Development of a Dry, Pathogen Free, Water Stable Lobster Bait

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THE FOOD CENTRE
of Western Australia (Inc)

WAFIC

FISHERIES
RESEARCH &
DEVELOPMENT
CORPORATION

Project Numbers 96/337 and 1999/373

“Development of a Dry, Pathogen Free, Water Stable Lobster Bait”

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1.0 NON-TECHNICAL SUMMARY

96/337 "The development of a dry pathogen-free, water stable lobster bait" **1999/373 "The development of a dry pathogen-free, water stable lobster bait - investigation into operational parameters"**

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OBJECTIVES: **(96/337)**

1. The production of a commercially acceptable, pathogen-free, dry Rock Lobster bait

(1999/373)

2. To determine the optimum level of key additives, while maintaining acceptable water stability

3. To determine the optimum shape and size parameters for commercial bait

4. To determine the optimum processing conditions, with particular regard to bait shape and size, and microbiological performance.

NON TECHNICAL SUMMARY:

FRDC project 96/337 was commissioned to determine whether a dry pathogen free, water stable lobster bait could be developed at a cost which would be attractive to commercial fishermen, and which would provide attractability equivalent to the then commercial baits being used.

Earlier project work had determined that it was likely that baits could indeed be produced commercially, with acceptable water stability characteristics.

The project would investigate a number of parameters, including the water stability of various formulations. These included the leaching rate, the microbiological characteristics, and in particular, the effect of a variety of attractants and other recipe materials.

A large number of tests has been performed, including some in an experimental tank, and others in a variety of sea trials.

At the interim stage at the completion of Project 96/337 most of the physical characteristics had been investigated in some detail, and the production process was under a reasonable degree of control.

However, although sea trials had shown a steady increase in the attractability of the baits, it remained to determine which of the possible attractants (if any) would prove to be viable.

The prolonged set of sea trials in 1998-1999 refined our knowledge of the attractability of a number of recipe modifications, and potential attractants. They demonstrated that under the right conditions, the dry baits could be substituted for hocks and hides and some of the fish. These trials demonstrated that further work needed to be done, to investigate key physical characteristics, in order to demonstrate whether a viable, commercial bait, could be produced.

This project was extended for a further 15 months, as FRDC project 1999/373. This project indicated that

a) Baits could be produced with varying levels of water stability and leaching rates and that the two characteristics were antagonistic.
b) The size of the bait did not affect either the water stability or leaching characteristics when manufactured under standard conditions.
c) A pathogen-free bait could be made which had an effective shelf life of at least 9 months when stored under normal warehouse conditions
d) None of the baits or bait combinations performed as well as the traditional fish plus ‘hocks and hides’ in trials where the two were directly compared. No trials were conducted where all, or even the majority, of pots were baited with the dry baits.
e) The combination of dry bait and limited amounts of fish proved to be a reasonable alternative to fish plus ‘hocks and hides’.
f) In all sea trials there was a high level of variability in both trial and control pots, which requires further investigation.

Keywords: Rock Lobster, bait, attractants

2.0 BACKGROUND

In 1995, the Western Rock Lobster industry of Western Australia was worth between 400 and 500 million dollars annually from a total harvest of 10,000 tonnes. The catch was harvested using baited lobster pots which were pulled 1 to 3 days after setting. The baits used were frozen fish and 'hocks and hides'.

This project was designed to investigate systematically, the parameters required to produce a bait that:

a) would be water stable for the maximum time required by the industry;
b) would attract lobsters for the duration of the time that the pot would be in place;
c) would be pathogen free.

The main objective specified for this project was the development of a bait which would minimise the need to use imported fish, having eliminated any pathogens during its manufacture.

It was also intended that the use of dry bait should be an economical alternative for fishermen. It was felt that a number of benefits would be gained from the successful conclusion of the project, particularly for:

- the WA Rock Lobster industry, which would have access to a more manageable bait;
- the WA Grain and Vegetable industry, which would see the development of a new market for its by-products;
- the WA environment which would see the reduction in the 900,000 bait cartons currently discarded annually; and
- the WA marine environment, from the production of a pathogen free-bait.

Following discussions with the Western Australian Fishing Industry Council ("WAFIC"), and Mr Mike Hoxey (later to become the Principal Investigator), an initial proposal was made to the Fishing Research Council ("FRDC") in November 1995.

Correspondence was exchanged between the parties in early 1996, and letters of support for the project were received from key industry bodies, including WAFIC and the Western Rock Lobster Association.

In April 1996, Mr Geoff Allen made certain suggestions in connection with the need to develop a bait which would attract lobsters at a sufficient rate to be of use to the industry, and made recommendations in connection with attractants.

A meeting was held with the FRDC Board in Fremantle, at which further suggestions were made as to the project's content.

Subsequently, a revised project proposal was submitted to the FRDC Board in late May 1996.

The contract was signed on 26 June 1996.

The first instalment of funding was received on 10 July 1996, and a contract was signed with the Principal Investigator shortly thereafter.

In the final year of project 96/337, it became clear that while the main project objectives had been achieved, further work was required to refine a number of operational parameters. In mid-August 1999, project 1999/373 was approved in which a series of sea trials was planned for the 1999-2000 season, to provide further information in several areas.

3.0 NEED

At the start of the project in 1995, approximately 18,000 tonnes of frozen fish were used annually, of which about 16,000 tonnes were imported, often in the closed season, and stored frozen to meet seasonal demand. The total bait cost was in excess of $18 million per annum, plus storage and handling costs which exceeded $2 million. The importation and use of an unprocessed form of such large quantities of fish had the potential to introduce exotic diseases into the Western Australian marine environment.

The situation is much the same at the present time.

There had been many attempts to develop a lobster bait which would not require refrigeration, to replace those that were currently used. The problems had included the poor water stability of any dry baits produced and their inability to attract lobsters.

As of 1995 there were no manufactured lobster baits commercially available, and so any recommendations from the National Task Force with regard to the limiting or prohibiting of the importation of fish would have been difficult (if not impossible) to comply with.

4.0 OBJECTIVES

The objective of the original project 96/337 was “The production of a commercially acceptable, pathogen-free, dry Rock Lobster Bait”.

At the conclusion of the project a project extension 1999/373 was authorised, with the following objectives:

- to determine the optimum level of key additives, while maintaining acceptable water stability
- to determine the optimum shape and size parameters for commercial bait

- to determine the optimum processing conditions, with particular regard to bait shape and size, and microbiological performance.

5.0 METHODS AND RESULTS/DISCUSSIONS

This section deals with the both the methods used and the results obtained in meeting the requirements of the original project 96/337. Each topic, Water Stability, Leaching Rate, Attractability and Disease Transmission is the subject of a sub-section within the report. Within each sub-section the individual trials, or in certain instances, series of trials, are presented in a standard format consisting of Method, Results and Conclusions. In most sub-sections there was a common protocol for the majority of the tests conducted and this is set out at the beginning of the sub-section.

Whilst certain sub-sections follow closely the format set out in the methods section of the original proposal, others had to be modified as results were obtained. Some alternative lines of investigation had to be followed (eg. in the leaching section), whilst, in other instances, firm conclusions could be drawn without completing the full original schedule, as in the water stability and disease control sections.

At the end of each sub-section the overall conclusions are summarised and discussed as required. Section 5.6 highlights the main conclusions of the original project.

5.1 INITIAL DEVELOPMENT

In order to meet the commitments of the project as far as the manufacture of trial baits was concerned, a laboratory scale product set-up was devised and installed. The decision as to the equipment to be used was based upon the alternative method of dry pelletising as reported upon in the first year report on FRDC Project 94/061.

The equipment consisted of a small commercial mincer (Nolex 51) powered by a 2 HP three-phase electric motor. This machine was equipped with 4 dies with hole sizes of 3 mm, 5 mm, 9 mm and 15mm. A further die with a hole size of 25 mm was also tested but found to be unsuitable for use on such a small machine. This machine was hand-fed and found to be capable of handling 20 to 25 kg of mixed bait material per hour on a dry weight basis. The handling rate was sufficiently large to complete the project as approved.

For drying purposes a fan ventilated laboratory drying oven was installed with a thermostatically controlled temperature range of 50 to 200ºC. This oven was capable of holding up to 20 kg of bait material on a dry weight basis.

To conduct the work comparing different drying techniques a domestic microwave oven was installed. This was a 750 watt machine with both variable power and time controls.

As the project called for the testing of bait blocks, a domestic, hand-operated, 'hamburger' press was supplied by The Food Centre of WA. This press produced a circular disc of 10 cm diameter and up to 3 cm thick. Experience demonstrated that this equipment was capable of producing bait blocks of approximately 100 grams when dried.

As the project did not require the production of large quantities of bait material, and frequently only very small quantities, it was decided that all mixing would be performed by hand and no mixing equipment would be installed.

In installing the equipment, consideration was given to the possibility that, should the project lead to a commercial scale bait production, the scale-up should be feasible using equipment which was both flexible in potential throughput and with reasonable capital and running costs.

5.2 WATER STABILITY TRIALS

5.2.1 Trial Protocols

In order to conduct the initial water stability trials as required by sub-section a) of the Methods section of the project, the following general protocol was devised.

a) Samples of wet fish and other high moisture animal and vegetable materials to be used in sub-section a-4) were put through the mincer using the 3 mm die. A weighed sample of the resultant minced material was then oven-dried at 105°C overnight and then reweighed. Loss of weight was considered to be due to moisture loss only. The total dry matter percent of the material was then calculated.

It should be noted that this dry matter determination was carried out on a separate sample from that incorporated into the trial baits due to the length of time required to produce a result. There could have been some slight variation in the actual dry matter content of the test materials used but experience showed that this variation was small and was unlikely to affect the results of the water stability tests.

b) All dry ingredients used were hammer-milled through a 3 mm screen unless already in meal form. In practice this produced powders with an average particle size of about 2 mm but with a proportion of very fine material (<0.5 mm) present. No attempt was made to screen these materials to a narrower particle size range.

c) The ingredients for the required formulation were weighed and placed in a container for hand mixing. As formulations were expressed on a dry matter basis, corrections were made for the moisture content of wet materials. The materials were mixed to form a dough with the addition of extra water as required. Experience showed that the best moisture content for most mixtures was about 35% but there was some variation dependent upon the actual formulation. The criterion for moisture content was the ability to produce a semi-moist pellet that did not clump together when first formed (too wet), would form a reasonable length pellet without excessive power requirements (too dry) and could be compressed into a block if required. Due to variations in the ideal moisture content the addition of water was left to the discretion of the operator rather than working to an exact, predetermined, level.

d) The ingredients were mixed by hand, ensuring an homogenous mixture was achieved including an even distribution of the moisture.

e) The semi-moist mix was put through the mincer set up with the required die in place. It was found by experience that putting the mix through the mincer a second time appeared to improve the texture of the pellet. This was probably due to improved moisture distribution. This then became the standard method of preparing the semi-moist pellets.

f) Where blocks were required the semi-moist pellets were weighed into portions that were calculated to form blocks with dry weights of approximately 100 grams each. These portions were put into the hand operated hamburger press and pressed into solid blocks without the use of undue pressure.

g) Once formed, both pellets and/or blocks were placed into the drying oven and dried overnight at a temperature of 95^oC. Tests carried out showed that this time/temperature regime produced a final product which would store well, as the residual moisture content was less than 8%.

5.2.2 Results of Water Stability Trials

This section reviews the work conducted to determine the water stability of various bait formulations as per the section of the project B11 Methods, a) Water stability.

5.2.2.1 Initial Stability Trials

The first set of stability trials was designed to investigate the effect of the inclusion level of fish on water stability (series a-1).

A series of baits was made containing mulies, a type of sardine commonly used in Western Australia as lobster bait. The procedure followed the protocol set out in section 5.2.1 of this report. On a dry matter basis the baits contained from 5% to 30% fish at 5% increments with the remainder being a 50/50 mix of ground wheat and ground lupin seed. The maximum level of fish had to be reduced to 30% from the 50% originally proposed due to the moisture content of the fish (up to 75%). Levels of fish inclusion above 30%, produced unacceptably moist pellets which did not maintain their physical integrity.

Samples were prepared in all 3 forms, ie. 9 mm and 15 mm pellets as well as 100 gram dry weight blocks. These samples were dried in the laboratory oven to less than 8% moisture as per the protocol. A selection was also dried in the microwave oven to a calculated moisture content of about 8%. This was achieved by subjecting weighed quantities of pellets or blocks to bursts of heating of 2 or 1 minute duration, allowing to cool and reweighing. This continued until a predetermined weight was achieved, which was calculated to give a final moisture content of approximately 8%.

Initially, due to time constraints with regard to the microwave drying, it was decided to compare only the 9 mm pellets and the blocks with the oven dried product. It was necessary to process the semi-moist material relatively soon after mincing, as freezing the product may have altered the water stability characteristics.

When formed, either 100 grams of each size of pellets or one weighed block from each fish inclusion level was placed in a 1 litre container of water and observed over a period of 14 days. At the end of this period the residual solid material was placed on a 1 mm screen, washed lightly with fresh water and dried in the oven overnight at 105ºC.

