Development of Bait Saving Strategies for the Western Rocklobster Fishery

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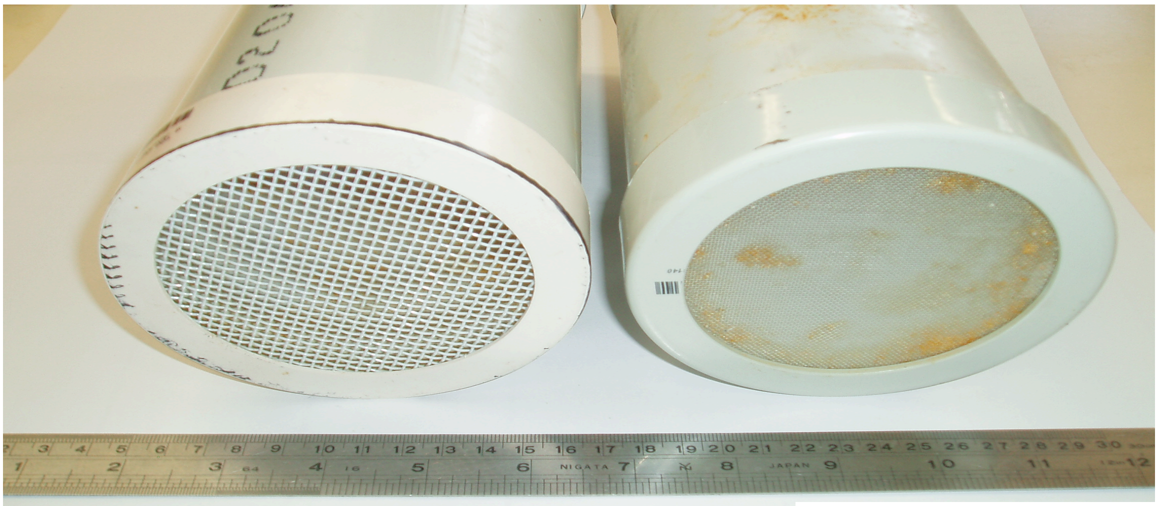

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NON-TECHNICAL SUMMARY

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OBJECTIVE

Reduce bait usage in the Western Rock Lobster Fishery without reducing catches.

OUTCOMES ACHIEVED TO DATE

Participants, and our results, suggest that the use of the baitsaver in at least one bait box would result in significant savings to fishers if used during the 'red' phase of the season ($33,000-$44,000). Based on an estimated 8.3 million pot lifts in 2006/07 (de Lestang *et al.,* 2008) this equates to a saving of approximately $18.5 million to the industry if all fishers adopted their use. Although the trial strongly suggests the benefits of using baitsavers, to the extent that one of the participants (Peter Vinci) is using all the baitsavers we have been able to provide him, continued discussions by one of the investigators (Andrew Winzer) with fishers shows that they are loathe to use them whilst catches remain so low. Disappointingly these discussions have also shown that the majority of fishermen are trying to squeeze even more bait into the bait boxes, even though it has been explained to them that unless pots are competing with other pots this has no effect on catch rate at all.

Based on an estimated 8.3 million pot lifts with 4 kg of bait in each pot, approximately 33,000 tonnes of bait would have been used in the 2006/07 season. With blue mackerel, a preferred bait, costing $1.50 – 1.70 per kg this equates to an expenditure of approximately $50-55 million (Winzer 2007; de Lestang et al. 2008). Any reduction in the amount of bait used that does not impact on the number of lobsters landed therefore has the potential for significant cost savings to the industry. One way in which such a reduction could be made is through the use of bait saving devices. For such a method to be accepted by the industry it must be as effective in catching lobsters as the traditional method of fishing, easy to deploy and result in cost savings to fishermen.

In addition to attracting Western Rocklobster, bait is also likely to attract non-target species. For example, amphipods and isopods have been shown to consume baits (and lobster) in lobster traps of some American and Japanese fisheries. The consumption of the bait by a non-target species prior to lobsters being attracted is also likely to reduce the catchability of that trap. Data collected during a sampling program to determine the species of sea lice present in Zone C, in addition to those collected in a written questionnaire distributed to commercial fishermen in Zones B and C, indicated that when lice numbers were low there was still some bait in pots after 24 hours. In contrast, when sea lice were abundant no bait remained in pots after one day. Therefore, when sea lice are abundant, it is likely that they will consume much of the bait used by lobster fishermen. Consequently, when sea lice are abundant the catchability of pots is likely to be reduced, particularly when soak times exceed 24 hours. In order to combat this loss of bait to lice, fishermen force as much bait as possible into their bait boxes, however, the data collected above indicated that this ploy did not result in bait remaining after 24 hours. Thus, the development of devices that exclude sea lice from entering the bait box, but still allow the bait to attract lobsters, has the potential to reduce the amount of bait used by commercial fisherman.

A baitsaver was designed during a preliminary trial and was further modified during the current project. This baitasaver was to have been trialled during the 2005/6 season by two fishermen in each of zones A, B and C of the fishery. The trials were to have included fishers using baitsavers in both of the bait baskets, one of the bait baskets and the other packed in the traditional way and controls using both bait baskets packed in the traditional way. Unfortunately, the 2005/6 season was particularly poor and five of the participants believed it would be uneconomic to continue with the trials. The sixth fisherman, Neil Dorrington, agreed to continue the trials but only using the combined method. These trials confirmed that savings could be made and lead to further modifications of the baitsaver. Even though the 2006/7 season was again very poor all six participants agreed to trial the combined method for that season.

Participants, and our results, suggest that the use of the baitsaver in at least one bait box would result in significant savings to fishers if used during the 'red' phase of the season ($33,000-$44,000). Based on an estimated 8.3 million pot lifts in 2006/07 (de Lestang *et al.,* 2008) this equates to a saving of approximately $18.5 million to the industry if all fishers adopted their use. Furthermore, even though these seasons were amongst the worst recorded most of the participants believed that the baitsavers would provide cost savings at certain times of the year and when fished under certain conditions, whilst others believed the savings would be season round. Indeed, one of the fishers (Peter Vinci in Zone C) was so impressed with the baitsavers he would have placed them in all of his pots. In addition the provision of baitsavers with end caps using different mesh sizes and bodies with or without cuts would allow fishermen to tailor the baitsaver to prevailing conditions. The poor results for theses two seasons in combination with the lower than usual number of lice did not allow us to determine whether baitsavers would be particularly useful when both lobster and lice numbers were high.

Although the trial strongly suggests the benefits of using baitsavers, to the extent that one of the participants (Peter Vinci) is using all the baitsavers we have been able to provide him, continued discussions by one of the investigators (Andrew Winzer) with fishers shows that they are loathe to use them whilst catches remain so low. Disappointingly these discussions have also shown that the majority of fishermen are trying to squeeze even more bait into the bait boxes, even though it has been explained to them that unless pots are competing with other pots this has no effect on catch rate at all.

KEYWORDS: Western Rocklobster, baitsavers, cost savings, sea lice.

ACKNOWLEDGEMENTS

The project could not have been completed without funding provided by FRDC or the help of the following fishermen - Zone A: Chris Patman, Peter Burton. Zone B: Luteon Brown, Steve Small. Zone C: Peter Vinci, Neil Dorrington. Professor Norman Hall provided advice on the most appropriate experimental design and statistical analyses.

1. Introduction

1.1. Background

The Western Rocklobster (spiny), *Panulirus cygnus* George, is found off the coast of Western Australia between North West Cape (21°45'S.) and Cape Leeuwin (34°22'S.) (Jernakoff & Phillips 1988). The West Coast fishery, situated from the high water line out to boundary of the Australian Zone between 21°44'S and 34°24'S, is one of the world's largest Rocklobster fisheries with an overall value in 2006/07 of AUD$245 million (de Lestang et al. 2008). In March 2000, it became the first fishery in the world to be certified as ecologically sustainable by the Marine Stewardship Council. The sustainable catch is estimated at between 10,000 and 15,000 tonnes per year, whilst the actual catch has been maintained at between 8,500 and 14,400 tonnes per year since the 1980's (Melville-Smith *et al.* 2004; de Lestang et al. 2008). The 2006/07 season saw approximately 8,500 tonnes landed with an estimated return to the fishers of $245 million. Based on an estimated 8.3 million pot lifts with 4 kg of bait in each pot, approximately 33,000 tonnes of bait would have been used in the 2006/07 season. With blue mackerel, a preferred bait, costing $1.50 – 1.70 per kg this equates to an expenditure of approximately $50-55 million (Winzer 2007; de Lestang et al. 2008). Thus, the cost of bait reduces the income to fishers by a significant proportion and any reduction in the amount of bait used that does not impact on the number of lobsters landed has the potential for significant cost savings to the industry. Two ways in which such a reduction could be made are through the use of either artificial baits, or devices that stop the bait being consumed by lobsters and other animals but still allow the bait to attract lobsters, i.e.bait saving devices (for more details of baitsavers see Materials and Methods and Appendix 1). For such methods to be accepted by the industry they must be as effective in catching lobsters as the traditional method of fishing and also be easy to deploy and result in cost savings to fishermen. Trials investigating the efficacy of commercially acceptable dry, water stable artificial baits found them to be nowhere near as effective as traditional methods (Hoxey 1996, 1999). Although at least two baitsavers are commercially available, fishers have been loath to use them as no in depth studies have been undertaken regarding their efficacy (Winzer 2007).

In addition to attracting Western Rocklobster, bait is also likely to attract non-target species. For example, amphipods and isopods (Fig. 1) have been shown to consume baits (and lobster) in lobster traps of some American and Japanese fisheries (Bowman 1974; Sekiguchi *et al*. 1981; Sekiguchi 1982; Stepien & Brusca 1985). The consumption of the bait by a non-target species prior to lobsters being attracted is likely to reduce the catchability of that trap (see for example Sekiguchi *et al*. 1981).

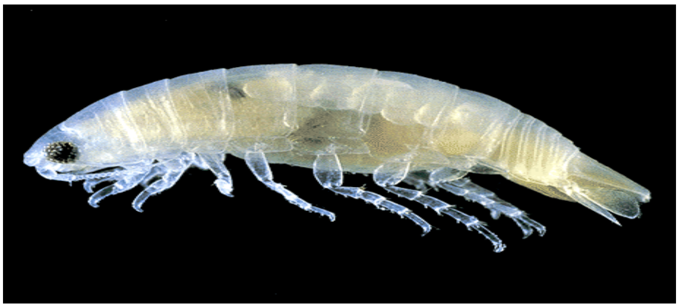

Figure 1. *Cirolana hesperia*, the most common species of sea lice caught in Zone C of the Western Rock Lobster fishery (size range 2.5 mm to 12.5 mm).

