out there taking as many if not more worms than the professional diggers*
14. As price of worms goes up more people dig for their own

Author's Response to comments:

Comment 1 There are currently five licensed bait-diggers in South Australia three of whom have been involved in this research to date, two of them have discussed collaboration and supplied live worms for use in the research. This project is not aiming to replace the wild harvest of bait-worms, but rather to develop alternative methods to meet market demands that can then be taken up by the currently licensed bait-diggers and any other interested parties. As such, the involvement of diggers in the aquaculture of bait-worms can be viewed as an opportunity rather than a threat.

Comments 2–8 suggest that the market for live cultured worms is promising as long as the supply chain is researched and developed to ensure rapid transport and high survival rates.

Comment 9 shows the necessity for researching transport methods and survival rates.

Comment 10 has highlighted the need for further research in the area of market demand. There is a need to assess the seasonal market requirements as it appears from this comment that different species may be required for different seasons.

Comments 11-14 Personal experience of recreational diggers on the Port River does not support the statement made in comment 11, which relates to wild harvest. Experience during recent SA field trips (mainly in summer) is that some recreational diggers do not backfill their holes, leaving

trenches and displaced 'fill' exposed to the hot summer weather and the seagulls maximising any negative environmental impact of the practise (Figures 7 and 8).

Figure 7 Trenches left at Port River Port Adelaide in November 2008 showing the impact of recreational bait harvesters and subsequent extent of bird predation.

Figure 8 Trenches left in November 2008 showing unfilled holes and exposed sediment which exposes organisms to predation and environmental effects and maximises the release of toxic heavy metals.

Conclusions

A survey of South Australian baitshops in 2008 assessed the state of the SA bait-worm market both qualitatively and quantitatively. The aim of the survey was to determine if there was both a need and a market for farmed worms in South Australia as a scoping step prior to the development of such an industry in SA. The survey had a return rate of 27% and the results suggest that there appears to be a need, and a market, for cultured bait-worms in both rural and metropolitan areas of South Australia. Baitshop owners responding to the survey averaged 14.2 years in the industry, so

their opinions are likely to be based on industry experience and so a good indicator of the true state of the industry.

The Survey findings report bait-worms as representing only a small portion of the South Australian bait market (~8%) but many of the comments and findings of this survey suggest that this low ranking is due to a lack of product availability rather than a lack of popularity. This suggestion is further confirmed by the facts that the majority (almost two thirds) of baitshop owners are keen to sell cultured worms and the majority (almost three quarters) of anglers buy their worms from baitshops rather than collecting their own from the wild. The major South Australian bait retailer (SA Bait Supply) has recently reported that since the Survey was conducted the bait situation within SA has changed. The bait deemed most popular by the survey, cockles, have since increased in price to the point that their popularity has decreased, whilst that of prawns and bait-worms has increased. The most recent data available (2001 Recreational and Indigenous Fishing Survey, Henry and Lyle, 2003) suggests that there were 225 000 recreational anglers in SA in 2001 with each spending an average of $452 on their hobby. These data equate to approximately $135 million of revenue in SA each year, for spending on recreational fishing related activities. As such, there is a positive outlook for the future of a bait-worm industry.

Currently, live worms are only sold in metropolitan baitshops and both sales and the supply chain reliability are, at best, only a third that of preserved worms. Preserved worms on the other hand are sold in all metropolitan shops and half of the rural shops so are much more readily available than live worms. This discrepancy in product type and location is possibly due to the extended shelf life of preserved worms, the reliability of the supply chain (76% preserved vs. 26% live) and the extra cost and effort associated with transporting live worms to rural areas. The survey has however, highlighted the fact that rural baitshops would sell live worms if they could get them at a good price and in good condition. All shops, regardless of product type, sourced their worms locally, showing support for local businesses. One retailer who trialled live cultured worms from interstate commented on the expense, transport problems, deaths and the extra effort required to keep them alive (comment 9). The potential sale of preserved worms was not considered whilst developing the survey but the findings suggest that this may be an area worth further consideration in the future. If a successful bait-worm culture industry was developed, it would be easy to include preserved worm production as well as live.

Many baitshop owners appear to have considered the effects of bait-digging upon the environment with almost a quarter believing the activity is harmful to the environment, almost half are unsure and almost a third consider the activity to be harmless. Scientific evidence suggests that under rare circumstances, some species/habitat combinations can sustain a certain level of wild harvest but these cases are the exception. In SA, the area harvested by the licensed diggers appears able to sustain the current level of harvest but as there is little chance of an increase in the number of licensed bait-diggers, or the extent of their activities. There appears to be only one viable option to increase bait-worms production in SA, which is to culture bait-worms in aquaculture facilities.

There appears to be little preference for any particular bait-worm species with all three common bait-worms showing almost equally popularity when scored on a weighted scale (tubeworms,

bloodworms then bungum worms). One baitshop owner commented that worm preference was reported based upon what was available rather than what was actually 'wanted' by anglers suggesting that further research may be required in order to assess the true seasonal preferences. The survey respondents currently account for approximately 250kg (or 3.5% of the commercially harvested bait) of live worms and estimates that they could sell 1.25 tonnes of live worms per year which is a fivefold increase. No estimate was made of the potential preserved worm sales but as the current sales are three times that of live worms (780kg vs. 250kg) it may also be advisable to consider preserving cultured worms at some stage in the future. When sale of both live and preserved worm were combined for responding shops this still only represents 15% of the estimated commercial harvest of bait-worms. As such, if the figures gleaned from the survey truly represent the current situation and the findings are scaled up to the reported commercial harvest (7 tonnes) the situation could be even more promising for worm farm advocates. However, this report can only be based on the findings of the survey which identifies that the potential for a 5 times increase and thus the opportunity for bait-worm aquaculture in South Australia. It is also hoped that the volume of cultured worms sold would increase over time if the nascent industry were diligent in ensuring a regular and reliable supply of product thus gaining consumer confidence.