Visual observation determined that all samples caused a discolouration of the water within 1 day, suggesting that some leaching was taking place. In no instance, however, did any of the samples visually show a significant level of breakdown after 3 days, the minimum time considered to be acceptable for a water stable product (as stated in the original methodology).

These observations were confirmed by the dry matter recovery rates after 14 days immersion, all of which were in excess of 70%, with no differences attributable to either the inclusion level of the fish or the method of drying. Results of individual dry matter recoveries are not quoted as the method of screening and washing was not sufficiently controlled to measure differences of less than 5% or possibly greater. Therefore only an overall minimum recovery rate as quoted above was determined. At this stage of the project was this information sufficient to demonstrate that a sufficiently water stable bait could be produced.

Further work later in the project quantified water stability in both laboratory and open sea conditions.

It was concluded from this series of tests that, although the mechanics of producing a water stable product were not understood, it did not appear to be dependent upon the level of fish present or the method of drying, despite the fact that the formulations used did not incorporate any of the traditional 'binders'.

Although not part of the original programme, baits were made in pellet form using just a 50/50 mix of ground wheat and ground lupins without any fish inclusion. These pellets were treated as above with similar results and again the final dry matter recovery rate was in excess of 70%. It can be concluded that fish is not an essential component of a dry bait as far as water stability is concerned.

5.2.2.2 Waste Fish Products

In the original project it was proposed to investigate the effect of different fish species on the water stability of the baits. Four fish species were suggested. Following the conclusion in section 5.2.2.1 that fish is not essential for water stability this section was modified to test two potential waste products.

The first product was the waste from the WA salmon industry, which consisted mostly of heads and backbone. This is a very bony product which, when minced produces a coarse product with relatively large bone chips in it.

The second product was the waste from a sardine filleting operation which, again, consists of the heads and backbones. When this waste is minced it produces a very fine, almost liquid. product.

These two products were tested to determine whether the difference in texture affected the stability of a bait.

The methodology followed that described above with fish inclusion rates of 10%, 20% and 30% on a dry weight basis. Again blocks of approximately 100 grams dry weight were formed and oven dried. Following the same test procedure it was concluded that neither the type of fish nor the inclusion rate affected the water stability of the bait. All dry matter recovery rates after 14 days immersion were again in excess of 70%.

5.2.2.3 Animal Protein Wastes

Sub-section a-3 of the original project required that non-fish animal proteins be investigated with regard to their effect on water stability. It was assumed at the time that the effect of fish in the baits was of major significance in this respect. Subsequent findings reported above found this to be untrue but some limited testing was carried out using a range of animal protein waste products.

Following the same procedure as above (section 5.2.1), slaughter house offal, pet meat and kangaroo waste were incorporated into baits, each at the 20% inclusion level on a dry weight basis. These were all wet wastes which were minced prior to being mixed into the baits. Some dried hatchery waste was also tested as this was being offered as a potential aquaculture feed ingredient.

Again, and not surprisingly in light of the previous results, there was no effect on water stability due to the inclusion of any of these products.

5.2.2.4 Other Components

Investigations to this point had been concerned solely with the effects of the fish/animal protein components of potential bait formulations. The investigations conducted under section a-4 were designed to test the effects of the other components of the potential bait formulations.

The first set of trials was conducted to test the possibility of using vegetable waste as a partial replacement for the cereal component. The original intention had been to replace the wheat/lupin mixture in the bait with either carrot pulp from a local carrot juice producer; or waste vegetables from the local market. These were to be included at 10% increments in formulations containing 30% fish on a dry weight basis. All inclusion rates are stated on a dry weight basis.

Due to the high moisture content of the vegetable material, in excess of 85% in all cases, only 10% of the test material on a dry weight basis could be included as, at higher levels, the mix could not be formed into semi-moist pellets or blocks. A very wet semi-liquid product resulted which would not hold its shape. Furthermore, the inclusion level of the fish had to be reduced.

When included at the 10% level on a dry weight basis, neither product had a significant detrimental effect on water stability. Further investigations with this type of product were not considered a priority as, if the process were to become a commercial reality, their use would be dependant upon availability, cost of product and cost of handling. These are variables that cannot be addressed within the scope of this project.

The second set of trials in this section investigated the replacement of the wheat/lupin mix with other grains or by-products. Using the base formulation of 30% fish on a dry weight basis, the following changes were made:

a) The lupins in the mix were replaced with ground wheat giving a mix with 70% wheat.
b) The wheat in the mix was replaced with ground lupins giving a mix with 70% lupins.
c) The wheat was replaced with fine ground oats.
d) The wheat/lupin mix was replaced incrementally with pollard, at increments of 10%.

The above formulations were made into 100 gram blocks (dry weight) and tested as previously. The tests showed that, with the exception of the pollard inclusion, there was no effect on water stability, and all blocks had a dry-matter recovery level in excess of 70% after 14 days immersion.

Blocks containing the pollard were satisfactory up to an inclusion rate of 20% but above this rapidly deteriorated so that at the 50% inclusion level they had completely disintegrated by 14 days. As a matter of observation it was noted that, whereas all water stable products showed very little swelling during immersion, the blocks containing higher levels of pollard swelled quite rapidly prior to disintegration.

5.2.2.5 Stability Trials

Following the results obtained to this point and the fact that the first sea trials had been completed, sub-section a-5 on the original proposal was omitted. Results from this sea trial as reported in Appendix 3, section A 3.1 of this report demonstrated that potential bait formulations were sufficiently stable under conditions experienced by the Western Australian Lobster Fishery.

5.2.2.6 Conclusions

From the work conducted to this point it can be concluded that a major obstacle to the production of a dry, water stable lobster bait, namely water stability, has been overcome. It is now possible to produce water stable baits using a wide variety of ingredients without resorting to the use of special binders. The stability appears to be a function of the production method and as such, means that it should be possible to produce baits which are commercially attractive with respect to both ingredient and manufacturing costs.

This concluded the initial work conducted on water stability under section B11 Methods, sub-section a) of the project.

Further water stability testing was found to be required as the project progressed to sub-sections b) and c) and is reported on where appropriate.

5.3 LEACHING TRIALS

Unlike aquaculture feeds where there is a need to minimise the leaching of nutrients, for baits the leaching of the attractants is essential if they are to be effective. The work summarised below was conducted during 1997/98 and designed to give a better understanding of the leaching characteristics of baits produced using the mincer/dryer method previously described (section 5.2.1).

The initial trial was designed, based on a previous project involving the principal investigator (Jasper & Hoxey) to provide data on the leaching rate of Protein, Lipid and a water soluble additive. The water soluble additive chosen was Fructose as a routine, low cost, analytical procedure was available. The mix was formed into 3mm pellets to increase the surface area and so maximise the effects of leaching.

The pellets consisted of wheat, lupins and fish to which 2.5% fructose and 5% fish oil was added. The pellets were formed semi-moist and dried to a final moisture content of less than 8%. The pellets were then immersed in water for up to 7 days and sampled at intervals. The following table is a summary of the results obtained.

	Original	Day 1	Day 2	Day 5	Day 7
%D.M. recovery		81.0	79.4	72.8	62.8
%Protein	38.7	39.2	39.0	38.8	39.4
% Lipid	10.2	10.4	10.7	10.9	11.0
% Fructose	2.6	0.9	0.8	0.4	0.4

The conclusions drawn from these results were that-

a) the pellets were reasonably stable in water despite the small initial size.

b) there was no reduction in the protein content of the residual dry matter, meaning that there was no leaching of the protein from the pellets.

c) similarly, there was no leaching of the lipids from the pellets.

d) there was a significant reduction in the fructose content of the residual dry matter, even from Day 1, showing that there was considerable leaching.

If, as both the literature suggests and this project confirms, the most probable attractants for lobsters are proteinaceous in origin, the lack of leaching of any protein from the dry pellets explains the lack of attraction of water stable dry baits containing fish. The lack of leaching of the lipids present is of little importance as these do not appear to be attractants.

From the above data a line of investigation developed regarding the possible 'solubilisation' of the fish component of the bait full details of which are reported in section 5.4.

5.3.1 General Protocol

The series of experiments reported below were conducted on baits in block form, manufactured using the hand press as described previously (5.1). All baits were dried by placing them in a laboratory drying oven set at 95°C for 16 hours except where the investigation was into the effect of drying temperature. Water stability was determined by immersing the dry bait in tubs of fresh water, removing them at the required time and drying the residue as above. Baits which did not maintain their physical integrity as they were removed from the water were considered to be unstable and are recorded as such.

Protein determinations were carried out by the Chemistry Centre of Western Australia and are expressed as total nitrogen x 6.25.

Protein leaching was determined by measuring the percentage protein in the recovered material and comparing this with the protein content of the original bait.

5.3.2 Results

Results for each trial are set out in individual sub-sections.

5.3.2.1 Trial 1

This trial was set up to quantify the effect on water stability of incrementaly replacing minced fish with enzyme treated fish. Relatively low fish inclusion levels were used in an effort to produce baits which were sufficiently stable to give valid results at the highest level of substitution of minced fish with enzyme treated fish.

Table 5.3.2.1a Shows the composition of the baits expressed on a dry matter basis.

Treatment	Wheat meal	Lupinseed meal	Minced fish	Enzyme treated fish
T1	40%	40%	20%	0%
T2	40%	40%	15%	5%
T3	40%	40%	10%	10%
T4	40%	40%	5%	15%
T5	40%	40%	0%	20%

Table 5.2.3.1a Composition of bait.

Water stability data were obtained after 1, 2 or 5 days and all results are set out in Tables 5.3.2.1b and 5.3.2.1c

Water Stability Results

	Day 1		Day 2		Day 5	
	Initial Wt (g)	Final Wt (g)	Initial Wt (g)	Final Wt (g)	Initial Wt (g)	Final Wt (g)
T1 1	87	83	88	80	92	74
T1 2	86	86	87	81	93	75
T2 1	90	81	90	78	94	74
T2 2	88	80	88	75	96	74
T3 1	89	78	84	69	94	70
T3 2	90	79	90	75	96	68
T4 1	86	75	86	71	92	68
T4 2	85	74	87	73	92	68
T5 1	91	81	90	75	100	73
T5 2	89	79	91	75	97	71

Table 5.3.2.1b Water stability data after 1, 2 and 5 days.

	Day 1		Day 2		Day 5	
	% DM recovery	Av.for Treat.	% DM recovery	Av.for Treat.	% DM recovery	Av.for Treat.
T1 1	95%	98%	91%	92%	80%	81%
T1 2	100%		93%		81%	
T2 1	90%	90%	87%	86%	79%	78%
T2 2	91%		85%		77%	
T3 1	88%	88%	82%	83%	74%	73%
T3 2	88%		83%		71%	
T4 1	87%	87%	83%	83%	74%	74%
T4 2	87%		84%		74%	
T5 1	89%	89%	83%	83%	73%	73%
T5 2	89%		82%		73%	

Table 5.3.2.1c Water stability (expressed as % dry matter) after 1, 2 and 5 days.

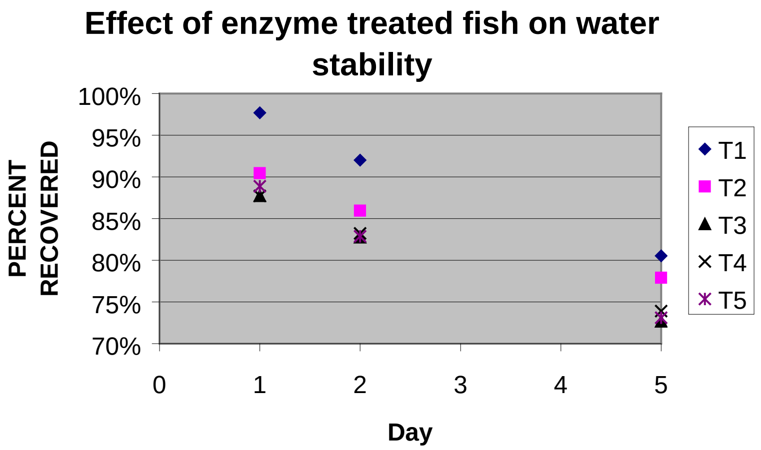


Figure 5.3.2.1a Effect of enzyme treated fish on water stability

Conclusions.

The data demonstrates that:-

1) All baits could be considered as water stable
2) Even at the lowest level tested, the substitution of minced fish with enzyme treated fish reduced the dry matter recovery after each immersion period.
3) The effect of substiution appeared to plateau at the 10% inclusion level of enzyme treated fish.

5.3.2.2 Trial 2

Water stability tests up to this period had been conducted in containers in the laboratory using fresh water. A short trial was set up to determine whether this test correlated well with baits in seawater in an open environment.

Baits were made using 80% of a wheat/lupin mix and 20% of phosphoric acid treated fish. Baits were placed in tubs of fresh water or in bait baskets and suspended from a jetty into the sea in a sheltered spot.