Data collected during a sampling program to determine the species of sea lice present in Zone C, i.e. south of latitude 30°S (de Lestang et al. 2008) of the West Coast Rocklobster Fishery in addition to that collected in a written questionnaire distributed to commercial fishermen in Zones A, i.e around the Abrolhos Islands and B, i.e. north of latitude 30°S (Winzer 2007; de Lestang 2008) and a follow-up face-to-face survey (for details of questionnaire and survey see Appendix 2), indicated that when lice numbers were low there was still some bait in pots after 24 hours. In contrast, when sea lice were abundant no bait remained in pots after one day. (Note: Analyses of the number of lice collected during three years (2004-06 inclusive) of trapping in C zone of the Western Rocklobster fishery clearly demonstrated that the numbers of lice and lobster caught in rocklobster pots were significantly affected by bottom type, moon phase, bait and depth (Winzer 2007). A summary of the main findings are: *Bottom type* - the greatest numbers of lice were trapped in rocklobster pots deployed on weed/rock and sand bottoms while significantly lower numbers of lice were trapped on rock or weed bottoms (means of approximately 400 per trap compared with approximately 250-275). In contrast, pots deployed on a rock/sand bottom were found to trap significantly greater numbers of lobster (6.95) than those deployed on any other substrate (e.g. 3.68 on bare rock). *Moon phase* - In regards to moon phase, rocklobster pots deployed during the new and last quarter of the moon phase trapped significantly greater numbers of both lice and lobster than those deployed during the full and first quarter phases (approximately 560 lice and 4.4 lobster compared with 130-270 and 2.5). *Bait* – Pots deployed using Australian salmon or blue mackerel caught the highest mean numbers of lice (330-410) and lobster (4.4-4.7) whilst those using orange roughy caught the least (230 and 2.7). *Depth* - pots deployed in depths ranging from 20-39 and 40-59 metres (10-19 and 20-29 fathom respectively) caught significantly greater numbers of lice and lobster than pots deployed in the 1-19 metre depth range. *Variability* – their was wide scale variability in catches of both lice and lobster dependent on the combination of the above variables and also in the case of lobster on the month (highest catches were during the "whites" phase, i.e. when the lobster are migrating). For example, lice numbers varied from 0 for a pot set on a rock bottom on a full moon in shallow water and using orange roughy for bait, to up to 7000 for a pot set on a weed/rock substrate on a new moon in deep water and using blue mackerel for bait. It is also worth noting that during these three years fishers reported that lice were in relatively low numbers. When sea lice were present in low numbers 0-100 most of the bait in the lice traps remained even after three days, at higher numbers, i.e. 100s bait remained after one day and sometimes after three, once numbers of lice were in the 1000s no bait remained in traps after one day).

The apparent similarities in habitat useage, activity cycles, and bait and depth "preferences" and the fact that they are both opportunistic predatory scavengers will increase the likelihood of competition for rocklobster pot baits between the two species. Therefore, when sea lice are abundant, it is likely that they will consume much of the bait used by lobster fishermen. Consequently, when sea lice are abundant the catchability of pots is likely to be reduced, particularly when soak times exceed 24 hours. In order to combat this loss of bait to lice, fishermen force as much bait as possible into their bait boxes, however, data from Winzer (2007) indicated that this ploy did not result in bait remaining after 24 hours. Thus, the development of devices that exclude sea lice from entering the bait box, but still allow the bait to attract lobsters, has the potential to reduce the amount of bait used by commercial fisherman.

There is obvious value in developing bait-saving strategies that reduce the amount of bait used to attract lobster and also limit the impact of sea lice and/or other scavengers on bait usage in order to increase the profitability of the industry. The future classification of a fishery as ecologically sustainable is likely to include further considerations of the impact of that fishery on other organisms, which in the case of the Western Rocklobster fishery and other fisheries that use baited pots/traps, may include its impact on bait species. Bait saving devices thus also have the potential to consolidate the fishery as ecologically sustainable. Although baitsavers have the potential to reduce the amount of bait being used without impacting on catch rates, all 60 commercial fishers contacted during the face-to-face survey regarding the effects of sea lice noted above considered that baitsavers would reduce their catches and consequently were loath to use them . Furthermore, while at least two bait-saving devices are commercially available, no data were available regarding their efficacy until the completion of the above study which tentatively suggested that baitsavers could increase the profitability of the fishery and also developed a new baitsaver

Based on the results of the questionairre and survey (Appendix 2) and the subsequent Western Australian Fishing Industry Council (WAFIC) funded *Do lobster pots employing bait saving devices catch less lobster than those deployed in the traditional manner? A preliminary investigation.* WAFIC IDU project 04-01 (Winzer & Gill, 2004; Appendix 1) the overriding objective of the current project was to develop a baitsaver that would not reduce the number of lobster caught but would provide savings to fishers through the use of less bait. In order to do this we used more fishers and extended our previous work throughout the season and in to all zones of the fishery.

The preliminary trials led to the development of the following hypotheses that were to be tested in this project:

- Baitsavers will be cost effective when deployed during periods when sea lice are abundant.

- Using a baitsaver in one bait box and the traditional method of bait deployment in the second box will be cost effective.

- The development of a baitsaver that provides an effective plume but still protects the bait from sea lice will be the most cost effective method of deploying bait and provide substantial savings to fishermen.

Unfortunately for the project sea lice were only very rarely in high abundance during the project, thus, hypothesis one could not be tested.

1.2. Need

In the 2006/07 Western Rock Lobster season between approximately 25-33,000 tonnes of bait was used at a cost to the industry of between approximately $37-55 million (Winzer 2007; de Lestang et al. 2008). Savings on bait that do not reduce the catch of lobster have the potential to significantly increase the profitability of the industry. A preliminary study (WAFIC IDU project 04-01, and excluding initial cost of baitsavers) into the efficacy of bait saving devices indicated that reductions in the amount of bait deployed of approximately 40% are likely to be achievable without reducing catch rates, whilst with a redesigned and more efficient baitsaver reductions could be by as much as 75%. Such a reduction in bait usage would equate to a saving of between $15 and $42 million in the 2006/07 season. The use of baitsavers may be even more important with the introduction by the Department of Fisheries W.A. of additional measures aimed at reducing fishing effort at the beginning of the 2005/06 season. These measures banned the lifting of pots around the full moon between February and June in Zone C and the lifting of pots on Sundays after the 15th of March in Zone B. These bans therefore increase the number of times pots will be in the water for two and three days. Projections, based on the Puerulus Settlement Survey, are for drastically reduced catch rates over the next three seasons (2007/08 – 2009/10, i.e. between 8,450 and 9,550 tonnes (de Lestang *et al* 2008, whilst oil prices continue to increase and are currently ~US$70 per barrel (West Australian 05/11/2009). Thus, there is an ever increasing need to develop ways in which fishermen can make savings. The development of bait saving strategies that do not reduce the catch of lobster is one way that fishermen could increase their profits. In future classification of a fishery as ecologically sustainable may include considerations of its impact on other organisms, e.g. its effects on bait species. The current study has the potential to further consolidate the fishery as ecologically sustainable.

The study was to have run during the 2005/06 season and to have included fishers using baitsavers in a) both of the bait baskets, b) one of the bait baskets and the other packed in the traditional way (combined method) and c) both bait baskets packed in the traditional way as controls (see Methods for details of bait packing). Unfortunately, the 2005/06 season was predicted and indeed was particularly poor and five of the participants believed that using baitsavers would reduce their catch even further and it would therefore be uneconomic to undertake the trials. The sixth fisherman, Neil Dorrington, agreed to undertake the trials but only using the combined method. The trials confirmed that savings could be made and lead to further modifications of the baitsaver. Even though the 2006/07 season was again very poor all six participants agreed to trial the combined method for that season (de Lestang *et al* 2008).

1.3. Objective

Reduce bait usage in the Western Rock Lobster Fishery without reducing catches.

Participants, and our results, suggest that the use of the baitsaver in at least one bait box would result in significant savings ($33,000-$44,000) to fishers if used during the 'red' phase of the season. (At the beginning of the season juvenile lobster inhabiting shallow inshore grounds, commonly known as 'whites' throughout the industry because of their pale coloured exoskeleton, migrate to deeper breeding grounds to moult and reproduce. Moulting results in a darker exoskeleton and these adults are referred to as 'reds' in the industry (de Lestang *et al.* 2008)). Even though the 2005/06 and 2006/07 seasons were amongst the worst recorded since records began (de Lestang *et al.,* 2008) most of the participants believed that the baitsavers would provide cost savings at certain times of the year and when fished under certain conditions, whilst others believed the savings would be season round. Indeed, one of the fishers (Peter Vinci in Zone C) was so impressed with the baitsavers he would have placed them in all of his pots. In addition the provision of baitsavers with end caps using different mesh sizes and bodies with or without cuts would allow fishermen to tailor the baitsaver to prevailing conditions (see Materials and Methods and Appendix 1 for details of baitsaver design). The poor results for the 2005/06 qnd 2006/07 seasons in combination with the lower than usual number of lice did not allow us to determine whether baitsavers would be particularly useful when both lobster and lice numbers were high.

2. Materials and Methods

2.1. Baitsaver Design

The baitsaver (Fig. 2) designed specifically for this study were modified lice traps used to collect lice for a Ph.D. project investigating the biology of lice and their effects on the Western Rocklobster fishery (Winzer, 2007). The initial baitsaver comprised a 100 mm diameter P.V.C. pipe the ends of which were closed by two bored-out 100 mm P.V.C. end caps, each containing

0.05 mm mesh inserts (Fig. 2). Seasonal sampling of sea lice over the three seasons preceding the trial (i.e length-frequency histograms) in conjunction with knowledge gained during the preliminary trial led to further modifications of the baitsavers used in that trial. Firstly, fishers were given the opportunity to use either the fine 0.05 mm mesh or end caps in which this fine mesh was replaced with a coarser, heavy-duty NITEX™ mesh of 0.5 mm aperture (Fig. 2). This coarser mesh was far more robust and therefore required replacing far less frequently and particularly when used in waters deeper than 25 fathoms this mesh size prevents the majority of the deep water lice population from entering the baitsaver (the median width of lice at depths greater than 25 fathoms is approximately 4.5mm) while being coarse enough to provide a good plume and thereby attract lobster. It was also envisaged that this particular sized mesh would also prove beneficial for fishers occupying shallow, inshore zones when either total lice numbers or the proportion of small lice are low. All fishers choose to use the coarser meshed end caps. It was anticipated that the deployment of two of these baitsavers in the two baitboxes, i.e. the small slatted boxes on each side of the lobster pot into which the bait is placed, or one baitsaver deployed in combination with a traditionally packed bait box would provide bait protection from buffeting and/or lice predation while permitting a strong odour plume and thus attract lobster. We also considered that this would be particularly important when pots were left in the water for two or three days due to either inclement weather or because of the new bans that restrict lifting pots at certain times in lifting pots over one, two and three days.