The establishment of a local bait-worm industry would allow the sustainable production of bait-worms in order to meet the growing demand for bait by anglers. Such a development would take place under the terms of the *Aquaculture Act (2001)* and the *Aquaculture Resource Management and Ecologically Sustainable Development Policy (2004)* which dictate strict environmental regulations in terms of effluent discharge. Culturing worms will also allow screening for various pathogens prior to sale if so required, along with the development and use of a sustainable diet during culture. A further benefit of worm culture will be a reduction in the environmental impact of recreational diggers on (see Figures 7 and 8) despite the belief that no negative implications accompany recreational bait-digging. One baitshop owner believes that recreational bait-diggers take at least as much if not more than the professional bait-diggers (comment 13) so combining this comment with the fact that recreational diggers do not always backfill their holes suggest that recreational bait-digging is neither sustainable nor low impact.

The development of a successful bait-worm culture industry will likely see the availability of bait-worms increase with a concomitant reduction in price so addressing comment 14 (above) and possibly reducing the impact of recreational digging. The possibility also exists to extend the initial bait market to include brood-stock aquaculture diets and maybe the export market in the future but these are beyond the scope of this survey

If a local worm culture industry is developed, this new industry is unlikely to displace the current licensed bait-worm harvesters but rather offer them an alternative way to produce bait-worms.

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Appendix A: Survey Package

BAITSHOP SURVEY MARCH/APRIL 2008.

My name is Sam Davies, I live in the Southern suburbs and I am about to embark on a post graduate degree (PhD) to develop a local polychaete worm aquaculture industry in South Australia. My preliminary research identified six species suitable for further evaluation. The species which prove successful during culture trials will be aimed at supplying the bait industry and as the industry expands will include the prawn and finfish brood-stock diet markets.

The findings of this survey will assist in characterising the local market for live marine polychaete worms as bait items and will help to establish the demand for live polychaete worms. This information will aid us in applying for research funding to further the industry development.

I am asking you for ten minutes of your time to fill in this survey to help secure research funding to develop a local industry which will provide a regularly supply of live marine worms to the bait market.

My research will only use local polychaete species reducing the likelihood of introducing either exotic worm species or diseases to local SA waters. Using local species will also reduce the costs and energy inputs required to culture the worms as they are adapted to the local environment.

I thank you for your time

Researchers name: Sam Davies
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Survey

Please circle the appropriate answer or write the required information in the space provided.

1. Name of Baitshop (optional) ……
2. Location of baitshop (suburb)……
3. Are you located in/near a popular fishing location Y N
4. If yes, name of location (optional)……..
5. How long have you been selling bait (in years) …… yrs
6. Of your total natural bait sales please state the proportions that you sell (annual % of total)

    a. Marine worms ……%
    b. Sardines or other fish ……%
    c. Cockles ……%
    d. Yabbies ……%
    e. Other (please name) ……%

7. Do you sell **live** marine worms (*if no go to question 8*) Y N
    - Do you have a on-going supplier of live marine worms Y N
    - Is your source of live worms regular and reliable Y N
    - What volume of live marine worms do you sell per annum kg number
    - From where do you get your live worms (circle) Local Interstate
8. Do you sell **preserved** marine worms (frozen/pickled) Y N
    - Do you have an ongoing supplier of preserved worms Y N
    - Is your source regular and reliable Y N
    - What volume of preserved marine worms do you sell per annum kg number
    - From where do you get your preserved worms (circle) Local Interstate

9. What are the preferred species of marine worms (please rank in order of demand with those highest in demand listed first)

……..

……..

……..

……..

10. Can you estimate the proportion of worms used by anglers which they dig themselves vs. those bought from shops.

From bait shops ……%
Self dug……..%

11. Do you believe that commercial or private bait-digging is harming the environment (please circle answer below)?

Yes No Maybe

12. Would you utilise a regular source of live cultured marine worms Y N

13. If yes, what volume do you think you could sell per annum kg number

14. Would prefer wild or cultured worms (circle)?

Wild Cultured Don't care

15. Are you interested in updates on the progress of this project? Y N

If yes please add your email address (this information will not be divulged to any third party or used for any purpose other than that described above)

Email address:

All information collected in this survey will be used for statistical and planning purposes; no information will be divulged to a third party without prior permission (assuming you have identified yourself).

Appendix B: Consent Form

CONSENT FORM FOR PARTICIPATION IN RESEARCH (by survey)

I ……

being over the age of 18 years hereby consent to participate as requested in the 'Letter of Introduction' for the research project on Polychaete worm aquaculture

1. I have read the information provided.
2. Details of procedures and any risks have been explained to my satisfaction.
3. I am aware that I should retain a copy of the Consent Form for future reference.
4. I understand that:
    - I may not directly benefit from taking part in this research.
    - I am free to withdraw from the project at any time and am free to decline to answer particular questions.
    - While the information gained in this study will be published as explained, I will not be identified, and individual information will remain confidential.

Participant's signature……Date……...

I certify that I have explained the study to the volunteer and consider that she/he understands what is involved and freely consents to participation.

Researcher's name…….....

Researcher's signature……..Date…….

NB: Two signed copies should be obtained.

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