Dry matter recovery was determined after 2 and 5 days. The laboratory test yielded 72.6% and 67.7% respectively. The baits in the sea yielded 74.6 and 67.0% respectively. Full details are set out below.

Effect of method of testing water stability of baits containing acid treated sardine waste

Inside in tubs

Immersion days	Initial Wt.	Final Wt.	Weight Loss	Recovery
	(grams DM)	(grams DM)	(grams DM)	(%)
1				0.0%
2	124	90	34	72.6%
3				0.0%
4				0.0%
5	127	86	41	67.7%

Outside in baskets

	Initial Wt.	Final Wt.	Weight Loss	Recovery
	(grams DM)	(grams DM)	(grams DM)	(%)
1	127	100	27	78.7%
2	122	91	31	74.6%
3				
4				
5	115	77	38	67.0%

Table 5.3.2.2a Testing water stability using different methods

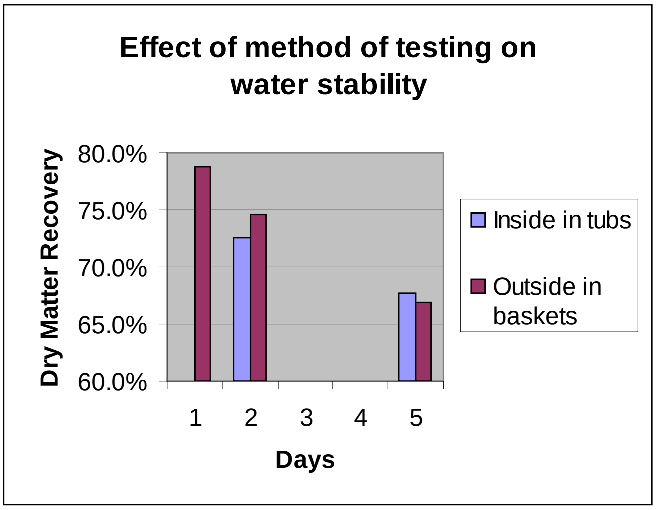


Figure 5.3.2.2a Testing water stability using different methods

It was concluded that there was no real difference between these two sets of results and thus the laboratory method of conducting water stability tests was suitable at this stage of the project.

5.3.2.3 Trial 3

This test was set up to determine the effect of the partial substitution of minced fish with either enzyme treated fish or acid hydrolysed fish. Substitution was made at two different levels 6% and 12%. Also tested was the effect of either the amount of enzyme used 0.2%, 0.4% and 0.6% or the pH of the treated fish 5.5, 4 and 3.

Details of the treatment s were:-

TREATMENTS. TRIAL 3

Control	33% wheat, 33% lupins, 33% untreated minced fish
Treatment 2	33% wheat, 33% lupins, 27% untreated minced fish, 6% minced fish treated with 0.2% enzyme
Treatment 3	33% wheat, 33% lupins, 27% untreated minced fish, 6% minced fish treated with 0.4% enzyme
Treatment 4	33% wheat, 33% lupins, 27% untreated minced fish, 6% minced fish treated with 0.6% enzyme
Treatment 5	33% wheat, 33% lupins, 21% untreated minced fish, 12% minced fish treated with 0.2% enzyme
Treatment 6	33% wheat, 33% lupins, 21% untreated minced fish, 12% minced fish treated with 0.4% enzyme
Treatment 7	33% wheat, 33% lupins, 21% untreated minced fish, 12% minced fish treated with 0.6% enzyme
Treatment 8	33% wheat, 33% lupins, 27% untreated minced fish, 6% minced fish treated with phosphoric acid to pH 5.5
Treatment 9	33% wheat, 33% lupins, 27% untreated minced fish, 6% minced fish treated with phosphoric acid to pH 4
Treatment10	33% wheat, 33% lupins, 27% untreated minced fish, 6% minced fish treated with phosphoric acid to pH 3
Treatment 11	33% wheat, 33% lupins, 21% untreated minced fish, 12% minced fish treated with phosphoric acid to pH 5.5
Treatment 12	33% wheat, 33% lupins, 21% untreated minced fish, 12% minced fish treated with phosphoric acid to pH 4
Treatment 13	33% wheat, 33% lupins, 21% untreated minced fish, 12% minced fish treated with phosphoric acid to pH 3

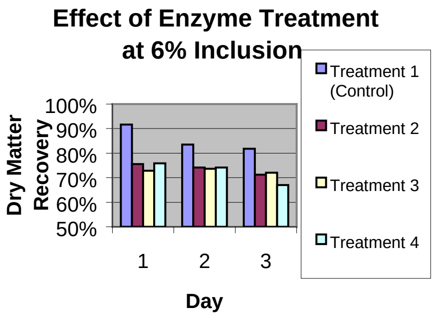
NB All inclusion levels are on a dry matter basis.

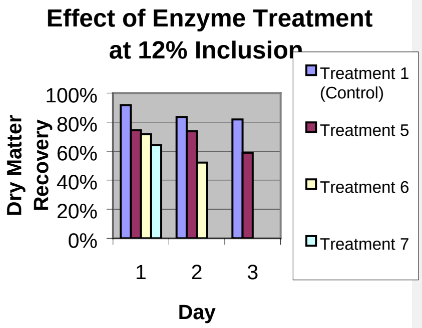
The results of the stability test are set out below.

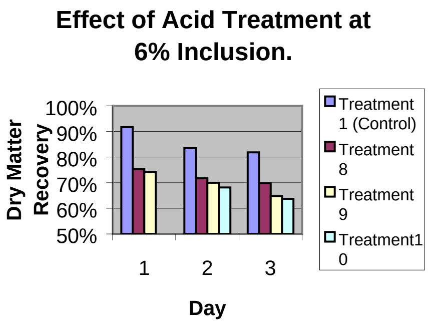
	Immersion time - 1 day		Immersion time - 2 days		Immersion time - 3 days		Percentage recovery		
Treatment	Initial Weight	Final Weight	Initial Weight	Final Weight	Initial Weight	Final Weight	Day 1	Day 2	Day 3
	(g)	(g)	(g)	(g)	(g)	(g)			
1	96	88	97	81	99	81	92%	84%	82%
2	94	71	93	69	94	67	76%	74%	71%
3	92	67	91	67	93	67	73%	74%	72%
4	91	69	93	69	91	61	76%	74%	67%
5	90	67	91	67	90	53	74%	74%	59%
6	88	63	92	48	88	NS	72%	52%	NS
7	92	59	91	NS	91	NS	64%	NS	NS
8	93	70	92	66	96	67	75%	72%	70%
9	89	66	90	63	88	57	74%	70%	65%
10	Not tested. Insufficient bait		88	60	91	58		68%	64%
11	95	74	94	72	93	71	78%	77%	76%
12	91	70	92	69	95	70	77%	75%	74%
13	93	72	95	71	95	70	77%	75%	74%

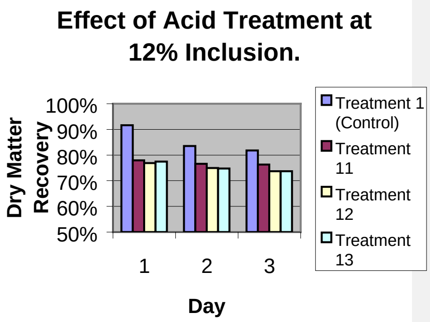
NS - not stable

Table 5.3.2.3a Water stability test over 3 days









Conclusions with regard to water stability.

1) All substitutions reduced the dry matter recovery after each immersion period.
2) Increased enzyme use had little effect on dry matter recovery when 6% enzyme treated fish was used.
3) At the 12% inclusion level of enzyme treated fish, there was an effect of increased enzyme use. Based on these data alone it would appear that the optimum level of enzyme use is 0.2%.
4) Substitution with acid hydrolysed fish at both inclusion levels produced similar results to those obtained with the lower inclusion level of enzyme treated fish.

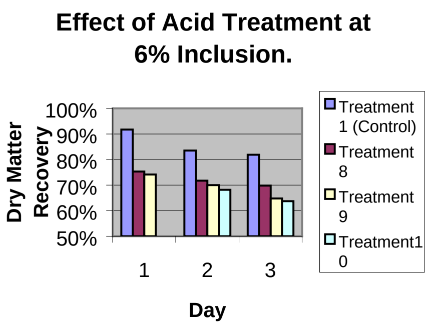
   There was no detectable effect of the pH levels tested

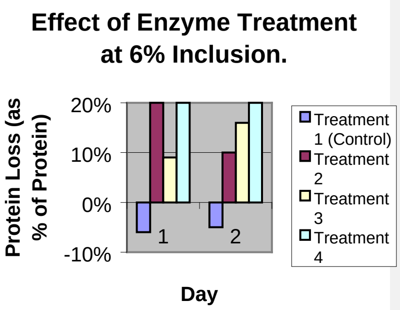
The results of the leaching rate trials are set out below.

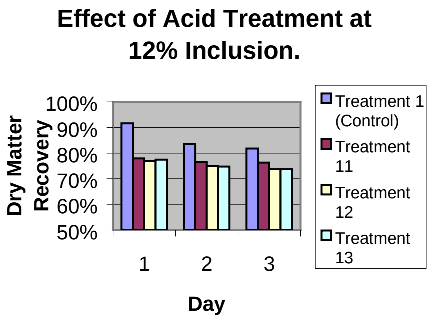
PROTEIN LOSS

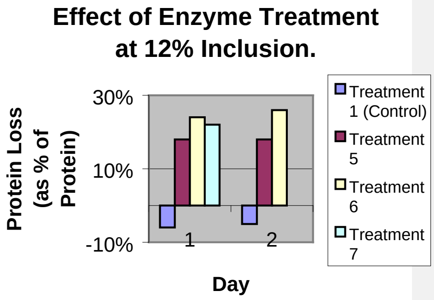
Treatment	Protein content of original bait	Protein content of residue		Protein content of residue as % of original. Protein content		Protein loss as % of original. Protein content	
		After 1 day immersion	After 2 days immersion	After 1 day immersion	After 2 days immersion	After 1 day immersion	After 2 days immersion
	(%)	(%)	(%)	(%)	(%)	(%)	(%)
1	33.2	35.2	34.9	106%	105%	-6%	-5%
2	34.5	27.6	31.0	80%	90%	20%	10%
3	33.4	30.3	27.9	91%	84%	9%	16%
4	33.2	26.4	26.5	80%	80%	20%	20%
5	33.5	27.5	27.4	82%	82%	18%	18%
6	36.0	27.3	26.6	76%	74%	24%	26%
7	36.2	28.1	No sample	78%	No sample	22%	No sample
8	36.8	31.7	31.0	86%	84%	14%	16%
9	38.2	33.7	31.7	88%	83%	12%	17%
10	39.6	No sample	31.2	No sample	79%	No sample	21%
11	36.6	30.5	30.8	83%	84%	17%	16%
12	35.8	30.8	31.7	86%	89%	14%	11%
13	37.6	31.3	36.7	83%	98%	17%	2%

Table 5.3.2.3b Protein loss after 2 days









Conclusions with regard to leaching.

1) As previously reported, protein from untreated minced fish does not leach from the baits. The increase in protein content of the recovered control material suggests that there is some leaching of non-proteinaceous material. This is not considered to be of significance with regard to bait attractability.
2) All treatments containing treated fish showed significant levels of leaching after 1 day of immersion.
3) Whilst the results are somewhat variable, there is a tendency for the enzyme treated fish to produce a higher leaching rate that the acid hydrolysed fish at the same substitution level.
4) Increased level of enzyme increases the leaching rate slightly.
5) Increasing the substitution level of enzyme treated fish increases leaching.
6) Acid hydrolysed fish has a lesser effect on leaching and does not appear to be affected by substitution level or pH.

From the data reported the use of a protease enzyme at the lowest level tested would appear to be the treatment of choice taking into consideration the effect on both water stability and leaching rate.

5.3.2.4 Trial 4

During the preparation of the baits for trial 3 it was noticed that the baits containing enzyme treated fish appeared much wetter than those with only minced fish. The actual moisture content was similar and so it was assumed that the enzyme treatment increased the percentage of 'free' water present. This test was conducted to determine whether the physical difference in the wet phase effected the water stability or leaching characteristics of the dry bait. A series of baits was made to the formulations set out below. Treatments 1 to 4 were formulated to give increasing levels of 'free' water from the enzyme treated fish. Treatments 5 to 7 were formulated to reduce the level of 'free' water from the enzyme treated fish with all the remaining moisture being derived from added water. All diets were formulated to the same calculated moisture content prior to drying.