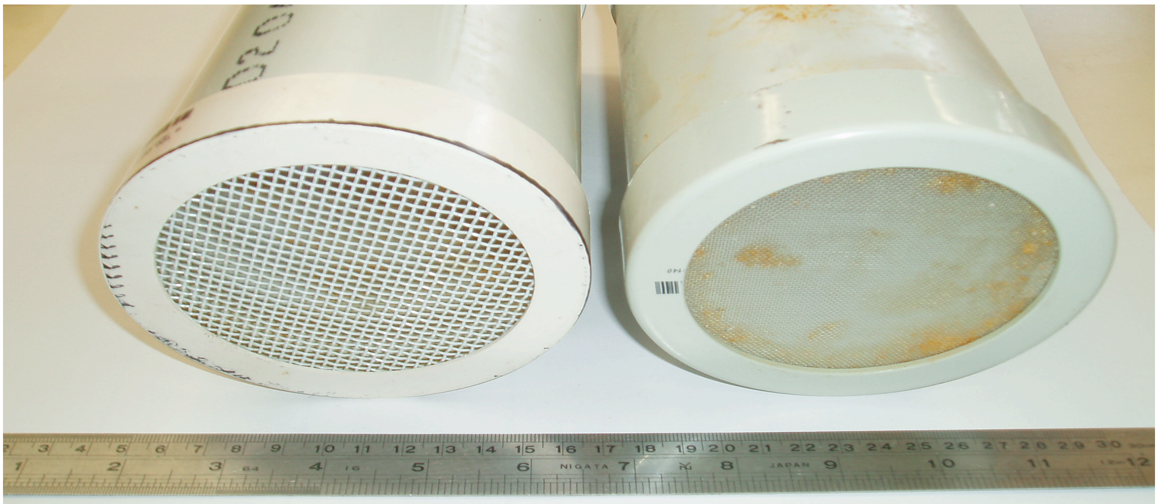

Figure 2. Baitsavers with NITEX mesh sizes of 0.5 mm (left) and 0.05mm (right).

Initially six fishermen (Zone A: Chris Patman, Peter Burton. Zone B: Luteon Brown, Steve Small. Zone C: Peter Vinci, Neil Dorrington) were to trial the baitsavers in the 2005/06 season, however, due to predictions of very low catches and a poor start to the season five of these six declined to continue with the study after the first couple of weeks due to financial considerations, i.e. the fishers believed that the season was going to be hard and the use of baitsavers would only make it harder (but see below). The remaining fisherman (Neil Dorrington) agreed to continue the trial using the combination method but not baitsavers in both bait boxes. The results of this trial and further discussions with the participant resulted in further modifications to the baitsaver for use in the 2006/07 season. For the final trials gaps 1.5 mm in width were cut longitudinally along the P.V.C. pipes to further enhance the bait plume emitted from the baitsaver.

2.2. Personnel & Location

Six fishermen (Zone A: Chris Patman, Peter Burton. Zone B: Luteon Brown, Steve Small. Zone C: Peter Vinci, Neil Dorrington) who responded to a survey entitled “Survey on the effect of sea lice on lobster baits” (Winzer, 2007 had shown a particular interest in providing assistance for any studies that would provide data on sea lice and ways that may mitigate their effect on the industry. On the basis of their interest these fishermen were approached, and subsequently agreed to take part in the current study. None of the participants in this trial were under any obligation to use the baitsavers for any designated period of time. As a result of the diminishing catch rates and consequent below average annual landings incurred by commercial fishers over the three seasons prior to 2005/06, competition within the fishery had reached new heights. Understandably, if a fisher using the baitsaver was of the opinion that his landings were suffering as a result of their use, he was under no obligation to proceed further (see above). Consequently, the design and to some extent the success of the trial was somewhat reliant upon its participants having an above average season. A successful season would effectively provide the grounds for a robust feasibility study comparing catch rates of lobster using the baitsaver and those derived using traditional means across the respective fishing zones. Additionally, ongoing use of the baitsaver over the duration of an entire season in which catch rates were above average would allow fishers to develop opinions on the perceived strengths and weaknesses of the baitsaver. This informed point of view would provide further insight into potential improvements to the design of a baitsaver in general, and also whether modifications to the design may be required for different zones and/or times of year (e.g. if sea lice size varies across zones or through time, aperture size may be changed). As noted above five of the six fishers withdrew from the trial, however, even though the 2005/06 season was again poor the results generated by the sole remaining participant were significant enough that the other five fishers agreed to rejoin the project and continue the trial for an additional season.

In an effort to encourage ongoing participation in 2006/07, the design of the trial was made to be as flexible as possible while ensuring meaningful conclusions could still be drawn. For example, for the 2006/07 season fishers had the choice of using different mesh inserts in the end caps (0.05 or 0.5mm) and different bodies (straight tube or 1.5mm cuts in tube), this strategy allowed fishermen to take into account such things as the numbers and sizes of lice encountered, length of soak and environmental factors such as water temperature and current (see Discussion and note that all fishermen choose to use the 0.5mm mesh and tubes with 1.5mm cuts). Furthermore, as a consequence of the well below average catch rates for the 2005/06 commercial season and low predicted catches for 2006/07, fishermen felt that whilst baitsavers alone could not be justified under the current catch rates they were happy to complete a trial that used a combination of one bait box containing 2kg of fish and the other containing 0.5kg of fish in a baitsaver versus two bait boxes each of which contained 2kg of fish, i.e. the traditional method of bait deployment.

2.3. Experimental Design & Deployment Of Pots

Although the most appropriate way to deploy the experimental pots would be truly random, a completely random deployment was seen as being very time consuming, hard to follow and difficult for the fisherman to execute. Thus, the following design was utilised as it was quick and easy for the fisherman and included some randomness within its design. On any one day, each fisher deployed a total of ten pots with one baitsaver (containing 0.5 kg of blue mackerel) in one bait box and 2 kg of blue mackerel in the remaining bait box. It was at the individual fisher's discretion as to which bottom type and depth these ten pots were deployed. The main constraint on the fisher was that all pots were deployed at similar depths and bottom type using the same fish bait. The control pots were deployed in the traditional manner with both bait boxes packed with blue mackerel (2 kg + 2 kg) and deployed at similar depths and bottom types to treatment group pots containing baitsavers. It was at the fisher's discretion as to whether these pots were deployed consecutively or in a random manner. The distance between pots was set at least 100 metres to ensure catch rates of neighbouring pots were independent of each other (Jernakoff & Phillips 1988). Lobster pot escape gaps remained open in order to simulate a commercial fishing situation.

2.4. Statistical Analyses

Randomization tests - Rather than performing a harsh transformation on the raw data, a randomisation test was used (Edgington 1995). Such a test was shown to be ideally suited to the type of data collected during the preliminary study, as it doesn't rely on assumptions of normality or equal variances. The randomisation method is ideal for testing sharp null hypotheses, that is, null hypotheses under which all potential outcomes are known exactly. The null hypothesis, which is assumed to be true for the purpose of the trial, states that the two sets of data are drawn from the same distribution (i.e. the treatment has no effect on the value of catch per pot recorded for each pot lift). Comparisons between a control and treatment group of the same soak time are ideally suited to a two-sample situation when attempting to compare the means of two sets of values by determining a t-statistic.

Comparison between the control and the treatment group and soak time involves pooling all values, and randomly selecting, with replacement, another complete data set from these original two treatment groups. The total sample size is then halved and assigned to the set number 1, our control group and the other remaining half of the data set is assigned to set number 2, our treatment group. A measure of the difference between the means is then calculated with equal sample sizes and unequal variances using the standard formula (but recognising that this is not the t-statistic that would be used with a standard table of t-values). This value is calculated by subtracting the mean of the treatment group from the mean of the control group, then dividing by the estimate of the standard deviation of the difference between the means. This statistic was calculated 20,000 times producing a very large number of random observations of the values of the t-statistic that one would be likely to encounter if the null hypothesis was true.

The final step in the calculation is to calculate the test statistic from the original pooled set of data (comprised of the control and a treatment group across a respective soak time). A count is then performed of the number of times within 20,000 observations from the null hypothesis that a value of the test statistic is obtained that is equal to or exceeds the value calculated from the recorded data. This count is then divided by 20,000 to provide an estimate of the probability that a test statistic value as large as that which is observed in the deployment trial could have occurred by chance if the null hypothesis was true.

This is a single-tail test as all that is being tested is whether the total catch of lobsters obtained with the treated pots is significantly less than the catch obtained by the control pots using the same soak time. It is assumed that the test statistic calculated is an appropriate measure of the difference between the mean catch per pot lift recorded across each treatment group and soak time. An additional assumption of this study is that there are sufficient observations in the combined data set and that a random sample with replacement is representative of the distribution of values that would be recorded if the experiment had been repeated (at the same time as the original trial, at the same location, with the same density of lobsters and under the same environmental conditions).

Poisson, Quasi-Poisson & Negative Binomial Generalised Linear Model Analyses - GLM analyses of data collected throughout the 2005/06 and 2006/07 season long trial were also conducted in order to validate the conclusions drawn from the randomisation tests. Goodness of fit tests were performed on three distributions in order to determine which model provided the best fit for the season long data set (i.e. Poisson versus Quasi-Poisson versus Negative binomial). As the Quasi-Poisson and Negative binomial distributions provided similar and better fits to the data than the Poisson distribution, i.e data fitted using the latter model was considerably over-dispersed, the results of both of these two models are reported. If differences were found in either of the season long tests using any of the above statistics then GLM analyses were also performed on data for individual months to determine if differences were season-wide or restricted to particular months.

2.5. Estimation Of Potential Savings

If no differences in catch rate were found for the two treatments then a calculation of potential cost savings with respect to bait expenditure for an individual fisherman using both traditional and combined methods of bait deployment was conducted. Dependent on the results of the statistical analyses this was conducted across the whole season if there was an overall difference in catch rate detected across the whole season or for only those months in which differences were not detected if there was an overall difference detected across the whole season.

These calculations were based on a bait cost of $1.50 per kg (Inc. G.S.T.) and estimates of one, two and three day soak times (i.e. the number of days before the pots were pulled) for fishermen (with 100 pots) fishing in different depths in the different zones.

Fishermen provided an estimate of the number of one-, two- and three-day soak times that they employed throughout an entire season. For the 2005/06 season the estimates provided by fishermen operating predominantly in inshore grounds in Zone C indicated that they had fewer two-day soak times than the fishermen who operated predominantly in offshore grounds of Zone C. Therefore, the following cost savings analyses were performed independently for these two groups and used 175 one-, 18 two- and 5 three day soak times for inshore fishermen (198 lifts) and 161 one-, 22 two- and 7 three day soak times for offshore fishermen (190 lifts). For the 2006/07 season the figures were: Zones A & B, 136 one-, 29 two- and 12 three day soak times for inshore fishermen (177 lifts) and 82 one-, 44 two- and 20 three day soak times for offshore fishermen (146 lifts); Zone C, 154 one-, 30 two and 12 three day soak times for inshore fishermen (196 lifts) and 100 one-, 45 two-day and 20 three day soak times for offshore fishermen (165 lifts). It should be noted that these estimates are based on the participating fishermen and that there is a huge variation amongst fishers, for example one Mandurah fisher fished for 145 days in 06/07 with about 80 one day soaks only. An analysis was also performed that considered the saving to the industry as a whole based on the use of the combined method used for an estimated 8.3 million pot lifts for the whole 2006/07 season across all three zones (de Lestang *et al*. 2008).

3. Results

3.1. 2005/06 Trial

With respect to data pooled across the entire season, the randomisation, quasi-Poisson and negative binomial tests all found significantly greater mean numbers ($P > 0.05$) of lobster were landed in pots using the traditional method (4.04 ± 0.12) in comparison to those using the combination method (3.38 ± 0.12) over a one day soak (Tables 1 & 2). In contrast, there was no significant difference in the mean numbers of lobster landed per pot between the two treatment groups using a two day soak time while minimal overlap was found between the two treatment groups with respect to a three day soak time. Note that insufficient numbers of experimental replicates for three day soak times prevented any statistical analyses from occurring.

Irrespective of the method of analysis, the first month of the commercial season resulted in significantly greater mean numbers ($P > 0.05$) of trapped lobster per pot using the traditional method of bait deployment in comparison to the combination method (Table 3, Figure 3). According to GLM based on a quasi-Poisson model, the first month of the 2005/06 commercial season was the only month in which one day soak times using the traditional method of bait deployment resulted in significantly greater mean numbers of lobster per pot than those deployed using the combination method. In contrast, analysis of data using a GLM fitted with a negative binomial model found one day soak times resulted in significantly higher mean numbers of lobster per pot using the traditional method of bait deployment than those using the combination method in months one, two and five of the 2005/06 commercial season.

Table 1. The probabilities that the difference between the mean numbers of lobsters caught using the traditional and the combined methods of bait deployment for both one and two day soak times across in Zone C based on the distribution of t-values generated using 20,000 randomisations of the pooled data for the 2005/06 season and via a GLM analyses based on both the Quasi-Poisson and Negative binomial models. (An * denotes highly significant results).

Statistical test	**One day soak time**	**Two day soak time**
Randomisation	0.00*	0.47
Quasi-Poisson	0.00*	0.14
Negative binomial	0.00*	0.14

Table 2. Mean ± S.E of lobster trapped using the traditional method and combined method of bait deployment for the one-, two- and three day soak times in the 2005/06 season. (Values with the same superscript letter are not significantly different, values different superscripts are significantly different, those without a superscript were based on samples with too few replicates to be statistically meaningful).

Method	Soak time		
	1-day	2-day	3-day
Traditional	4.04 ± 0.12[a]	5.33 ± 0.85[a]	3.64 ± 0.49
Combined	3.38 ± 0.12[b]	5.27 ± 0.54[a]	4.92 ± 0.23

Table 3. The probabilities that the difference between the mean numbers of lobsters caught using the traditional and the combined methods of bait deployment for one day soak times for each month of the season in Zone C of the 2005/06 season using GLM analyses based on both the quasi-Poisson and negative binomial models. (An * denotes highly significant results).

Model Month	Quasi-Poisson	Negative binomial
1	0.00*	0.00*
2	0.63	0.04*
3	0.73	0.94
4	0.98	0.47
5	0.84	0.01*
6	0.72	0.10
7	0.33	0.79
8	0.35	0.19

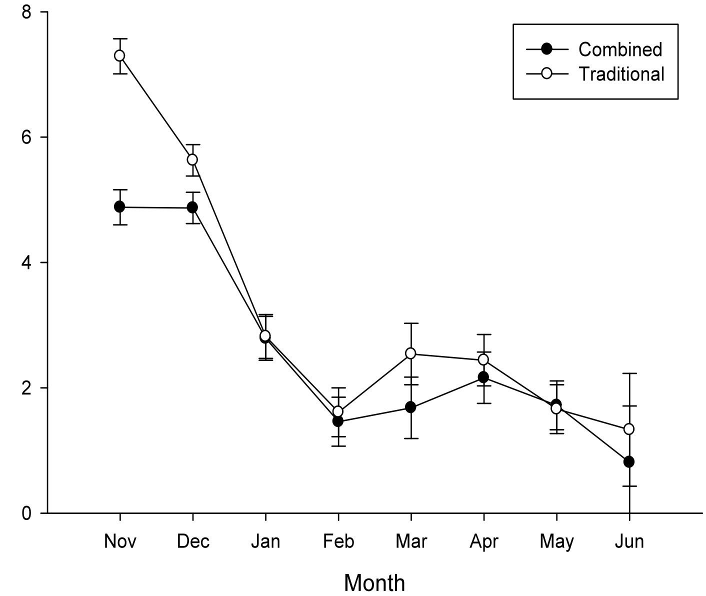

Figure 3. Comparison of mean ± S.E of lobsters trapped using the traditional methods and combined methods of bait deployment across a one day soak time throughout the 2005/06 season.

3.2. Cost Savings 2005/06

Cost savings to fishermen based in inshore waters deploying 100 pots using the combined method of bait deployment for 151 soaks (i.e. January through to end of season) would result in an estimated 22,650 kilogram reduction in bait usage per fisher from month three until the end of the commercial season. This equates to an annual cost saving of $33,975 per fisher.

Cost savings to fishermen based in offshore waters deploying 100 pots using the combined method for 158 soaks would result in an estimated 23,700 kilogram reduction in bait usage per fisher from month three until the end of the commercial season. This equates to an annual cost saving of $35,550 per fisher.

3.3. 2006/07 Trial

In the 2006/07 season none of the analyses demonstrated any significant differences in the numbers of lobster caught in pots using the traditional method of bait deployment or those using the combined method for one-, two- or three day soak times (Table 4). Catches ranged from a low of 1.36 (± 0.58) lobsters per pot in Zone B for a three day soak using the traditional method of bait deployment to a high of 2.62 (± 0.24) lobsters per pot in Zone B for a one day soak time also using the traditional method of deployment (Tables 5, 6 and 7). The two following examples highlight the similarity in catch rates regardless of zone, method of deployment or soak time. Firstly, the traditional method of deployment had a slightly higher mean catch rate when compared to that of the combination method for the same soak time in the same zone in four of the nine comparisons. Secondly, the highest catch rates were for a one day soak using the traditional method in Zone A (2.62 ± o.24), a two day soak using the combined method in Zone B (2.51 ± 0.21) and virtually the same catches for three day soaks using the traditional and combined methods in Zone C (2.25 ± 0.28 and 2.20 ± 0.37, respectively).

Table 4. The probabilities that the difference between the mean numbers of lobsters caught using the traditional and the combined methods of bait deployment for both one, two and three day soak times across all zones based on the distribution of t-values generated using 20,000 randomisations of the pooled data for the 2006/07 season and via a GLM analyses based on both the Quasi-Poisson and Negative binomial models. (An * denotes highly significant results).

Statistical test	One day soak time	Two day soak time	Three day soak time
Randomisation	0.68	0.47	0.38
Quasi-Poisson	0.72	0.67	0.44
Negative binomial	0.65	0.40	0.69

Table 5. Mean ± S.E of lobster trapped using the traditional method and combined method of bait deployment for the one-, two- and three day soak times in Zone A during the 2006/07 season. (Values with the same superscript letter are not significantly different values different superscripts are significantly different, those without a superscript were based on samples with too few replicates to be statistically meaningful).

Method	Soak time		
	1-day	2-day	3-day
Traditional	2.62 ± 0.24^a	2.60 ± 0.20^a	1.53 ± 0.72^a
Combined	2.39 ± 0.19^a	2.33 ± 0.16^a	1.66 ± 0.83^a

Table 6. Mean ± S.E of lobster trapped using the traditional method and combined method of bait deployment for the one-, two- and three day soak times in zone B during the 2006/07 season. (Values with the same superscript letter are not significantly different values different superscripts are significantly different, those without a superscript were based on samples with too few replicates to be statistically meaningful).

Method	Soak time		
	1-day	2-day	3-day
Traditional	1.99 ± 0.24^a	2.45 ± 0.12^a	1.36 ± 0.58^a
Combined	2.26 ± 0.19^a	2.51 ± 0.21^a	1.79 ± 0.63^a

Table 7. Mean ± S.E of lobster trapped using the traditional method and combined method of bait deployment for the one-, two- and three day soak times in zone C during the 2006/07 season. (Values with the same superscript letter are not significantly different values different superscripts are significantly different, those without a superscript were based on samples with too few replicates to be statistically meaningful).

Method	Soak time		
	1-day	2-day	3-day
Traditional	1.71 ± 0.24[a]	2.23 ± 0.20[a]	2.25 ± 0.28[a]
Combined	1.88 ± 0.19[a]	2.02 ± 0.16[a]	2.20 ± 0.37[a]

3.4. Cost Savings 2006/07

Zones A & B - Cost savings to fishermen based in inshore waters resulted in the use of the combined method of bait deployment for 177 soaks and an estimated 26,550 kilogram reduction in bait usage per fisher fishing 100 pots. This equates to an annual cost saving of $39,825 per fisher paying $1.50 per kilogram of bait.

Cost savings to fishermen fishing in offshore waters based on 146 days use of the combined method of bait deployment would result in an estimated 21,900 kilogram reduction in bait usage per fisher. This equates to an annual cost saving of $32,850 per fisher.

Zones C - Cost savings to fishermen based in inshore waters resulted in the use of the combined method of bait deployment for 196 soaks and an estimated 29,400 kilogram reduction in bait usage per fisher. This equates to an annual cost saving of $44,100 per fisher.

Cost savings to fishermen fishing offshore waters based on 165 days use of the combined method of bait deployment would result in an estimated 24,750 kilogram reduction in bait usage per fisher. This equates to an annual cost saving of $37,125 per fisher.

Based on a nominal fishing effort of 8.3 million pot lifts (de Lestang *et al.,* 2008) and savings of 1.5 kg of bait per pot at $1.50 per kg, the industry could have made a total saving of approximately $18.5 million in the 2006/07 season if all participants had used a baitsaver in one bait box.

4. Discussion

4.1. 2005/06 Trial

As was the case with the preliminary trial, it was unfortunate from both a commercial fishers and researcher's perspective that the 2005/06 commercial season resulted in below average landings across all zones of the fishery. As a consequence, participants in the season long baitsaver trial were understandably hesitant to test a product that could potentially further reduce their landings. In addition to this, the low numbers of sea lice encountered in the shallow, inshore waters across all zones of the fishery didn't provide any further encouragement for participants to continue in the trial. Consequently, as noted in the Materials & Methods, only one fisherman continued with a modified version of the proposed trial throughout the 2005/06.