Effect of varying fish/enzyme fish inclusion plus water addition.
Treatment details:-

TREATMENTS

Treatment 1 500 g wheat meal, 500 g lupinseed meal, 800 g wet minced fish
Treatment 2 500 g wheat meal, 500 g lupinseed meal, 700 g wet minced fish, 100 g enzyme treated fish
Treatment 3 500 g wheat meal, 500 g lupinseed meal, 600 g wet minced fish, 200 g enzyme treated fish
Treatment 4 500 g wheat meal, 500 g lupinseed meal, 400 g wet minced fish, 400 g enzyme treated fish
Treatment 5 500 g wheat meal, 500 g lupinseed meal, 400 g enzyme fish, 300 g water
Treatment 6 500 g wheat meal, 500 g lupinseed meal, 200 g enzyme fish, 450 g water
Treatment 7 500 g wheat meal, 500 g lupinseed meal, 100 g enzyme fish, 525 g water

This test was conducted over 3 days in the laboratory and the water stability results are set out below.

DRY MATTER RECOVERY

Treatment	Day 1		Day 2		Day 3		%Dry Matter Recovery		
	Initial Wt. (g)	Final Wt. (g)	Initial Wt. (g)	Final Wt. (g)	Initial Wt. (g)	Final Wt. (g)	Day 1	Day 2	Day3
1	84	73	84	71	86	71	87%	85%	83%
2	82	64	80	57	83	61	78%	71%	73%
3	86	69	84	67	86	66	80%	80%	77%
4	90	76	88	72	92	70	84%	82%	76%
5	88	72	89	70	87	70	82%	79%	80%
6	88	71	88	68	90	72	81%	77%	80%
7	91	77	90	75	92	77	85%	83%	84%

Table 5.3.2.4a Dry matter recovery up to 3 days

Conclusions regarding water stability.

1) Substitution of minced fish with enzyme treated fish (treatments 1 – 4) reduced the dry matter recovery but not as markedly as in previous trials.
2) The addition of water to replace the moisture derived from the fish component of the diet (treatments 5 – 7) had a marginal effect on dry matter recovery. The trend, however, was to increase water stability as the level of enzyme treated fish was reduced. It can therefore be concluded that the reduction in water stability experienced with the use of enzyme treated fish is not due to the increase in the 'free' water component of the bait prior to drying.

The results regarding leaching rates are set out below. Due to the relatively large difference in the initial protein content of the baits in treatments 5 to 7, protein loss is expressed as both the percentage loss of the total protein and the percentage loss of that portion of the protein calculated to have been derived from the fish.

Protein Leaching

	Protein Content (%)											
	Day 1		Day 2		Day 3		Protein Loss (as % of Bait)			Protein Loss (as % of Protein)		
Treatment	Initial	Final	Initial	Final	Initial	Final	Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
1	33.1	32.4	33.1	30.3	33.1	30.7	0.7	2.8	2.4	2.1	8.5	7.3
2	32.2	32	32.2	31	32.2	29.8	0.2	1.2	2.4	0.6	3.7	7.5
3	31.9	29.2	31.9	27.7	31.9	27.5	2.7	4.2	4.4	8.5	13.2	13.8
4	31.9	28.6	31.9	28.1	31.9	25.3	3.3	3.8	6.6	10.3	11.9	20.7
5	29.4	25.1	29.4	24.4	29.4	25.6	4.3	5.0	3.8	14.6	17.0	12.9
6	26.8	22.5	26.8	22.5	26.8	21.3	4.3	4.3	5.5	16.0	16.0	20.5
7	24.4	22.3	24.4	22.5	24.4	23.3	2.1	1.9	1.1	8.6	7.8	4.5

Table 5.3.2.4b Protein leaching rates for up to 3 days

Protein leaching based on calculated protein content derived from fish (%)

	Day 1		Day 2		Day 3		Protein Loss (g)			Protein Loss (as % of Protein)		
Treatment	Initial	Final	Initial	Final	Initial	Final	Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
1	14.8	14.1	14.8	12.0	14.8	12.4	0.7	2.8	2.4	5	19	16
2	13.9	13.7	13.9	12.7	13.9	11.5	0.2	1.2	2.4	1	9	17
3	13.6	10.9	13.6	9.4	13.6	9.2	2.7	4.2	4.4	20	31	32
4	13.9	10.3	13.9	9.8	13.9	7.0	3.6	4.1	6.9	26	29	50
5	9.4	5.1	9.4	4.4	9.4	5.6	4.3	5	3.8	46	53	40
6	5.9	1.6	5.9	1.6	5.9	0.4	4.3	4.3	5.5	73	73	93
7	2.9	0.8	2.9	1.0	2.9	1.8	2.1	1.9	1.1	72	66	38

Table 5.3.2.4c Leaching rates of fish protein

Conclusions relating to leaching.

1) Protein leaching increased in treatments 1 – 4 in line with the level of enzyme treated fish present. This is in line with the results from other tests reported.
2) In treatments 5 – 7 the protein leaching rate expressed as % of total protein was variable but this was certainly due to the non-fish protein present which would not be expected to have a high leach rate. When expressed as % of fish derived protein the rate was high in line with the leach rate of that portion of the protein derived from enzyme treated fish where both treated and non-treated fish were present.
3) The data presented demonstrate that the increase in protein leaching due to the presence of enzyme treated fish is not due to the physical effects of 'free' water on the wet baits.

The overall conclusion from this trial is that water can be added to the mix when manufacturing baits, to produce a suitable mix, without affecting the water stability or the leaching characteristics of the dry bait.

In the commercial production of aquaculture feeds a number of binders are frequently used to increase the water stability of the product. A series of tests were set up to determine the effect of two of these binders on both the water stability and the leaching characteristics of baits. Data relating to leaching was of particular importance as there was very little information available on the effects of binders on this parameter. This line of investigation is of particular importance as there is some circumstantial evidence that increasing the water stability reduces the leaching rate.

5.3.2.5 Trial 5

A small trial was set up to determine the effect of two commonly used binders, ie. rice flour or wheat gluten, as a replacement for wheat, on bait water stability. The treatments are set out below.

Effect of rice flour or wheat gluten

Treatment 1 rice flour 400g; lupinseed meal 600g; minced fish (wet) 800g.
Treatment 2 rice flour 400g; lupinseed meal 600g; enzyme treated fish (wet) 400g.
Treatment 3 rice flour 400g; lupinseed meal 600g; enzyme treated fish (wet) 200g.
Treatment 4 wheat gluten 250g; wheat meal 250g; lupinseed meal 500g minced fish (wet) 800g
Treatment 5 wheat gluten 250g; wheat meal 250g; lupinseed meal 500g enzyme treated fish (wet) 400g
Treatment 6 wheat gluten 250g; wheat meal 250g; lupinseed meal 500g enzyme treated fish (wet) 200g

The test was conducted over a 3 day period and the results are set out below.

Dry Matter Recovery

	Day 1		Day 2		Day 3		Day 1	Day 2	Day 3
Treatment	Initial Wt. (g)	Final Wt. (g)	Initial Wt. (g)	Final Wt. (g)	Initial Wt. (g)	Final Wt. (g)	Dry Matter Recovery (%)		
1	96	Unstable	96	Unstable	89	Unstable			
2	89	Unstable	88	Unstable	73	Unstable			
3	88	Unstable	89	Unstable	87	Unstable			
4	95	81	92	76	93	75	85	83	81
5	114	100	105	92	108	95	88	88	88
6	100	91	106	96	104	92	91	91	88

Table 5.3.2.5a Dry matter recovery after 3 days.

Conclusions

1) Rice flour had an adverse effect on water stability even at the shortest period tested and so is of no further relevance to this project.
2) Wheat gluten at the inclusion level tested gave very high dry matter recovery rates with both minced fish and enzyme treated fish.

From this initial test it was decided to fully investigate the effect of wheat gluten on both water stability and leaching characteristics of baits containing enzyme treated fish.

5.3.2.6 Trial 6

This test was designed to investigate the effect of wheat gluten on a bait formulation based on wheat and enzyme treated fish.

The formulations tested are set out below.

Effect of wheat gluten

TREATMENTS

Treatment 1 750 g wheat meal, 250 g wheat gluten, 800 g enzyme treated fish (wet)
Treatment 2 750 g wheat meal, 250 g wheat gluten, 400 g enzyme treated fish (wet)
Treatment 3 850 g wheat meal, 150 g wheat gluten, 400 g enzyme treated fish (wet)
Treatment 4 900 g wheat meal, 100 g wheat gluten, 400 g enzyme treated fish (wet)

The dry matter recovery results are set out below.

Dry Matter Recovery

	Day 1		Day 2		Day 3		Day 1	Day 2	Day 3
Treatment	Initial Wt. (g)	Final Wt. (g)	Initial Wt. (g)	Final Wt. (g)	Initial Wt. (g)	Final Wt. (g)	Dry Matter Recovery (%)		
1	106	94	107	94	109	92	89	88	84
2	104	98	105	101	101	85	94	96	84
3	107	93	104	99	107	92	87	95	86
4	107	95	108	94	109	90	89	87	83

Table 5.3.2.6a Dry matter recovery after 3 days

Conclusions

1) Overall the inclusion of wheat gluten increased the dry matter recovery rates when compared to other tests conducted using enzyme treated fish.
2) At the higher level of wheat gluten inclusion a stable bait was produced which contained a high level of enzyme treated fish.
3) Increasing the inclusion level of wheat gluten above the minimum tested had little effect on water stability of baits containing the lower level of enzyme treated fish.

Leaching characteristics

The results obtained are set out below

Protein Loss

	Protein Content (%)											
	Day 1		Day 2		Day 3		Protein Loss (as % of bait)			Protein Loss (as % of Protein)		
	Initial	Final	Initial	Final	Initial	Final	Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
Treatment												
1	37.4	40.4	37.4	38.3	37.4	37.2	-3.0	-0.9	0.2	-8.0	-2.4	0.5
2	34.9	33.9	34.9	34.3	34.9	34.1	1.0	0.6	0.8	2.9	1.7	2.3
3	29.0	28.8	29.0	28.6	29.0	28.8	0.2	0.4	0.2	0.7	1.4	0.7
4	25.9	26.4	25.9	26	25.9	25.1	-0.5	-0.1	0.8	-1.9	-0.4	3.1

Table 5.3.2.6b Protein loss after 3 days

Conclusions

1) In all treatments there was little if any leaching of protein, which is strongly at variance with the results of all previous tests which included enzyme treated fish.

These results support the circumstantial evidence that increasing the water stability of the bait reduces the protein leaching rate even when there is a high level of water soluble protein present.

5.3.2.6b Trial 6b

This trial was set up to counter the possible conclusion that the stability and leaching rates recorded in Trial 6 were due to the higher use of wheat instead of the wheat/lupin mix used previously. Also the substitution of wheat with lupin in formulations containing wheat gluten was tested.

The formulations tested are set out below

Effect of wheat gluten on baits containing wheat and lupins

Treatment 1 wheat meal 1000g; enzyme treated fish (wet) 400g
Treatment 2 wheat meal 750g; lupinseed meal 150g, wheat gluten 100g; enzyme treated fish (wet) 400g
Treatment 3 wheat meal 600g; lupinseed meal 300g, wheat gluten 100g; enzyme treated fish (wet) 400g
Treatment 4 wheat meal 450g; lupinseed meal 450g, wheat gluten 100g; enzyme treated fish (wet) 400g
Treatment 5 wheat meal 400g; lupinseed meal 400g, wheat gluten 200g; enzyme treated fish (wet) 400g

The dry matter recovery rates are set out below

Dry Matter Recovery

	Day 1		Day 2		Day 3		Day 1	Day 2	Day 3
Treatment	Initial Wt. (g)	Final Wt. (g)	Initial Wt. (g)	Final Wt. (g)	Initial Wt. (g)	Final Wt. (g)	Dry Matter Recovery (%)		
1	99	80	96	75	96	74	81	78	77
2	102	82	100	76	102	76	80	76	75
3	102	84	100	85	102	83	82	85	81
4	101	91	101	90	101	84	90	89	83
5	97	87	99	88	98	85	90	89	87

Table 5.3.2.6bb Dry matter recovery after 3 days

Conclusions

1) Overall, the water stability of all treatments was high.
2) The result from treatment 1 indicated that the use of wheat without wheat gluten gave only slightly inferior water stability. This is comparing this result with the data from trial 6.
3) The substitution of wheat with lupins did not reduce the water stability of the baits. The trend, in fact, was for there to be an increasing rate of dry matter recovery with higher lupin inclusion.

Leaching characteristics

Protein loss rates are set out below.

Protein Loss

	Protein Content (%)											
	Day 1		Day 2		Day 3		Protein Loss (as % of bait)			Protein Loss (as % of Protein)		
Treatment	Initial	Final	Initial	Final	Initial	Final	Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
1	21	17.7	21	17.7	21	17.1	3.3	3.3	3.9	16	16	19
2	25.8	25.7	25.8	24.3	25.8	24.1	0.1	1.5	1.7	0	6	7
3	27.8	28.8	27.8	28.5	27.8	28.4	-1.0	-0.7	-0.6	-4	-3	-2
4	30.2	32.5	30.2	31.3	30.2	30.1	-2.3	-1.1	0.1	-8	-4	0
5	35.4	35.1	35.4	35.9	35.4	35.9	0.3	-0.5	-0.5	1	-1	-1

Table 5.3.2.6bc Protein loss after 3 days.