The randomisation and GLM tests performed are recognised as being very robust and thus allow definitive conclusions to be drawn with respect to soak time and fishing method. Therefore, it can be said with some conviction that where one day soak times were employed over the 2005/06 commercial season, a greater number of lobsters would be caught if the traditional method of bait deployment was used throughout the season rather than if the combined method was used. In contrast, where two day soak times were concerned, there would be no difference in the numbers of lobster landed over the whole season between the two methods of bait deployment.

The demonstration of differences in catch across the whole season suggest that the use of baitsavers has no financial benefit, indeed, if the loss of revenue from reduced catches and the cost of the baitsavers are factored in, their use could reduce rather than increase profitability. However, analysis of monthly trends for the 2005/06 season clearly demonstrated that differences in catch were essentially restricted to the start of the season. Thus, all tests showed that the traditional method of bait deployment caught more lobster than the combined method in the first month of the season, whilst the negative binomial distribution also found differences in months two and five when using a one day soak. Thus, if a fisher using 100 pots had used the traditional method of bait deployment in the first two months of the season in conjunction with the combined method for the rest of the season they would potentially have saved between $33,000 (offshore) and $36,000 (inshore).

4.2. Why Did The Traditional Method Work Better At The Start Of The Season?

The differences in effectiveness of the two methods of bait deployment at different times of the season appear to be the result of a combination of lobster behaviour, prevalence of sea lice and environmental factors.

Lobster behaviour - At the beginning of the season juvenile lobster inhabiting shallow inshore grounds (de Lestang *et al.* 2008) As a result of this migration taking place, comparatively dense aggregations of lobster, that are particularly vulnerable to fishing, can be found in the predominantly shallow, inshore areas of the fishery at this time. A consequence of this is that when these aggregations are found fishers will 'bomb' them with as many pots as possible, this leads to lobster pots competing with other pots within a small area. It is therefore vitally important that a pot must provide a strong and attractive odour plume if it is to compete effectively against other pots. This 'competition theory' has been accepted by numerous professional fishers (Peter Vinci pers. comm.) and fisheries scientists (Professor Norm Hall pers. comm.). The converse also holds in that when lobster are more sparsely distributed and thus more difficult to catch, e.g. after the migration and moult ('reds' phase) and/or lobster inhabiting deeper, offshore grounds, fishers will also be more sparsely distributed and not congregate and 'bomb' relatively small areas. Therefore, when an 'informed' fisher places pots in an area in which lobster are prevalent, pots will not be competing they will catch lobster regardless of deployment method. This supposition that 'pot competition' only occurs at the beginning of the season when fishers target dense aggregations of lobster and catches are traditionally high but does not occur later in the season when lobster are more sparsely distributed and catches are lower is further supported in figure 3. That figure indicates that, although the first two months of the 2005/06 commercial season resulted in the greatest number of lobster being landed per pot regardless of deployment method the traditional method of deployment caught more lobster than the combined method. Furthermore, during the rest of the season when catches were low deployment method had no effect on catch rate.

Prevalence of sea lice – Sea lice were not very prevalent during the 2005/06 trial and, as such, their effects on lobster catches could not be statistically explored, however, some points can be raised. In general pots using the traditional method of deployment still had bait in them after one day, whereas little if any bait remained in pots using this method of deployment after two or three days or when sea lice were abundant after one day. In contrast bait remained in the baitsavers after one two and three days no matter what the abundance of lice. On the very few days that lice were abundant both the participant and other fishers felt that catch rates after a one day soak time were negatively impacted, whilst the trial fisher felt that catches in pots that employed the combined method were better than those using the traditional method.

Environmental factors - A lack of inclement weather (i.e. small swells and seas) experienced in the initial few months of the season long trial possibly contributed towards the significantly lower average landings when pots were deployed using the combined method. Generally speaking, a lack of inclement weather equates to minimal bait agitation and therefore it is likely that the bait inside the baitsavers would produce a smaller plume, and consequently be less efficient at attracting lobster. However, when swells and currents are large and strong, baitsavers are likely to provide some protection from buffeting, thereby maintaining the integrity of the fish bait, effectively extending the leach time and subsequent catchability of the pot beyond those deployed using traditional means.

4.3. Conclusions From The 2005/06 Trial

It was hypothesised that throughout 'the whites phase' of the season, irrespective of soak time or fishing zone, traditional methods of bait deployment will result in significantly greater numbers of lobster per pot than those deployed using combined methods (i.e. a baitsaver). It was also hypothesised that irrespective of soak time or fishing zone, combined methods of bait deployment will be equally effective as traditional methods for the rest of the season (i.e. predominantly 'the reds phase').

From our results and discussions with fishermen it was felt that providing commercial fishers with custom sized fine and course sized mesh for the baitsavers and bodies with or without 1.5mm wide cuts will only increase it's capacity to cater for varying soak times in addition to an estimated 3000% variation (temporal and/or spatial) in lice abundance encountered across the various zones of the lobster fishery (Winzer, 2008).

4.4. 2006/07 Trials

Although the 2006/07 was also predicted to be very poor, the very promising results generated during the 2005/06 season, along with further modifications to the baitsaver brought about by that trial and extensive consultations with Neil Dorrington, allowed us to continue the trial with the original six fishermen, i.e. the trial was extended to include the 2006/07 season and run in zones A, B and C. Whilst any differences between the use of different mesh sizes or the absence or presence of slits in the body of baitsavers could not be tested, the provision of these choices ensured the trial into baitsaving strategies could continue. Furthermore, the fishermen made it clear that for such a method to be accepted by the industry it must be flexible enough to allow fishermen to take into account such things as prevalence and size of lice, and environmental conditions. Due to the very poor start to the season (both predicted and real), fishermen did not start the trial until the middle of December.

In contrast to the results for one day soaks from the 2005/06 season, in 2006/07 no differences were detected in the number of lobster caught using the traditional or combined methods whether pooled across all zones or for individual zones. Furthermore, no differences were detected between one-, two- or three day soaks. Based on this it was estimated that fishermen could have made savings of between approximately $33,000 (zones A & B offshore) and $44,000 (Zone C inshore) if they had used the combined method for 100 pots in the 2006/07 season. With regard o the entire fishery, and based on a nominal fishing effort of 8.3 million pot lifts (de Lestang *et al.,* 2008), savings of approximately $18.5 million could have been made in the 2006/07 season if all participants had used a baitsaver in one bait box.

4.5. Why Did The Traditional Method Work Better At The Start Of The Season In 2005/06 But Not In This Period During 2006/07?

The reasons for the differences between the two years are probably twofold. Firstly, fishers did not start the trial until a few weeks into the season, i.e. they missed some of the period when catches are traditionally amongst the highest. Secondly, participants in the trial (and the rest of the industry) had particularly low catches during both the whites and red phases of the 2006/07 season and the participants reported that there was little ‘bombing’ of small areas. If, as was reported, this was the case then competition between pots would presumably be far lower than would be expected during an average or above average season. Thus, it is likely that catch rates would more closely parallel those during the reds phase of the season and therefore mirror the results for that period of the 2005/06 trial. It is also worth noting that although the GLM based on the negative binomial found a difference between catch rates in the second month of the season it was the only test to do so. Whenever a statistical test is conducted there is always a chance that a difference determined to be real is not and a chance that real differences will not be detected, when multiple tests are performed these chances increase. It may therefore be the case that differences in the second month detected using the negative binomial model are an example of this. Whatever the reason it is apparent that the use of the combined method of bait deployment resulted in significant savings in both years.

4.6. Overall Conclusions and Recommendations

General Conclusions - The results of the 2005/06 and 2006/07 season trials provide support for the notion that the use of baitsavers in one bait holder at least and during the ‘red’ phase of the season would provide significant savings to fishers. Furthermore, even though these seasons were amongst the worst recorded most of the participants believed that the baitsavers would provide cost savings at certain times of the year and when fished under certain conditions, whilst others believed the savings would be season round. Indeed, one of the fishers (Peter Vinci in Zone C) was so impressed with the baitsavers he would have placed them in all of his pots.

Participants, and our results, suggest that the use of the baitsaver in at least one bait box would result in significant savings to fishers if used during the ‘red’ phase of the season. In addition the provision of baitsavers with end caps using different mesh sizes and bodies with or without cuts would allow fishermen to tailor the baitsaver to prevailing conditions. For example, if large numbers of small lice are present during periods of strong currents and the soaks are likely to be for more than one day then it may be appropriate to use smaller mesh sizes and no cuts in the body. This would ensure that bait is retained even though it may provide only a weak odour plume. However, if lice are large, and/or currents are weak it may be more appropriate to use end caps with a larger mesh and a body with cuts in it. This will not only ensure bait is present throughout a one, two or three day soak, but also that it produces a constant and strong odour plume. The use of the larger mesh and bodies with slits may be particularly important when water temperatures are relatively high and currents are weak. Participants in the trial reported that during such periods the large amount of bait remaining in baitsavers using fine mesh and no body slits was rancid and felt that this probably deterred lobster from entering the pots. In contrast baitsavers with coarser mesh and slits in the body contained less bait and this was not rancid.

Benefits and Adoption - The trials strongly suggest the benefits of using baitsavers (between $33,000 and $44,000 for fishers deploying 100 pots with one baitbox using a baitsaver and up to $18.5 million to the industry as a whole in the 2006/07 season). However, while one of the participants (Peter Vinci) is using all the baitsavers we have been able to provide him, continued discussions by one of the investigators (Andrew Winzer) with fishers shows that they are loathe to use them whilst catches remain so low. This is despite the fact that the results have not only been discussed informally with fishers but have also been presented formally (by Andrew) in all zones of the fishery during the 2006/07 and 2007/08 annual tour by the Rocklobster Industry Advisory Committee's. Disappointingly discussions, both at these meetings and informally during the course of Andrew's day-to-day meetings with fishers, have also shown that the majority of fishermen are trying to squeeze even more bait into the bait boxes, even though it has been explained to them that unless pots are competing with other pots this has no effect on catch rate at all.

Further Development – As noted above Andrew Winzer has continued to promote the use of the baitsaver right up until his departure from the Industry in 2009, but has met with little success due to the very poor seasons experienced over the past few years. When and if catches return to more normal levels fishermen may then take up their use. The provision of different end-caps and bodies was certainly seen as important by the fishermen who participated in the trials.

Planned outcomes – The project has demonstrated that the use of the baitsavers with the coarser mesh in the end caps and slits in the body could reduce bait usage by at least 40% in the Western Rock Lobster Fishery without reducing catches particularly during the 'red' phase of the season.

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6. Appendix 1: Intellectual property

This project demonstrates that the use of baitsavers in lobster pot baitboxes has the potential to reduce amount of bait used without reducing the catchability of pots at certain times of the year.

7. Appendix 2: Staff

Luteon Brown (Fisher, Zone B)

Peter Burton (Fisher, Zone A)

Neil Dorrington (Fisher, Zone C)

Howard Gill (Murdoch University)

Chris Patman (Fisher, Zone A)

Steve Small (Fisher, Zone B)

C: Peter Vinci (Fisher, Zone C)

Andrew Winzer (Murdoch University and funded by FRDC and Murdoch University).

7. Appendix 3: WAFIC IDU project 04-01 - Do lobster pots employing bait saving devices catch less lobster than those deployed in the traditional manner? A preliminary investigation.

Acknowledgements

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Introduction

The Western Rock (Spiny) Lobster, *Panulirus cygnus* George, is found off the coast of Western Australia between North West Cape (21°45'S.) and Cape Leeuwin (34°22'S.) (Jernakoff & Phillips 1988). This fishery is one of the world's largest Rock Lobster fisheries with a gross yearly income of AUD$200-$400 million (Phillips *et al.* 2000). In **????** it became one of the first fisheries in the world to be certified as ecologically sustainable by the Marine Stewardship

Council. The sustainable catch is estimated at between 10,000 and 15,000 tonnes per year, whilst the actual catch has been maintained at between 8,500 and 14,400 tonnes per year since the 1980's (Melville-Smith *et al.* 2004). The 2000-2001 commercial Western Rock Lobster season saw fishermen use approximately 16,000 tonnes of frozen bait to land approximately 11,000 tonnes of Western Rock Lobster (Melville-Smith *et al.* 2004). At a cost of approximately $1.35 per kilogram (current price being paid by Neil Dorrington) the industry spent approximately $21.6 million on bait in that season. Any reduction in the amount of bait used that does not impact on the number of lobsters landed has the potential for significant cost savings to the industry. Two ways in which such a reduction could be made are through the use of artificial baits and bait saving devices. For such methods to be accepted by the industry they must be as effective in catching lobsters as the traditional method of fishing and also be easy to deploy and result in cost savings to fishermen. Trials investigating the efficacy of commercially acceptable dry, water stable artificial baits found them to be nowhere near as effective as traditional methods (Hoxey 1996,1999; Caputi 1999). No comparable studies have been undertaken regarding the efficacy of bait saving devices.

In addition to attracting Western Rock Lobster, bait is also likely to attract non-target species. For example, amphipods and isopods (Fig. 1) have been shown to consume baits (and lobster) in lobster traps of some American and Japanese fisheries (Bowman 1974; Sekiguchi *et al.* 1981; Sekiguchi 1982; Stepien & Brusca 1985). The consumption of the bait by a non-target species prior to lobsters being attracted is likely to reduce the catchability of that trap (see for example Sekiguchi *et al.* 1981).

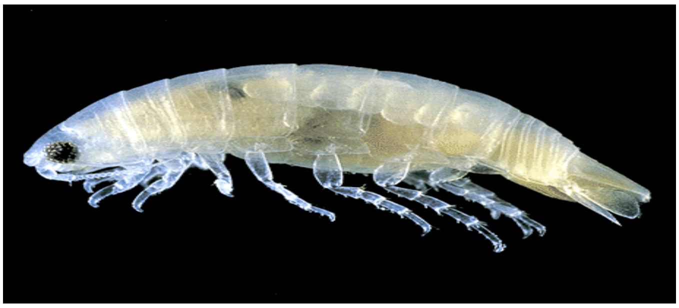

Figure 1. *Cirolana hesperia*, the most common species of sea lice caught in Zone C of the Western Rock Lobster fishery (size range 2.5 mm to 12.5 mm).

Data collected during a sampling program to determine the species of sea lice present in Zone C, in addition to those collected in a written questionnaire distributed to commercial fishermen in Zones B and C, indicated that when lice numbers were low there was still some bait in pots after 24 hours. In contrast, when sea lice were abundant no bait remained in pots after one day (Winzer unpublished data). Therefore, when sea lice are abundant, it is likely that they will consume much of the bait used by lobster fishermen. Consequently, when sea lice are abundant the catchability of pots is likely to be reduced, particularly when soak times exceed 24 hours. In order to combat this loss of bait to lice, fishermen force as much bait as possible into their bait boxes, however, our data indicated that this ploy did not result in bait remaining after 24 hours. Thus, development of devices that exclude sea lice from entering the bait box, but still allow the bait to attract lobsters, have the potential to reduce the amount of bait used by commercial fisherman while increasing the catch rate of pots over two and three day soak times.

Clearly, there is value in developing bait-saving strategies to reduce the amount of bait used and limit the impact of sea lice on bait usage in order to increase the profitability of the industry. Furthermore, in the future, the classification of a fishery as ecologically sustainable is likely to include further considerations of the impact of that fishery on other organisms which, in the case of the Western Rock Lobster fishery, and other fisheries that use baited pots/traps, may include its impact on bait species. Thus, bait saving devices have the potential to consolidate further the fishery as ecologically sustainable. While at least two bait-saving devices are commercially available, as we have noted above no data are available regarding their efficacy.

The aim of this study was, therefore, to determine whether pots using different bait savers containing reduced quantities of bait would catch the same numbers of lobsters (both legal and undersize) as conventional pots using the typical amounts of bait employed in the fishery.

Materials and Methods

Personnel & Location of trial

The study was conducted over a twelve day period (8/10- 20/10) during the last quarter and new moon phases of the lunar cycle, and took place in conjunction with the 2004/5 Western Rock Lobster breeding stock survey in zone B of the fishery (ranging from S31°02 161 E115°18 850 to S31°03 463 E115°19 119). This trial was conducted in typical shallow, coastal nursery areas where juvenile Rock Lobsters forage. A commercial Rock Lobster fisherman and his boat were hired for the duration of the trial to ensure the fishing practices used were consistent with those employed in the fishery by commercial fishermen.

Baitsaver descriptions

Two types of commercially available bait savers were provided for use in this study by their designers John Servass and Graheme Drew.

One of the commercially available bait savers (designed by John Servass, Fig. 2) consists of two 95 mm diameter half cylinders (moulded plastic) placed around the bait. These are then held closed by a sacrificial anode thereby preventing sea lice from attacking baits during daytime hours. Once the anode dissolves, elastic bands cause the cylinders to open allowing lobsters and lice access to the bait. Two types of anode are available, the first, recommended for one day soak times, takes approximately five hours to dissolve, whilst the second, recommended for two day soak times, takes approximately ten hours to dissolve (John Servass Jr, personal communication). Therefore, for each of the pots scheduled for one-day soak times, bait savers were fitted with five hour sacrificial anodes, while those scheduled for two-day soak times were fitted with ten hour sacrificial anodes.

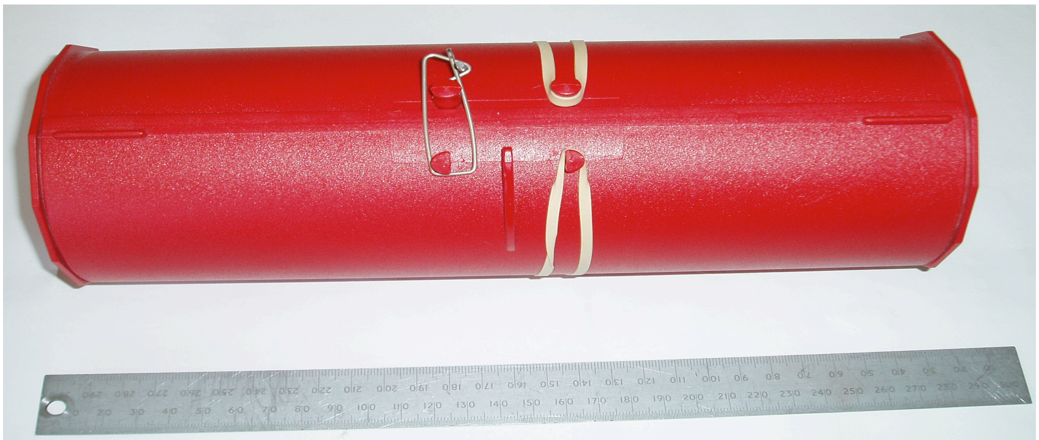

Figure 2. John Servass' bait saver

The other commercially available device (Graheme Drew's, Fig. 3) is a simple flip-top canister with a series of small slits (2 mm width) down the sides permitting water flow.

Figure 3. Graheme Drew's bait saver

In addition to the two commercially available bait savers, a bait saver was designed specifically for this study and comprises a 100 mm diameter P.V.C. pipe whose ends were closed by two bored-out 100 mm P.V.C. end caps, each containing 0.05 mm mesh inserts.

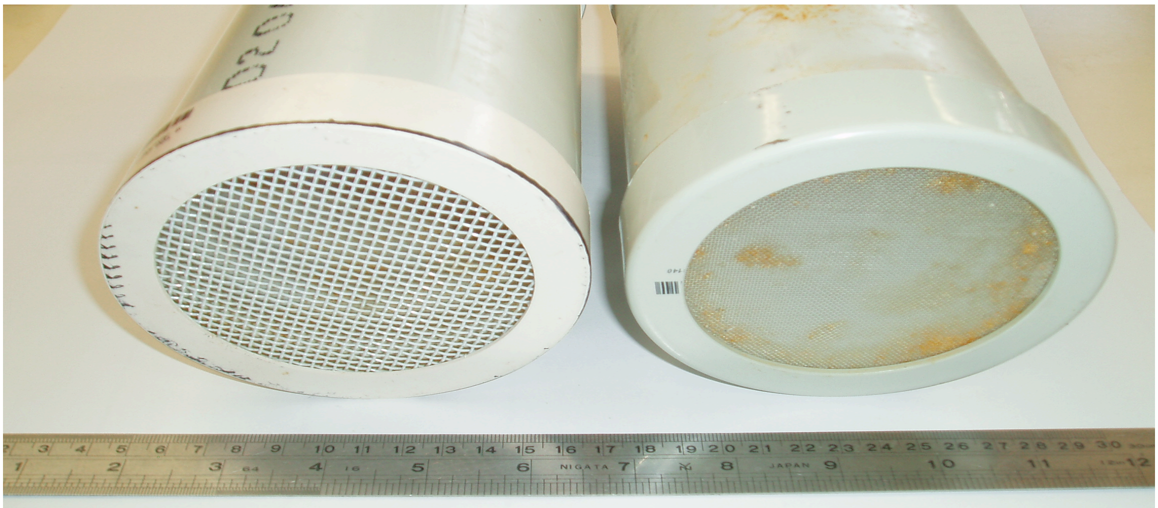

Figure 4. New design (ND) bait saver with mesh sizes of 0.5 mm (left) and 0.05mm (right).