Conclusions

1) Protein loss in treatment 1 was relatively high demonstrating that the addition of wheat gluten reduces the leaching rate in baits containing a high wheat content.

2) In all baits containing wheat gluten treatments 2-5 the protein loss was very low or negative confirming that the inclusion of wheat gluten reduces protein leaching.

3) The partial substution of wheat with lupinseed meal had no effect on protein leach rates.

5.3.3 General conclusions

The data presented in this section confirm the general conclusions of the section on water stability in so far as the production method used to produce the trial baits was suitable for producing a water stable product. The degree of stability is further quantified as is the effect of certain ingredients in the bait formulation.

The data demonstrate that the inclusion of a protein source with a high level of water solubility significantly reduces the water stability of baits but increases the protein leach rate. This is a potential problem that will have to be addressed in the commercialisation of a dry bait as this will need to be water stable but with a sufficiently high leach rate to release the attractants present in a controlled way.

The use of certain binders, such as wheat gluten, have a marked effect on both water stability and leach rates. Such products are useful tools in manipulating the balance between water stability and leach rates.

Although only a limited rage of formulations and ingredients could be tested, it can be concluded that high starch ingredients (such as wheat) can be substituted with low starch ingredients (such as lupinseed meal), without reducing the water stability characteristics. Also, this substitution does not effect the leaching characteristics of the bait. This finding is at variance with the generally held view in the aquaculture feed industry that a starchy grain, particularly wheat, is a required ingredient to produce a water stable product.

5.3.4 Additional trial

This project was originally intended to investigate the effect of different formulations on both water stability and leach rate. As a result of an independent trial conducted by Fisheries WA it became evident that other factors were of significance, one of which was the temperature at which the baits were dried. Due to equipment failure baits produced for this trial had to be dried at 70°C for two days. These baits were found to be unstable and disintegrated within a few hours in the lobster pots. This finding was at variance with some preliminary work conducted prior to the commencement of this project. In this trial the was no significant difference in the water stability of 3mm pellets dried as 55 °C and 100 °C.

A trial was set up to investigate the effect of the drying temperature on bait blocks with regard to both water stability and leaching characteristics.

5.3.4.1 Trial 7

For this trial two sets of baits were made as follows:-

Set 1 – 500g wheat, 500g lupins, 1500g minced fish (wet).

Set 2 – 500g wheat, 500g lupins, 750g minced fish (wet), 750g enzyme treated fish (wet).

Each set of baits were dried to a final moisture content of less that 8% at 80, 90 or 100°C. These were then tested for water stability and leaching rates.

A high inclusion level of fish/enzyme treated fish was used in an effort to maximise the effect of the drying temperature.

The dry matter recovery rates are set out below.

Water Stability Results

Effects of drying temperature - samples with fish only

		Day 1		Day 2		Day 3		Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
Treatment		D M Weight		D M Weight		D M Weight					Dry Matter Recovery (%)		
		Initial	Final	Initial	Final	Initial	Final	Dry Matter Recovery (%)			Average of Replicates		
Drying temp.	Duplicate												
80	1	80	58	76	55	81	55	73%	72%	68%	72%	72%	68%
80	2	78	56	75	53	78	53	72%	71%	68%			
90	1	80	62	81	60	78	56	78%	74%	72%	78%	74%	72%
90	2	80	62	81	60	82	60	78%	74%	73%			
100	1	74	58	73	55	73	53	78%	75%	73%	79%	74%	68%
100	2	74	59	75	54	74	47	80%	72%	64%			

Samples with Fish and Enzyme Treated Fish

Drying temp.	Duplicate								
80	1	78	Not Stable	76	Not Stable	79	Not Stable		
80	2	78	Not Stable	78	Not Stable	82	Not Stable		
90	1	80	58	81	60	79	Not Stable	73%	74%
90	2	82	60	81	60	80	Not Stable	73%	74%
100	1	75	56	73	Not Stable	73	Not Stable	75%	
100	2	74	54	74	Not Stable	74	Not Stable	73%	

Table 5.3.4.1 Effect of drying temperature on dry matter recovery

Conclusions

1) Where the baits do not contain enzyme treated fish the drying temperature had little effect on the water stability as measured by dry matter recovery. (Researchers note – although the data do not show this, the baits dried at the lowest temperature were very fragile when removed from the water and would not be suitable in a commercial environment.

2) Baits containing enzyme treated fish were much less stable and, although the data are far from conclusive, a minimum drying temperature of not less than 100°C is suggested.

Further investigations related to drying temperature on water stability are reported in the section giving the results of the pot trials in the 1999/2000 season (section 6).

Protein Leaching

The results are set out below

Protein Leaching

		Day 1		Day 2		Day 3		Day 1	Day 2	Day 3	Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
Treatment		Protein (%)		Protein (%)		Protein (%)										
		Initial	Final	Initial	Final	Initial	Final	Protein Loss (as % of Bait)			Protein Loss (as % of Protein)			Protein Loss (as % of Protein)		
														Average of Replicates		
Samples with Fish Only																
Drying temp.	Duplicate															
80	1	35.8	30.4	35.8	28	35.8	29.7	5.4	7.8	6.1	15%	22%	17%	15%	18%	20%
80	2	35.8	30.6	35.8	30.6	35.8	27.9	5.2	5.2	7.9	15%	15%	22%			
90	1	35.5	34.9	35.5	35.3	35.5	33.1	0.6	0.2	2.4	2%	1%	7%	3%	0%	7%
90	2	35.5	34.3	35.5	35.5	35.5	33	1.2	0	2.5	3%	0%	7%			
100	1	34.9	28.1	34.9	26.1	34.9	25.9	6.8	8.8	9	19%	25%	26%	20%	29%	27%
100	2	34.9	27.7	34.9	23.4	34.9	24.8	7.2	11.5	10.1	21%	33%	29%			
Samples with Fish and Enzyme Treated Fish																
Drying temp.	Duplicate															
80	1	37		37		37		37	37	37	100%	100%	100%			
80	2	37		37		37		37	37	37	100%	100%	100%			
90	1	35.4	30.9	35.4	29.8	35.4	25.7	4.5	5.6	93.7	13%	16%	27%			
90	2	35.4	29.2	35.4	29.8	35.4	26.1	6.2	5.6	9.3	18%	16%	26%			
100	1	34.9	30.5	34.9	25.3	34.9		4.4	9.6	34.9	13%	28%	100%			
100	2	34.9	29.8	34.9	24.8	34.9		5.1	10.1	34.9	15%	29%	100%			

Table 5.3.4.1b Protein leaching after 3 days

Conclusions

1) These results are very variable due to the poor water stability of most samples and no definite conclusions can be made.

Although not fully substantiated by this trial it is a recommendation of the researchers that baits in the form of blocks of 100 grams or more should be dried at a minimum temperature of 100°C.

5.4 ATTRACTABILITY

The Western Rock Lobster industry relies on the use of fish as the major attractant and this has proved successful for many years. Whilst most fisherman have their own favourite species there is not real consensus as to which, if any, produce a higher catch rate under all conditions. At the commencement of this project it was anticipated that if a dry, stable bait could be produced containing a high level of fish then this would have a satisfactory level of attractability.

Early pot trials conducted by Fisheries WA (see Appendix 3, section A 3.1) demonstrated that although fish formed 30% of a dry bait on a dry matter basis, the resulting baits were not as attractive as the traditional wet fish used. These findings confirmed the need for a more in-depth study into attractability than was originally outlined in the project agreement.

A search of the literature revealed little information on effective attractants that could be added to a commercial dry bait. Studies show that the feeding behaviour of crustacea is stimulated by the use of aqueous extracts of organisms eaten by the target species. This is due to the presence of a number of nitrogenous compounds such as amino-acids, nucleosides, nucleotides etc. (Carr and Derby 1986). There are, however, no references which demonstrate that the addition of individual amino-acids to a bait effectively increase its attractability.

Due to the lack of any commercially available proven attractants, a line of investigation was set up to determine if the fish used could be chemically modified to increase the water soluble fraction of the protein by increasing the free amino-acid and short chain peptide concentration.

A search of the literature suggested that there are two method of achieving this which have commercial potential, namely acid hydrolysis and enzyme treatment using a protease.

5.4.1 Acid Hydrolysis.

Where the fish component is wet waste, particularly that containing gut material, acid hydrolysis, or more correctly autolysis with acid stabilisation, is a possibility. This process is used to produce fish silage and fish emulsion fertiliser. The alternative is to add proteases to the wet material to reduce the protein to a mixture of free amino-acids and short chain, water soluble peptides.

Initial work to investigate the use of acid-stabilised waste was carried out using the by-product from a sardine filleting operation as reported in section 5.2.2.2 with a moisture content of about 70%. This material was minced prior to acid addition and treated with various acids. The effect of the acid used, time and temperature were investigated. The 'hydrolysed' product was then added to wheat and formed into bait blocks as previously described.

The measure of effectiveness of the hydrolysis was the level of protein leaching achieved. It was originally intended to make the blocks of starch and purified cellulose with a zero protein content to which the fish hydrolysate was added. In such baits all the protein present would be derived from the fish hydrolysate under test. Unfortunately this approach could not produce a water stable product, the blocks breaking up within a hour of being immersed in water. For this reason wheat had to be used at the carrier.

Work on the preparation of the hydrolysate led to then following observations and conclusions.

a) Minced product, with no acid addition, allowed to stand at room temperature overnight became visually more liquid but became putrid and unattractive to lobsters as reported in Appendix 5. No attempt was made to make this material into bait blocks.
b) Addition of any of the test acids (hydrochloric, phosphoric or lactic) initially increased the viscosity of the minced waste but this gradually reduced with time to give a product very much more liquid than the original. It was assumed that this was due to an increase in the solubility of the proteins present.
c) All acids, when added to the minced waste to give a pH level of 4 or lower, stabilised the product for a period of up to 1 week, the maximum period investigated. There being no detectable smell of ammonia during this period. This was confirmed by the acceptability of the hydrolysed product, using either phosphoric or lactic acid, by lobsters in the tank as reported in Appendix 5.
d) At room temperature this process required 3 to 4 days to liquefy the waste and was not dependent upon the type of acid used.
e) At 60°C, maximum liquification occured within 24 hours.

Attempts to quantify the degree of solubilisation achieved, failed to yield any meaningful results. Filtering the hydrolysate was difficult unless using a buchner funnel and cloth filter which retained very little solids, but much of the filtrate was finely divided and not soluble. As the main criteria for judging the success of this part of the project was to be measured by the degree of leaching of the protein and, eventually, whether the process improved the attractability of the baits, no extra resources were put into attempting to measure soluble protein accurately. It should be noted that, according to references in the literature, this process produces free amino-acids and peptides that are water soluble and not heat coagulated. This is the result that this project is attempting to achieve.

Following the responses of lobsters in the tank as reported in Appendix 5, it was decided to concentrate on processing the waste using phosphoric acid to a pH of 4 and holding at room temperature for 5 days.

A range of baits was made to determine whether the soluble fish waste leaches faster than normal and if it had any effect on the water stability of the bait. This work can be summarised as follows-

1) Effect of hydrolysate on the water stability of baits with different non-fish substrate.

Two formulations were tested. Either wheat or lupins formed the base with 20% fish hydrolysate on a dry weight basis added.

Results-

Lupins plus Fish Hydrolysate

	Day 1	Day 2	Day 4
% Residual D.M.	83.5	69.9	67.6

Wheat plus Fish Hydrolysate

	Day 1	Day 2	Day 4
% Residual D.M.	86.9	88.0	85.9

From these data it can be concluded that the non-fish component of the bait can effect the water stability when fish is replaced with fish hydrolysate.

2) Effect of the addition of 20% (D.M. basis) of fish hydrolysate on water stability and the leaching rate of protein.

In this trial wheat was used as the bait substrate.

	Original	Day 1	Day 2	Day 5
% Residual D.M.		78.7	74.6	67.0
% Protein in Residual D.M.	17.7	17.4	17.5	15.6

These figures are at variance to those above with regard to the water stability of wheat based baits. They also demonstrated that there was no significant leaching of protein except for Day 5.

3) Effect of the addition of 30% (D.M. basis) of fish hydrolysate on water stability and the leaching rate of protein

In this trial wheat was used as the bait substrate.

	Original	Day 1	Day 2	Day 3
% Residual D.M.		71.5	68.5	68.0
% of Protein in Residual D.M.	23.2	20.3	19.0	18.5

These results suggest that the higher inclusion of the fish hydrolysate affects the water stability of the bait. Also protein was leached from the bait particularly during the first day in the water.

Conclusions.

From the data presented it can be concluded that waste fish which includes gut material can be treated with acid to produce a product with a high level of water soluble proteins. The exact composition of this hydrolysate is unknown in terms of amino-acid and peptide composition and the analytical techniques required to determine this are beyond the scope of this project.

The data presented on leaching rates demonstrates that the hydrolysed protein remains water soluble after the baits are heated in order to dry them although the actual leaching rate is also effected by the non-fish component of the diet. Further data presented in section 5.3 confirm these findings although the effect of inclusion level of the hydrolysate is at variance with the findings reported above. This may be due to the non-fish component of the test baits, ie wheat/lupin mix as opposed to wheat alone.

5.4.2 Supplementary Trial

Due to the uncertainty of a supply of suitable fish waste on a continuous basis, investigations were conducted to determine whether fish meal could be modified to replace the fish waste. It had been determined that the inclusion of fish meal in a dry bait produces a protein leaching rate of virtually nil, and a highly water stable bait. The possibility of increasing the solubility of fish meals by acid hydrolysis was investigated.

Three sources of fish meal were each mixed with water on a 1:2 basis and the pH reduced to 3 using phosphoric acid. The mix was allowed to stand at room temperature for four days which followed the procedure adopted for the hydrolysis of the wet fish waste. A range of baits was made using 40% of the test material and 60% of the wheat/lupin mix used in previous trials. The test materials used were either normal or acid treated fish meal from three sources, German, New Zealand or a new local source derived from the Patagonian Tooth Fish ('Albany' Fish Meal).

Baits were manufactured and tested for both water stability and protein leaching rates based on the standard protocol.

The results of the water stability test are set out below.

Comparison of Different Fish Meals

Material	Immersion days	Initial Wt.	Final Wt.	Weight Loss	Recovery
		(grams DM)	(grams DM)	(grams DM)	(%)
German Fish Meal (untreated)	1	57	43	14	75.4%
	2	56	44	12	78.6%
	3	57	43	14	75.4%
German Fish Meal (pH 3)	1	68	42	26	61.8%
	2	71	33	38	46.5%
	3	75	36	39	48.0%
New Zealand Fish Meal (untreated)	1	57	49	8	86.0%
	2	58	49	9	84.5%
	3	59	50	9	84.7%
New Zealand Fish Meal (pH3)	1	47	38	9	80.9%
	2	48	39	9	81.3%
	3	48	38	10	79.2%
Albany Fish Meal (untreated)	1	57	49	8	86.0%
	2	59	49	10	83.1%
	3	56	47	9	83.9%
Albany Fish Meal (pH3)	1	59	45	14	76.3%
	2	59	45	14	76.3%
	3	59	42	17	71.2%

Table 5.4.2a Water stability with different fish meals

Figure 5.4.2a Water stability with different fish meals

Conclusions

1) All baits containing untreated fish were relatively stable which is consistent with previous findings.
2) There were differences due to source of fish meal with the German material producing inferior results compared to the other two sources.
3) All baits containing acid treated fish were less stable than those containing untreated fish from the same source.
4) There were significant differences in the reduced stability of the acid treated baits due to the source of fish meal. Baits containing the acid treated Germen fish meal were relatively unstable compared to all other treatments.

The results of leaching rate tests are set out below.

Comparison of Different Fish Meals

Material	Immersion days	Initial Protein (%)	Final Protein (%)	Protein Loss as % of bait	Protein Loss as % of Protein
German Fish Meal (untreated)	1	39.0	35.6	3.4	8.7%
	2	39.0	35.8	3.2	8.2%
	3	39.0	36.1	2.9	7.4%
German Fish Meal (pH 3)	1	32.5	35.6	-3.1	-9.5%
	2	32.5	35.8	-3.3	-10.2%
	3	32.5	36.1	-3.6	-11.1%
New Zealand Fish Meal (untreated)	1	39.5	41.2	-1.7	-4.3%
	2	39.5	41.5	-2	-5.1%
	3	39.5	42.2	-2.7	-6.8%
New Zealand Fish Meal (pH3)	1	37.4	38	-0.6	-1.6%
	2	37.4	38.1	-0.7	-1.9%
	3	37.4	37.9	-0.5	-1.3%
Albany Fish Meal (untreated)	1	37.6	37.8	-0.2	-0.5%
	2	37.6	38.4	-0.8	-2.1%
	3	37.6	38	-0.4	-1.1%
Albany Fish Meal (pH3)	1	33.6	34.4	-0.8	-2.4%
	2	33.6	34.5	-0.9	-2.7%
	3	33.6	34.7	-1.1	-3.3%

Table 5.4.2b Leaching rates and the use of different fish meals

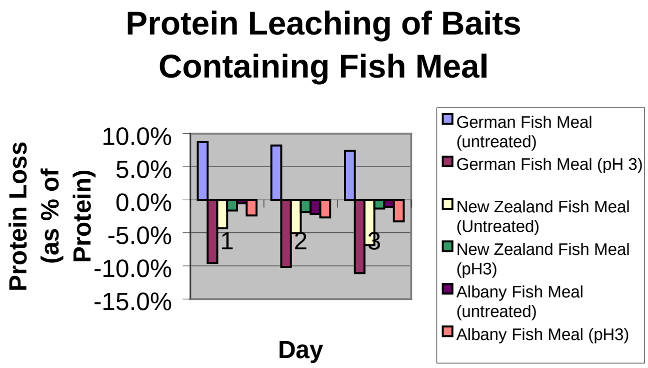


Figure 5.4.2b Protein leaching of bait with different fish meals

Conclusions

1) The results obtained with the German fish meal are inconsistent with other data produced in that there appeared to be significant leaching of protein when untreated fish meal was used. This was reversed when the treated product was used.
2) Both the New Zealand and Albany fish meals produced results closer to expectations with no leaching occuring from baits with either untreated or treated fish meal.
3) From the data presented it would appear unlikely that acid treated fish meal could successfully replace treated fish waste as an attractant in dry baits due, mainly, to lack of protein leaching.

Whilst the use of acid hydrolysis achieves some of the objectives with regard to increasing the potential attractability of the dry bait by increasing the leaching rate of water soluble proteins, the data were not conclusive and further work using enzymes was conducted.

5.4.3 Enzyme Treatment

Following discussions with a number of suppliers, a protease preparation was chosen to be used in a series of tests to determine the suitability of such preparations for the hydrolysis of fish waste to be used in a dry bait. The enzyme preparation chosen was Protomex, supplied by Novo Nordisk A/S. A major factor the decision was the claim by the supplier that "In contrast to many endoproteases, Protomex will produce non-bitter hydrolysates even at low degrees of hydrolysis".

Little information was available on the optimum enzyme concentration and hydrolysis conditions required for this project. The major use of this product is for the partial hydrolysis of various proteins in human foods. For this project a higher level of hydrolysis was considered to be required.

A series of laboratory tests were initiated to determine the effect of varying a number of parameters on the level of hydrolysis achieved using fish waste from a sardine filleting operation. These variables were 1) concentration of enzyme, 2) temperature, 3) treatment time and 4) pH.

5.4.4 Test Protocol.

One kg of sardine waste was minced, placed in a 2 litre beaker and the required additive/s thoroughly mixed into the material. The beaker was placed in an incubator for the required time and the resultant product assessed. As with the acid hydrolysed product it was found impractical to directly measure the degree of solubility achieved and so a subjective assessment was made based how liquid the product appeared.

1) Enzyme Concentration.

A range of enzyme additions from 0.1% to 1% was originally tested with a treatment time of 3 hours at a temperature of 40°C. The time and temperature used were based on normal parameters for human food products.

At the end of the test period it was apparent that hydrolysis was incomplete although the resultant product was considerably more liquid than the untreated material. This was in line with advice received from the suppliers that most users only require partial hydrolysis.

There was no noticeable increase in the level of hydrolysis achieved with increasing levels of enzyme addition above 0.2%. This observation was confirmed when baits were made including this material and tested for leaching rate. There results are reported in section 5.3.2.3 of this report.

2) Temperature.

A product data sheet from the supplier gave an optimum temperature range of 35 – 60°C for this particular enzyme. This range was confirmed to be optimal using the test substrate.

3) Treatment Time.

A recommended treatment time of 3 hours as used in 1) above was based on microbial considerations with a rapid build up of bacteria due to the substrate used. For this project, further processing reduced the importance of bacterial content in the wet material. Treatment times were tested ranging from 3 to 24 hours at a temperature of 40°C.

There was a noticeable correlation of substrate liquefaction with time up to the maximum time tested. After the full 24 hours of processing the substrate appeared to be completely liquified. Whilst this result was very encouraging it was noted that there was also an increase in ammonia production, presumably due to putrification. As reported in Appendix 5, this has a very negative effect on the attraction characteristics of the product.

4) pH

The product data sheet stated that the optimal working conditions for this enzyme preparation is pH 5.5 – 7.5. It is also stated that inactivation occurs after 30 minutes at 50°C at a pH of 4. However this is very substrate dependent.

The possibility of being able to increase the hydrolysis time without increasing ammonia production was investigated. A sample of minced sardine waste was lowered to a pH of 5 using phosphoric acid, 0.2% enzyme was added and the mix incubated for 24 hours at 40°C.

The resultant product was highly liquified and did not smell of ammonia. It would appear that this treatment is effective in producing a highly water soluble fish product without any putrifaction. Tests reported in Appendix 5 suggested that this product was acceptable to rock lobsters.

Conclusions.

From the tests conducted it can be concluded that protease enzymes such as Protomex can be used to convert waste fish into a product containing a high level of water soluble proteins. Based on tests reported in Appendix 5, a decision was made to concentrate on developing the concept of using a mixture of acid and enzymes to produce a modified fish hydrolysate for use as the attractant in a dry bait.

In all the trials reported in section 5.3 referring to enzyme fish, the fish was treated with 0.2% enzyme except where otherwise stated.

5.5 DISEASE TRANSMISSION

As detailed in the original research project, the current use of fresh and frozen fish, much of which is imported, carries with it the potential to introduce exotic disease organisms into the local marine environment. There have been two major sardine kills in recent years in southern Australian waters. The exact cause of these kills has never been proved but all circumstantial evidence suggests that they have been caused by the use of imported frozen fish as feed.

One major advantage of producing a dried bait is the potential for adjusting the manufacturing process to ensure that the product is effectively sterile. This would be virtually impossible and an extremely expensive operation with the frozen fish baits currently used.

Based on finding from this project relating to both water stability and leaching characteristics, it is recommended that;

1) Baits should contain minced fish and/or enzyme treated fish together with non-fish components such as ground grain and legumes.
2) The baits should be formed into blocks with an initial moisture content of about 35%.
3) The drying process requires a minimum temperature of 100°C.
4) The final moisture content should not be greater than 10% with an optimum level of 8%. Using equipment available to the project and detailed in section 5.1, this required approximately 24 hours.

A series of tests was conducted to determine the effect of each stage of the production process on the microbiological characteristics of the product.

5.5.1 Trial 1

Samples of the bait ingredients used, (ie. ground wheat, ground lupinseed meal and minced fish waste) together with the wet bait mixture containing 30% fish on a dry matter basis, were subjected to a Standard Plate Count and a count of B. cereus. The former provides general indication of bacterial content and the latter is measuring a spore forming bacteria. The presence B. cereus may indicate potential problems with extended storage of the baits.

Results

	Standard Plate Count (SPC)	B. cereus
Ground wheat	130,000	>100
Ground lupinseed	300,000	>100
Minced fish	6,700,000	>100
Moist Bait	1,100,000	>100

Conclusions

The results are very much as expected in that the grains had a relatively low bacterial count but the minced fish was relatively high. The SPC of the moist bait mix was lower than might have been expected from the inclusion rate of minced fish. This difference was not sufficiently high to suggest that simply mixing the ingredients reduces the bacterial loading. In all samples the presence of B. cereus could not be confirmed.

5.5.2 Trial 2

This was set up to determine whether the enzyme treatment of the minced fish altered the bacterial status of the product. The products tested were minced fish, enzyme treated minced fish, and bait mix containing either minced fish or enzyme treated fish prior to drying.

Results

	Standard Plate Count (SPC)
Minced fish	640,000,000
Enzyme treated fish	640,000,000
Bait mix with minced fish	2,700,000,000
Bait mix with enzyme treated fish	2,400,000,000

Conclusions

All counts were very high and much higher than in both previous and succeeding tests. No attempt was made to sterilise equipment during any of the processing as this is unlikely to occur in any commercial plant producing a dry bait. It is possible, therefore, that these high results were due to the use of 'dirty' equipment.

From the results obtained it can be concluded that enzyme treating wet, minced fish does not affect the microbial count.

5.5.3 Trial 3

It was established that, in order to produce a water stable bait, a minimum drying temperature of 100°C is required. A trial was set up to determine whether this minimum drying temperature was sufficient to sterilise bait blocks.

Blocks calculated to be of approximately 100 grams dry weight were made using the standard formulation of 70% wheat/Lupin mix and 30% minced fish, on a dry matter basis. These were placed in a drying oven set at 100°C and removed at intervals for microbial testing. All samples were placed in a freezer and maintained at –20°C prior to testing.

Results

Drying time	Standard Plate Count (SPC)	B. cereus
1 hr	140,000,000	>100
2 hr	570,000	>100
3 hr	1,500	>100
5 hr	800	>100
6 hr	600	>100
7 hr	300	>100
24 hr	200	>100

Conclusions

From a very high initial SPC there was a rapid reduction with time to very low levels after 5 hours and this continued to decline. As a drying time of about 24 hours is required to reduce the residual moisture content to under 10%, baits made by the method tested are essentially sterile when removed from the dryer. As these results are so conclusive, it was decided not to test higher drying temperatures as originally planned.