Experimental Design

Thirty-two regular jarrah batten pots of the form used by commercial fishermen (Bowen 1980), were deployed, 16 of which were pulled every day and 16 of which were pulled every second day. Within each of these two groups of 16 pots, four pots were deployed using the traditional fishing practice of filling each of the two bait boxes within each pot with approximately 2 kg of bait (4 kg per pot), four were deployed with John Servass bait savers, four with Graheme Drew bait savers and four were deployed with the bait saver designed for the current study. Each pot deployed with the bait saver used a single bait saver that contained approximately 0.5 kg of blue mackerel as bait. Thus, over the duration of the trial, a maximum of 48 replicates for each treatment using one day soak times and 24 replicates for each of the treatments using two day soak times were possible, weather conditions permitting.

Although the most appropriate way to deploy the experimental pots would be truly random, a completely random deployment would be very time consuming, hard to follow and difficult for the fisherman to execute. Thus, the following design was utilized as it was quick and easy for the fisherman and included some randomness within its design. On the first day of the trial the first four pots were randomly assigned to each of the four treatments/controls, the next four pots were then assigned a treatment/control in the same order as the first four, and so on through to the full 32 pots. Each time that pots were redeployed after retrieval, the order of treatment was rotated, such that a pot with treatment one was redeployed with treatment two, treatment two became three, treatment three became four and treatment four became one. The treatments were: Control, 1; John Servass bait saver, 2; Graheme Drew bait saver, 3; New design bait saver, 4.

All pots were deployed on a weed/rock substrate at a depth of 7-12 fathoms, ensuring that depth and bottom conditions were standard for all pots. The distance between pots was set at least 100 metres to ensure catch rates of neighbouring pots were independent of each other (Jernakoff & Phillips 1988). Lobster pot escape gaps remained open in order to simulate a commercial fishing situation. Although different amounts of bait were used in the control group and the bait saver groups the design emulates a commercial fishing scenario where fishermen pack both bait boxes to their capacity of 2 kg each (i.e. 4 kg of bait in total), in comparison to bait savers (0.5 kg in total). Lobsters caught across the respective treatment/control groups were returned to the water after being counted, carapace lengths measured and recorded. Pots were rebaited and redeployed, with the treatments rotated after each pull as noted above.

As a consequence of bad weather over days 3-4 (11/10-12/10) of the deployment trial, pots could not be pulled, consequently on day 5 (13/10) all pots were pulled (one and two day soak time replicates) and considered a three day soak time. A risk analysis conducted prior to the commencement of the deployment trial had identified inclement weather as a threat. Therefore the experiment was designed in such a way that it was sufficiently robust to overcome such an event occurring once or twice.

Statistical Analyses

Rather than performing a harsh transformation on the raw data, a randomisation test was used (Edgington 1995). Such a test is ideally suited to the type of data collected during the current study, as it doesn't rely on assumptions of normality or equal variances. The randomisation method is ideal for testing sharp null hypotheses, that is, null hypotheses under which all potential outcomes are known exactly. The null hypothesis, which we assume to be true for the purpose of the trial, states that the two sets of data are drawn from the same distribution (i.e. the treatment has no effect on the value of catch per pot recorded for each pot lift). Comparisons between a control and treatment group of the same soak time are ideally suited to a two sample situation where we are attempting to compare the means of two sets of values by determining a t-statistic.

Comparison between a control and a specific treatment group and soak time involves pooling all values, and randomly selecting, with replacement, another complete data set from these original two treatment groups. The total sample size is then halved and assigned to the set number 1, our control group and the other remaining half of the data set is assigned to set number 2, our treatment group. A measure of the difference between the means is then calculated with equal sample sizes and unequal variances using the standard formula (but recognising that this is not the t-statistic that we would use with a standard table of t-values). This value is calculated by subtracting the mean of the treatment group from the mean of the control group, then dividing by the estimate of the standard deviation of the difference between the means. This statistic was calculated 20,000 times producing a very large number of random observations of the values of the t-statistic that one would be likely to encounter if the null hypothesis was true.

The final step in the calculation is to calculate the test statistic from the original pooled set of data (comprised of the control and a treatment group across a respective soak time). A count was then performed of the number of times within our 20,000 observations from the null hypothesis that a value of our test statistic is obtained that is equal to or exceeds the value we have just calculated from the recorded data. This count was then divided by 20,000 to provide an estimate of the probability that a test statistic value as large as that which was observed in the deployment trial could have occurred by chance if the null hypothesis was true.

This is a single-tail test as all that is being tested is that the total catch of lobsters (size and undersized) obtained with the treated pots should not be significantly less than the catch obtained by the control pots using the same soak time. It is assumed that the test statistic calculated is an appropriate measure of the difference between the mean catch per pot lift recorded across each treatment group and soak time. An additional assumption of this study is that there are sufficient observations in the combined data set that a random sample with replacement is representative of the distribution of values that would be recorded if the experiment had been repeated (at the same time as the original trial, at the same location, with the same density of lobsters and under the same environmental conditions).

The power of this approach to detect an effect size of a specific magnitude, given the sampling variability has not been explored for this study. Therefore any null hypothesis that is accepted, contains a probability that could be associated with the type II error.

Insufficient numbers of replicates across all treatment groups prevented analyses of the effect of three day soak times on catch rates.

Cost benefit analyses

In order to provide an estimate of the costs and/or benefits associated with using bait savers to fishermen a cost benefit analysis was performed. However it is important to note that, as the cost benefit analysis had to rely on the raw data obtained from this study that was conducted over a twelve-day period in inshore grounds of Zone B, the following major assumptions had to be made in developing this projection:-

1) That this twelve day fishing period is representative of an entire season.
2) That inshore and offshore catch rates are the same.
3) That catch rates are the same in all Zones.

The model also assumes that:-

4) Bait costs are $1.35 per kg.
5) Fishermen receive $19.00 per kg of lobster or approximately $9.00 per animal.
6) The fisherman is licensed for 100 pots.

Number of one-, two- and three-day soak times. Commercial fishermen provided an estimate of the number of one-, two- and three-day soak times that they employed throughout an entire season. The estimates provided by fishermen operating predominantly in inshore grounds indicated that they had fewer two- and three-day soak times than the fishermen who operated predominantly in offshore grounds. Therefore, the following cost benefit analyses were performed independently for these two groups and used 213 one-, 12 two- and four three-day soak times for inshore fishermen and 175 one-, 25 two- and eight three-day soak times for offshore fishermen.

Profit per pot per lift. The profit per pot, i.e. the value of the catch minus the cost of bait, was determined for all treatment groups. These values were calculated for the mean, and the upper and lower bounds (95% C.I.). These values were used to derive the annual net profit projections below.

Annual net profit. Based on the estimated number of one-, two- and three-day soak times provided by inshore and offshore fishermen and the profit per pot per lift calculated above, the hypothetical annual net profit for a fisherman who has 100 pots was calculated. This estimate included the costs of buying the relevant bait savers where appropriate.

Combining methods. A fourth analysis was performed that provided an estimate of the costs/benefits associated with filling one bait box with bait in the traditional way and using a bait saver in the other bait box. This analysis assumes that the combination will be as effective as the traditional method for one-day soak times and equally as effective as bait savers over two- and three-day soak times. During the current study the pots using the traditional deployment method caught more lobster than those using bait savers for the one-day soak time. However, no differences were detectable between the methods of deployment for the two-day soak time, whilst for three-day soak times the new design of bait saver seemingly provided better catches. This model further assumes that pots using the traditional deployment method have bait remaining in the pot after 24 hours and are therefore still fishing effectively; this is apparently the case when sea lice are in low abundance. The use of a combined method of bait deployment should therefore have no adverse effect on catch rate. However, in times when lice are very abundant the use of a bait saver may in fact increase the catchability of pots as a bait plume from the bait saver will still be attracting lobsters to the pot (see Discussion).

Results

Pots that employed the traditional method of bait deployment caught a mean of 5.11 (± 0.76) lobster when deployed for one day, whereas those that used bait saving devices caught between 2.55 (± 0.42) and 3.91 (± 0.49) (Table 1, Fig. 5). The randomisation tests indicated that the number of lobsters landed in pots that used the traditional deployment method was significantly different ($P \leq 0.02$) from the numbers caught in those using bait savers (Table 2). Whilst there was only slight overlap in the 95% confidence intervals of the number of lobsters landed in pots that used the traditional deployment method and those caught using the Servass bait saver, there was no overlap between the number of lobsters landed in pots that used the traditional deployment method and the other bait savers (Fig. 5).

Pots that employed the traditional method of bait deployment caught a mean of 3.50 (± 1.06) lobsters when deployed for two days, whereas those that used bait saving devices caught between 2.20 (± 0.66) and 2.85 (± 0.77) (Table 1, Fig. 5). In contrast to the one day soak time, no significant differences ($P \geq 0.15$) were detected between the number of lobsters landed using the traditional deployment method and the bait savers (Table 2) and there was a large overlap of the 95% confidence intervals of the number of lobsters landed in pots using the traditional methods of bait deployed and those of all the groups using bait savers.

Pots that were deployed for three days caught between 2.38 (± 0.63) (Drew bait saver) and 3.12 (± 0.95) (bait saver designed for this study) lobsters (Table 1, Fig. 5). The small number of replicates for the three-day soak time precluded statistical analysis.

Table 1. Mean (± S.E.) and 95% confidence intervals of total lobster landed using the traditional method of bait deployment, and bait deployed in the 3 types of bait saver for one, two and three day soak times.

Treatment group	Soak time	Mean (± S.E.)	95% Confidence Interval	
			Lower bound	Upper bound
Traditional	1	5.11 (± 0.76)	3.62	6.60
	2	3.50 (± 1.06)	1.42	5.58
	3	3.00 (± 0.65)	1.73	4.27
Servass	1	3.91 (± 0.49)	2.95	4.87
	2	2.20 (± 0.66)	0.91	3.49
	3	2.75 (± 0.84)	1.1	4.40
Drew	1	3.55 (± 0.46)	2.65	4.45
	2	2.85 (± 0.77)	1.34	4.36
	3	2.38 (± 0.63)	1.15	3.61
New Design	1	2.55 (± 0.42)	1.73	3.37
	2	2.50 (± 0.50)	1.52	3.48
	3	3.13 (± 0.95)	1.27	4.99

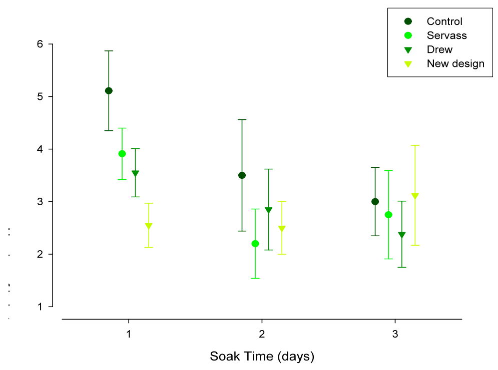

Figure 3. Mean numbers of lobsters landed using the traditional method of bait deployment, and bait deployed in the 3 types of bait saver for one, two and three day soak times, and their 95% confidence intervals.