Storage Test

Results from B.cereus tests suggested the absence of spore forming bacteria the presence of which may affect the storage life of the dry baits. To confirm, or otherwise, this supposition, dry baits were stored for up to 9 months in open boxes in non-sterile conditions. These were then tested to determine the effect of storage on bacterial content.

Storage time	Standard Plate Count CFU/g	Bacillus cereus CFU/g
4 months	<1,000	<100
5 months	>1,000	<100
6 months	1,000	<100
8 months	<1,000	<100
9 months	4,000	<100

These results demonstrate that, provided the moisture content does not exceed 10%, dry baits can be stored for extended periods in normal, commercial conditions ie. “in a cool dry place” for extended periods and remain essentially sterile.

The absence of B cereus indicates that the manufacturing process completely sterilizes the baits including the destruction of spore forming bacteria. This means that it is very unlikely that baits, manufactured under the conditions outlined in this project, would transmit exotic diseases to the fishery where they are used.

5.6 CONCLUSIONS

The main conclusions from project 96/337 are summarised below.

The aim of this project was to produce a dry lobster bait that could replace the current baits of fish and 'hocks and hides'. The parameters researched to produce a successful bait were Water Stability, Leaching Rate, Attractability and Pathogenicity. Based on these parameters the following conclusions could be drawn-

a) Water stable baits could be produced using a range of ingredients. This stability could be modified if required by adjusting the blend of ingredients used and by altering the processing conditions, specifically drying temperature.
b) Leaching from stable baits was restricted to water soluble compounds. As it is generally considered that lobster attractants are nitrogenous compounds derived from protein, the leaching rate of protein was intensively studied. It was demonstrated that only water soluble proteins leached from the baits. It was also shown that the characteristics of good water stability and high rates of leaching were antagonistic.
c) As no effective lobster attractants could be identified from the literature the project concentrated on methods of producing fish protein with a high level of water solubility. It was found that both acid treatment and the use of proteolytic enzymes were effective in achieving this. The effectiveness of this product was tested in pot trials during the 1999/2000 season under an extension to this project (1999/373)
d) Baits were made under normal conditions required to achieve an acceptable level of water stability were found to have a low bacterial plate count and could be considered as effectively free from pathogens. As the ingredients used in the baits, particularly the fish products, had very high plate counts it could be concluded that the manufacturing process, particularly the temperature at which the baits were dried, effectively sterilised the product. Testing of baits after up to 9 months storage in open boxes in a warehouse revealed no significant increase in the numbers of bacteria present. It was concluded that pathogen free baits could be produced and these remained pathogen free during storage.

6.0 POT TRIALS 1999/2000

A extension to the original projec was obtained using normal fishing conditions to test some of the parameters identified in FRDC Project 96/337 as being important in the development of a commercial dry lobster bait. Pot trials were conducted under contract by eight commercial fishermen in areas ranging from Perth to Geraldton. The intention was to conduct the trials for the whole of the 1999/2000 season but logistical problems associated with fishing in remote areas meant that not all participants could complete all the trials..

The trial protocol followed required that the trial pot form part of a pot line of 80+ pots which were normally baited with a mixture of fish and hide or fish heads. The trial pot was baited as per instructions from the Principal Investigator. Pots were pulled after one, two or three days, with one day pulls being the commonest. This time period was left to the discretion of the fisherman with the trial pots being treated exactly the same as the normally baited pots. Records were required to be kept of the catch of the trial pot compared to the line average, the catch of the preceding and next pot in the line together with information of fishing depth, sea conditions and temperature. Also an estimate of the amount of bait remaining at each pot pull was required.

Each bait formulation was normally tested over a two to three week period with all participants using the same trial bait. This allowed for comparisons to be made as to the catching effectiveness and water stability of the bait in different sections of the fishery, different fishing depths, etc.

6.1 Bait Size.

Previous work conducted used a bait produced on a hand operated 'hamburger' press which formed a circular block, 90mm diameter and a dry weight of up to about 100 grams. The project required the testing of different block sizes and shapes and to facilitate this a small hydraulic press was acquired which could produce 100mm diameter blocks of varying lengths, and therefore weights, up to 300mm. This length was in fact well above the maximum length of a block that would fit into the bait baskets used in the industry.

Blocks of about 300 and 450 grams dry weight were tested, the latter size being the largest that would fit into the smaller of the two bait baskets used by the industry. The effect of block size on water stability was tested both in the sea trials and under the standard laboratory conditions used previously. Discussions with the industry prior to the trial period showed a preference for the larger blocks rather than the 100 gram ones previously tested. The perceived advantages were,

a) Better control of attractant release rates.

b) Less abrasion in the bait basket.
c) Less potential for predation due to less surface area.
d) Easier to add one large block per basket rather than multiple smaller ones.

6.1.1 Bait Formulations.

Work conducted during 1998/99, particularly relating to the use of enzyme treated fish, demonstrated that the leaching rate of proteinaceous material could be controlled under laboratory conditions. The major objective of the sea trials for the 1999/2000 season was to determine whether these findings could be used as a basis for the production of a dry bait that was as attractive as the fish baits currently used. Attractiveness was determined by comparing the catch rate of the trial pot with the catch rate of the normally baited pots.

The varying inclusion rate of enzyme treated fish was used to meet the project requirements to investigate the optimum level of key additives as no specific attractant had been identified.

In addition to the catch rate, the water stability of the trial baits was also assessed. Comparisons were then made between both attractiveness (catch rate) and water stability and also between the water stability of the various formulations.

Results for the various formulations used are set out and summarised for each individual formulation together with appropriate comments. The conclusions to be drawn from the whole trial are then summarised in section 6.2.

6.1.2 BAIT 99/01

This formulation was based on laboratory findings with regard to both bait stability and leaching characteristics and was the first to be tested under commercial conditions using enzyme treated fish.

Formulation

Ground wheat	450 grams
Ground lupinseed	450 grams
Wheat gluten	100 grams
Enzyme treated fish*	600 grams (wet weight)

* Whole sardine treated with 0.2% protease at 40°C for 3 hours.

Bait produced as approx. 100 gram ‘hamburger’ blocks. Drying temperature 100°C.

Baiting Procedure.

Trial pots to be baited with 3 dry blocks in one basket plus one half, approx. 1 kg, of fish in the other. No hide or other holding bait used. Standard pots baited with about 2 kg of fish plus either hides or fish heads as holding bait.

Results.

The trial data is reported overleaf.

Observations

a) All participants recorded some success with the trial bait but, in terms of the number of lobsters caught per pot per day the results, whilst variable, were below those achieved using the conventional baits.
b) Bait stability, as assessed by the participants, appeared to be very variable, ranging from very good (PN) to extremely poor (MP). There were also significant daily differences with individual participants that were not related to the number of days that the pots were set. No convincing explanation is forwarded for this variability.

The average bait stability was not satisfactory and may have affected the catch rate of the trial pot.

BAIT 99-01
SUMMARY

Size Lobsters

PARTICIPANT	Trial pot Catch	No. of pots	Line average Catch	No. pots	Pot before Catch	No. of pots	Pot after Catch	No. of pots	Average catch/pot/day Trial Pot	Line Average	Pot Before	Pot After
PA	23	10	59.5	10	56	10	66	10	2.3		5.6	6.6
ND	93	14	110.5	15	87	13	173	15	6.6	7.4	6.7	11.5
RB	33	15	54.5	15	83	15	52	15	2.2	3.6	5.5	3.5
SF	38	13	75.0	15	51	13	64	12	2.9	5.0	3.9	5.3
GP	37	19	71.3	19	71	19	74	19	1.9	3.8	3.7	3.9
PN	80	14	100.5	15	114	13	85	15	5.7	6.7	8.8	5.7
HD	39	9	54.3	9	74	9	78	9	4.3	6.0	8.2	8.7
MP	23	8	37.0	8	40	8	42	8	2.9	4.6	5.0	5.3
TOTAL	366	102	562.6	106	576	100	634	103				
AVERAGE/POT	3.6		5.3		5.8		6.2		3.6	5.3	5.9	6.3

Undersize Lobsters

PARTICIPANT	Trial pot Catch	No. of pots	Line average Catch	No. pots	Pot before Catch	No. of pots	Pot after Catch	No. of pots	Average catch/pot/day Trial Pot	Line Average	Pot Before	Pot After
PA	58	10		0	98	10	68	10	5.8		9.8	6.8
ND	153	14	163	15	185	13	193	15	10.9	10.9	14.2	12.9
RB	44	15	101	15	81	15	93	15	2.9	6.7	5.4	6.2
SF	41	13	115	15	90	13	64	12	3.2	7.7	6.9	5.3
GP	79	19	139.5	19	88	19	133	19	4.2	7.3	4.6	7.0
PN	85	14	173	15	167	13	123	15	6.1	11.5	12.8	8.2
HD	30	9	59.3	9	69	9	53	9	3.3	6.6	7.7	5.9
MP	30	8	80	8	47	8	65	8	3.8	10.0	5.9	8.1
TOTAL	520	102	830.8	96	825	100	792	103				
AVERAGE/POT	5.1		8.7		8.3		7.7		5.0	8.7	8.4	7.6

	Bait stability % recovered
PA	18
ND	69
RB	57
SF	70
GP	36
PN	80
HD	62
MP	5
TOTAL	397
AVERAGE	50

6.1.3 BAIT 99/02

This trial was set up to test alterations to the 99/01 formulation designed to improve bait stability whilst maintaining leaching characteristics.

Formulation

Ground wheat	700 grams
Ground lupinseed	150 grams
Wheat gluten	150 grams
Enzyme treated fish*	800 grams (wet weight)

* Whole sardine treated with 0.2% protease at 40°C for 5 hours.

Bait produced as approx. 100 gram ‘hamburger’ blocks.
Drying temperature 100°C.

Baiting Procedure.

Trial pots to be baited with 3 dry blocks in one basket plus one half, approx. 1 kg, of fish in the other. No hide or other holding bait used. Standard pots baited with about 2 kg of fish plus either hides or fish heads as holding bait.

Results.

The trial data reported overleaf.

Observations

a) The overall performance with regard to catch rate was similar to that achieved with bait 99/01 with a similar degree of variability.
b) This bait was much more stable than bait 99/01 with generally less variability between participants. There was also less variability on a daily basis in all but one instance (GP).
c) From a stability criterion this formulation was satisfactory but not with regard to attractiveness as measured by catch rate.

BAIT 99/02 SUMMARY

Average Catch per Pot

Size Lobsters

PARTICIPANT	Trial pot Catch	No. of pots	Line average Catch	No. of pots	Pot before Catch	No. of pots	Pot after Catch	No. of pots	Average catch/pot/day Trial Pot	Line Average	Pot Before	Pot After
PA	18	14	54	15	56	15	65	14	1.3	3.6	3.7	4.6
ND	113	22	133	22	139	22	150	21	5.1	6.0	6.3	7.1
RB	15	5	18	5	23	5	20	5	3.0	3.6	4.6	4.0
SF	93	24	123	21	168	25	115	22	3.9	5.9	6.7	5.2
GP	29	17	61	17	70	17	68	17	1.7	3.6	4.1	4.0
PN	32	10	52	11	62	10	31	9	3.2	4.7	6.2	3.4
HD	172	28	185	28	186	28	225	28	6.1	6.6	6.6	8.0
MP	11	8	39	8	43	8	55	8	1.4	4.9	5.4	6.9
TOTAL	483	128	665	127	747	130	729	124				
AVERAGE/POT	3.8		5.2		5.7		5.9		3.2	4.9	5.5	5.4

Undersize Lobsters

PARTICIPANT	Trial pot Catch	No. of pots	Line average Catch	No. of pots	Pot before Catch	No. of pots	Pot after Catch	No. of pots	Average catch/pot/day Trial Pot	Line Average	Pot Before	Pot After
PA	122	14		15	272	15	198	14	8.7	0.0	18.1	14.1
ND	231	22	231	22	191	22	241	21	10.5	10.5	8.7	11.5
RB	4	5	17	5	11	5	11	5	0.8	3.4	2.2	2.2
SF	118	24	177	21	216	25	213	22	4.9	8.4	8.6	9.7
GP	212	17	258	17	300	17	339	17	12.5	15.2	17.6	19.9
PN	52	10	76	11	64	10	47	9	5.2	6.9	6.4	5.2
HD	408	28	431	28	413	28	472	28	14.6	15.4	14.8	16.9
MP	34	8	132	8	99	8	116	8	4.3	16.5	12.4	14.5
TOTAL	1181	128	1322	127	1566	130	1637	124				
AVERAGE/POT	9.2		10.4		12.0		13.2		7.7	9.5	11.1	11.8

	Bait stability % recovered
PA	79
ND	91
RB	100
SF	86
GP	57
PN	82
HD	87
MP	86
TOTAL	668
AVERAGE	84

6.1.4 BAIT 99/03

This trial was set up to further investigate alterations to the 99/01 formulation designed to alter bait stability whilst maintaining leaching characteristics. The bait also contained Betaine which, some researchers claim, is an attractant when incorporated into crustacea feeds.