Table 2. The test statistic (t-value), i.e. the difference between the mean numbers of lobsters caught using traditional bait deployment methods and each of the bait savers for both one and two day soak times, and the probabilities (based on the distribution of t-values generated using 20,000 randomisations of the pooled data) of these differences occurring by chance.

	One day soak time		**Two day soak time**	
Treatment group	t-value	Probability	t-value	Probability
Control vs Servass	2.97	0.00	1.04	0.15
Control vs Drew	2.05	0.02	0.50	0.32
Control vs New design	2.77	0.00	0.86	0.20

Cost-Benefit Analyses

The mean maximum net profit per pot per lift of $40.59 was obtained when bait was deployed using the traditional method over a one-day soak time, this translates to a mean annual net profit of $792 855 and $904 527 for fishermen operating predominantly in offshore and inshore waters, respectively (Tables 3, 4 & 5). The large overlap in the upper and lower bounds of mean profit per pot per lift across all treatment groups using a two-day soak time reflects the fact that no significant differences could be detected in the number of lobster caught using the different methods of bait deployment.

Table 3. Mean, upper and lower bound projected net profit per pot per lift ($) across all treatment groups and soak times incorporating value of lobster at $19 / kg (approx. $9 per lobster) and bait costs of $1.35 per kg but excluding the cost of the bait savers.

Treatment group	Soak time	Lower Bound	mean	upper bound
Traditional	1	27.18	40.59	54.00
	2	7.38	26.10	44.82
	3	10.17	21.60	33.03
Servass	1	25.88	34.52	43.16
	2	7.52	19.13	30.74
	3	9.23	24.08	38.93
Drew	1	23.18	31.28	39.38
	2	11.39	24.98	38.57
	3	9.68	20.75	31.82
New Design	1	14.90	22.28	29.66
	2	13.01	21.83	30.65
	3	10.76	27.50	44.24

Table 4. Mean, upper and lower bound projections of annual net profit of a commercial fisherman predominantly fishing offshore grounds with a 100-pot license incorporating 175 one-day pulls (65%) 25 two-day pulls (25%), 8 three-day pulls (10%). Upper value is using bait savers throughout the season, lower is for using baitsavers only for two and three day soak times. Price of bait savers and bait for 100 pots included (*Servass saver* @ \$11.15 each (including one timer), i.e. \$1115 for 100 pot license; *Drew saver* @ \$5.50 each, i.e. \$550 for 100 pot license; *New Design* @ \$6.00 each, i.e. \$600 for 100 pot license).

Treatment group	lower bound	mean	upper bound
Traditional	502 236	792 855	1 083 474
Servass	477 969 500 719	670 074 776 299	862 179 1 051 879
Drew	441 319 511 319	625 900 788 825	810 481 1 066 331
New design	301 283 516 183	465 875 786 300	630 467 1 056 417

The estimate of mean profit for fishermen predominantly fishing offshore grounds was far higher when using traditional methods for the whole season than when using bait savers for the whole season. The estimate of mean profit for fishermen using a combination of methods approached that for fishermen using traditional methods. The large range in the upper and lower bound estimates reflects the large variation recorded in the number of lobster landed per pot throughout the duration of the trial. As previously noted, the net profit per pot (Table 3) used to derive the annual net profit projections listed above, is based on catch rates obtained from the current trial. Despite this trial being conducted in shallow, inshore grounds the analysis still serves as a comparative tool between the respective treatment groups.

Table 5. Mean, upper and lower bound projections of annual net profit of a commercial fisherman predominantly fishing inshore grounds with a 100-pot license incorporating 213 one-day pulls (85%), 12 two-day pulls (10%), 4 three-day pulls (5%). Upper value is using bait savers throughout the season, lower is for using baitsavers only for two and three day soak times. (Price of bait savers for 100 pots included).

Treatment group	lower bound	Mean	upper bound
Traditional	591 858	904 527	1 217 196
Servass	562 845 590 535	766 749 896 040	970 653 1 201 545
Drew	510 724 595 924	703 990 902 293	897 256 1 208 662
New design	336 686 598 250	511 160 901 163	685 634 1 204 076

As was the case for fishermen predominantly fishing offshore grounds, the estimate of mean profit for fishermen predominantly fishing inshore grounds was far higher when using traditional methods for the whole season than when using bait savers for the whole season. The estimate of mean profit for these fishermen using a combination of methods likewise approached that for fishermen using traditional methods. Taking into account the various assumptions that these analyses makes, it would seem apparent that the use of bait savers currently available are unlikely to result in significant savings to the industry.

Table 6. Mean, upper and lower bound projections of annual net profit of a commercial fisherman using lobster pots containing the modified new design bait saver (0.5 kg bait) in one bait box and one bait box packed in the traditional manner (2 kg fish bait). Net profits are based on the results for traditional profit per pot per lift figures for one and two-day soak times and those for the new design for a three-day soak time.

Treatment group	lower bound	Mean	upper bound
Offshore			
traditional + baitsaver	542 608	837 403	1 132 342
Traditional	502 236	792 855	1 083 474
Inshore			
traditional + baitsaver	637 057	951 814	1 266 643
traditional	591 858	904 527	1 217 196

An increase in net profit of approximately $45, 000 for both inshore and offshore based fishermen may be achieved by using the new design bait saver in one bait box and bait deployed traditionally in the second bait box.

Discussion

The current study clearly demonstrates that for one day soak times, pots that deployed bait in the traditional manner caught significantly more lobster than those that used bait savers. This finding supports the suspicions of commercial fishermen, i.e. that bait savers reduce catches when soak times are for only one day. Fishermen believe that bait savers reduce the intensity of odour plume released from the pots, thereby reducing the area over which they are likely to attract lobsters. Fishermen also believe that any lobsters that enter a pot will be more likely to leave that pot if they cannot access the bait. Thus, in the case of pots deployed in the traditional manner lobsters are likely to remain in that pot until all of the bait has been consumed, whereas in pots that the bait is present but unavailable, i.e. those deploying bait savers, lobsters are likely to remain in the pots for a shorter period.

In contrast to one day soak times, no significant difference could be detected between the number of lobster caught in pots using the traditional method of bait deployment and those using any of the three bait savers when deployed for two days. Although catches over a three day soak time could not be tested for significance, our data suggest that bait savers are at least as, if not more, efficient at catching lobster as the traditional method of bait deployment.

Using catch data generated during the current study it is clear that, whilst bait savers reduce the amount of bait used, and thus provide an opportunity for fishermen to reduce overheads, the savings generated if they were used over the entire season would not be enough to compensate for losses associated with reductions in the number of lobster landed. The use of the traditional method of bait deployment for one day soak times and bait savers for two and three day soak times appears to be cost neutral, whilst annual net gains of *ca* $45 000 per fisherman may be possible if pots were deployed using the traditional method of bait deployment in one bait box and a bait saver in the other. However, the following points are worth noting. Firstly, during the current trial lice were noticeable by their absence and bait remained in pots using the traditional method after one day, the soak time that had the highest catch rates for these pots. However, after two and three days little if any bait remained in pots using the traditional method of bait deployment and their catch rates were not detectably different to those using bait savers. Our ongoing study on sea lice abundance has demonstrated that when sea lice are abundant little if any bait remains in pots after one day. This suggests that catch rates using the traditional method of bait deployment in the presence of high sea lice numbers will be more akin to those recorded for two and three day soak times. Secondly, during this study, with the exception of the period when a three day soak time was used, there were only small swells and seas. Thus, agitation of baits would be minimal and it is likely that the bait in bait savers would be likely to produce a smaller plume, and thus be less efficient at attracting lobster. However, when swells and currents are large and strong, bait savers are likely to provide some protection from buffeting, resulting in longer bait life than bait deployed in the traditional manner, whilst stronger currents may well lead to a plume that attracts over a longer distance. Under such conditions, some types of bait saver may be more efficient than the traditional method. Finally, the following untested assumptions have been made: 1) catch rates during the trial are representative of the season as a whole; 2) catch rates in the area the trial was conducted are representative of catch rates of other areas; 3) catch rates are the same for inshore and offshore fishermen; 4) the catch rates estimated for a single three day soak time are valid estimates; 5) combining the methods will not result in a reduction in the attraction and retention of lobsters for one day soak times. It is also worth noting that, in addition to the massive overlap in the estimates of net gain, the lack of data for catches over a three day soak time meant that differences in profit could not be tested for significance.

In summary, the following conclusions (1 - 3) can be drawn and hypotheses (4 - 6) developed from this preliminary investigation into the use of bait savers in the lobster industry:

1) If the conditions experienced during this preliminary study, i.e. the absence of sea lice and strong currents, persisted for an entire season, then the sole use of any of the bait savers currently available would not be cost effective if they were used over the entire season.
2) If the conditions experienced during this study persisted for an entire season, then the use of any of the currently available bait savers would likely be cost neutral if they were used solely for two and three day soak times and bait was deployed in the traditional way for one day soak times.
3) Current bait saver designs require modification if they are to compete with traditional deployment methods over a one day soak time.
4) Bait savers will be cost effective when deployed during periods when sea lice are abundant and during periods of strong currents.
5) Using a bait saver in one bait box and the traditional method of bait deployment in the second box will be cost effective.

6) The development of a bait saver that provides an effective plume in periods of low current but still protects the bait from sea lice will be the most cost effective method of deploying bait and provide substantial savings to fishermen.

In light of these findings the bait saver designed for the current study has been modified, i.e. based on the length frequency data for lice collected during our study on the distribution and prevalence of sea lice in Zone C of the lobster fishery the 0.05 mm mesh has been replaced with a heavy-duty mesh of 0.5 mm aperture (Fig. 4). Preliminary data using this bait saver suggest that it is as effective at catching lobster as the traditional method of bait deployment when used for 24 hour soak times.

Recommendations

Conducting a trial over only a twelve day period in order to determine the cost benefits that bait savers may have over an entire season has its limitations. These included the generally low catch rates that were also highly variable within each treatment, and the various assumptions that had to be made when developing cost-benefit analyses encompassing different zones and different depths. Not withstanding these drawbacks, the results of the trial do, however, encourage further research to be undertaken. Conducting a deployment trial over a complete commercial season with the assistance of numerous professional fishermen in the Fremantle zone, would effectively reduce the effects of variations in catch rates due to both biotic and abiotic factors (i.e. prevalence of lice, weather conditions, phase of the moon, habitat being fished etc). Such an approach is likely to provide more robust data and therefore should provide a better test of the efficacy of the commercial viability of bait savers. As noted above, modifications to the bait saver that was designed specifically for the current study (new design) may well have resulted in a bait saver that can compete with the traditional deployment method, even when used for one day soak times. Further research aimed at investigating the benefits of using this modified bait saver either on its own or in combination with traditional deployment methods will hopefully provide avenues that will enhance the profitability and long-term sustainability of the fishery.

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