Formulation

Ground wheat	425 grams
Ground lupinseed	415 grams
Wheat gluten	150 grams
Betaine	10 grams
Enzyme treated fish*	800 grams (wet weight)

* Whole sardine treated with 0.2% protease at 40°C for 4 hours.

Bait produced as approx. 100 gram 'hamburger' blocks.
Drying temperature 100°C.

Baiting Procedure.

Trial pots to be baited with 3 dry blocks in one basket plus one half, approx. 1 kg, of fish in the other. No hide or other holding bait used. Standard pots baited with about 2 kg of fish plus either hides or fish heads as holding bait.

Results.

The trial data is reported overleaf.

Comments

a) Overall the catch rate for the whole fishery was very much lower than in the previous trials.
b) There was still a high level of variation in the relative catch rate of the trial pot as compared to the normally baited pots although the trend was towards the trial pot catch being inferior.
c) There was no real evidence that the addition of Betaine, in this particular formulation improved attractability.
d) The water stability of the bait was lower than had been expected but was still very variable between participants and on a day by day basis. This variation was greater than experienced with bait 99/02.

Researchers note: Measuring water stability as the amount of bait remaining when the pot is pulled excludes the possibility of predation. It is possible that this bait was predated in certain areas and under some changing conditions experienced on a day to day basis. The ability to measure predation under commercial conditions was beyond the scope of this project and so all data has to be taken at face value.

BAIT 99/03 SUMMARY

Average Catch per Pot

Size Lobsters

PARTICIPANT	Trial pot Catch	No. of pots	Line average Catch	No. of pots	Pot before Catch	No. of pots	Pot after Catch	No. of pots	Average catch/pot/day Trial Pot	Line Average	Pot Before	Pot After
PA	12	15	17	16	15	15	20	16	0.8	1.1	1.0	1.3
ND	9	17	21	17	26	16	12	17	0.5	1.2	1.6	0.7
RB	16	8	26.5	8	21	8	19	8	2.0	3.3	2.6	2.4
SF	19	15			27	11	21	9	1.3		2.5	2.3
GP	20	16	26.5	16	30	16	33	16	1.3	1.7	1.9	2.1
PN	15	17	32.3	17	36	17	14	12	0.9	1.9	2.1	1.2
HD	11	11	17.5	14	17	14	20	13	1.0	1.3	1.2	1.5
MP	13	10	11.8	10	11	10	13	9	1.3	1.2	1.1	1.4
TOTAL	115	109	152.6	98	183	107	152	100				
AVERAGE/POT	1.1		1.6		1.7		1.5		1.1	1.7	1.8	1.6

Undersize Lobsters

PARTICIPANT	Trial pot Catch	No. of pots	Line average Catch	No. of pots	Pot before Catch	No. of pots	Pot after Catch	No. of pots	Average catch/pot/day Trial Pot	Line Average	Pot Before	Pot After
PA	15	15		16	17	15	20	16	1.0	0.0	1.1	1.3
ND	42	17	53.5	17	37	16	12	17	2.5	3.1	2.3	0.7
RB	15	8	35	8	22	8	19	8	1.9	4.4	2.8	2.4
SF	21	15			39	11	21	9	1.4		3.5	2.3
GP	22	16	29	16	61	16	33	16	1.4	1.8	3.8	2.1
PN	13	17	25	17	15	17	14	12	0.8	1.5	0.9	1.2
HD	15	11	45	14	48	14	20	13	1.4	3.2	3.4	1.5
MP	21	10	40	10	20	10	13	9	2.1	4.0	2.0	1.4
TOTAL	164	109	227.5	98	259	107	152	100				
AVERAGE/POT	1.5		2.3		2.4		1.5		1.5	2.6	2.5	1.6

	Bait stability % recovered
PA	13
ND	71
RB	33
SF	36
GP	48
PN	
HD	80
MP	74
TOTAL	355
AVERAGE	51

6.1.5 BAIT 99/04

This trial was set up to investigate the effect of altering the size of the dry bait from 100 grams to about 300 grams. The formulation used was the same as for trial 99/03. At the time the baits were made no results were available from the previous trial and so the lower than expected water stability characteristics of this formulation were not taken into account.

Formulation

Ground wheat	425 grams
Ground lupinseed	415 grams
Wheat gluten	150 grams
Betaine	10 grams
Enzyme treated fish*	800 grams (wet weight)

* Whole sardine treated with 0.2% protease at 40°C for 4 hours.

Bait produced as approx. 300 gram blocks with a diameter of 100mm.
Drying temperature 100 °C.

Baiting Procedure.

Trial pots to be baited with 1 dry block in one basket plus one half, approx. 1 kg, of fish in the other. No hide or other holding bait used. Standard pots baited with about 2 kg of fish plus either hides or fish heads as holding bait.

Results.

The trial data is reported overleaf.

Comments

a) As reported for the previous trial catch rates were low throughout the fishery.
b) There is some suggestion that the larger bait size showed a slight advantage over the same amount of bait but in 3 blocks instead of one. Results from some participants showed a catch rate at least equal to the normally baited pots. For others the results were still markedly inferior.
c) The average level of water stability suggests a slight improvement of the larger bait over the smaller ones but there is no consistency between the results from the individual participants. There is no real evidence that the stability of the larger block is inferior.

BAIT 99/04 SUMMARY

Size Lobsters

PARTICIPANT	Trial pot Catch	No. of pots	Line average Catch	No. of pots	Pot before Catch	No. of pots	Pot after Catch	No. of pots	Average catch/pot/day Trial Pot	Line Average	Pot Before	Pot After
PA												
ND	31	18	25	18	26	16	21	16	1.7	1.4	1.6	1.3
RB	59	15	58.5	15	30	15	45	15	3.9	3.9	2.0	3.0
SF												
GP	11	8	14.2	8	14	8	14	8	1.4	1.8	1.8	1.8
PN	15	17	32.3	17	36	17	14	12	0.9	1.9	2.1	1.2
HD	14	11	19.3	11	8	11	20	11	1.3	1.8	0.7	1.8
MP	1	6	5.8	6	3	6	6	6	0.2	1.0	0.5	1.0
TOTAL	131	75	155.1	75	117	73	120	68				
AVERAGE/POT	1.7		2.1		1.6		1.8		1.6	1.9	1.5	1.7

Undersize Lobsters

PARTICIPANT	Trial pot Catch	No. of pots	Line average Catch	No. of pots	Pot before Catch	No. of pots	Pot after Catch	No. of pots	Average catch/pot/day Trial Pot	Line Average	Pot Before	Pot After
PA												
ND	30	18	38.5	18	33	16	29	16	1.7	2.1	2.1	1.8
RB	48	15	86	15	65	15	59	15	3.2	5.7	4.3	3.9
SF												
GP	9	8	12.5	8	20	8	14	8	1.1	1.6	2.5	1.8
PN	13	17	25	17	15	17	14	12	0.8	1.5	0.9	1.2
HD	9	11	21.5	11	15	11	21	11	0.8	2.0	1.4	1.9
MP	5	6	20	6	10	6	11	6	0.8	3.3	1.7	1.8
TOTAL	114	75	203.5	75	158	73	148	68				
AVERAGE/POT	1.5		2.7		2.2		2.2		1.4	2.7	2.1	2.1

	Bait stability % recovered
PA	
ND	31
RB	44
SF	
GP	73
PN	77
HD	71
MP	82
TOTAL	378
AVERAGE	63

6.1.6 BAIT 99/05

In an effort to improve attractability even at the expense of water stability a change was made to the method of enzyme treating fish. The details are set out below. This trial tested the new fish hydrolysate in a formulation similar to that used in bait trial 99/04.

Formulation

Ground wheat	420 grams
Ground lupinseed	415 grams
Wheat gluten	150 grams
Betaine	15 grams
Enzyme treated fish*	800 grams (wet weight)

* Whole sardine treated with 0.2% protease at 40°C for 20 hours.

Bait produced as approx. 300 gram blocks with a diameter of 100mm.
Drying temperature 100°C.

Baiting Procedure.

Trial pots to be baited with 1 dry block in one basket plus one half, approx. 1 kg, of fish in the other. No hide or other holding bait used. Standard pots baited with about 2 kg of fish plus either hides or fish heads as holding bait.

Results.

The trial data is reported overleaf.

Comments

a) Catch rate of size lobsters were higher throughout the fishery.
b) As was anticipated the increase in the enzyme treatment of the fish reduced the water stability of the bait. Again there was a large variation in this parameter between participants but the poorer water stability was a constant feature in all but one instance
c) Despite the inferior water stability, this bait performed as well as bait 00/04 relative to the controls and better in absolute terms. In some instances (ND and RB) it performed at least as well as the normal bait. It would appear possible, therefore, that the increased enzyme treatment time did improve attractability.
d) During the manufacture of this bait there was a noticeable smell of ammonia, suggesting that the fish was starting to putrefy. During the tank trials ammonia was found to repel

lobsters. It must be assumed, thereforee, that the drying process removed the ammonia and the dry product was acceptable.

BAIT 99/05 SUMMARY

Average Catch per Pot

Size Lobsters

PARTICIPANT	Trial pot Catch	No. of pots	Line average Catch	No. of pots	Pot before Catch	No. of pots	Pot after Catch	No. of pots	Average catch/pot/day Trial Pot	Line Average	Pot Before	Pot After
PA	15	12	23	12	23	12	20	12	1.3	1.9	1.9	1.7
ND	42	12	27	12	29	11	23	10	3.5	2.3	2.6	2.3
RB												
SF												
GP	26	12	24	12	25	12	28	12	2.2	2.0	2.1	2.3
PN	50	10	71	11	70	10	68	11	5.0	6.5	7.0	6.2
HD	29	8	21.3	9	23	10	26	10	3.6	2.4	2.3	2.6
MP	3	7	33	7	32	7	50	7	0.4	4.7	4.6	7.1
TOTAL	165	61	199.3	63	202	62	215	62				
AVERAGE/POT	2.7		3.2		3.3		3.5		2.7	3.3	3.4	3.7

Undersize Lobsters

PARTICIPANT	Trial pot Catch	No. of pots	Line average Catch	No. of pots	Pot before Catch	No. of pots	Pot after Catch	No. of pots	Average catch/pot/day Trial Pot	Line Average	Pot Before	Pot After
PA	5	12			3	12	8	12	0.4		0.3	0.7
ND	23	12	18	12	11	11	16	10	1.9	1.5	1.0	1.6
RB												
SF												
GP	8	12	15.1	12	14	12	8	12	0.7	1.3	1.2	0.7
PN	42	10	40.3	11	34	10	36	11	4.2	3.7	3.4	3.3
HD	14	8	17.3	9	22	10	25	11	1.8	1.9	2.2	2.3
MP	3	7	8	7	4	7	5	7	0.4	1.1	0.6	0.7
TOTAL	95	61	98.7	51	88	62	98	63				
AVERAGE/POT	1.6		1.9		1.4		1.6		1.6	1.9	1.4	1.5

	Bait stability % recovered
PA	65
ND	65
RB	
SF	
GP	13
PN	29
HD	37
MP	56
TOTAL	265
AVERAGE	44

6.1.7 BAIT 99/06

This trial was set up to investigate the effect of using two different dry baits, one very stable as a holding bait and the other, containing enzyme treated fish, as an attracting bait. The attracting bait was made to the 99/04 formulation, results of the 99/05 trial not being available when the baits were made. The holding bait was made to the same formulation but with minced fish replacing enzyme treated fish as this approach had been successful in laboratory water stability tests.

Formulation

Ground wheat	425 grams	425 grams
Ground lupinseed	415 grams	415 grams
Wheat gluten	150 grams	150 grams
Betaine	10 grams	10 grams
Minced fish	800 grams (wet wt.)	
Enzyme treated fish*		800 grams (wet wt.)

* Whole sardine treated with 0.2% protease at 40°C for 4 hours.

Bait produced as approx. 300 gram blocks with a diameter of 100mm.
Drying temperature 100°C (see comments)

Baiting Procedure.

Trial pots to be baited with 1 dry holding block in one basket and one dry attracting block in the other. No fish, hide or other holding bait used. Standard pots baited with about 2 kg of fish plus either hides or fish heads as holding bait.

Results.

The trial data is reported overleaf.

Comments

a) This trial was abandoned after a short time due to very poor catch rates. One participant did persist but the remainder terminated the trial to reduce economic loss.

b) Contrary to expectations the water stability of the baits produced was extremely poor and this was evident from day 1 of the trial. No confirmed explanation if offered for this but it is possible that due to power failure the drying temperature was not maintained. Low drying temperatures have been shown to have an adverse effect on water stability, see section 5.3.4.1.

Commented [BH1]:

BAIT 99/06 SUMMARY

Size Lobsters

PARTICIPANT	Trial pot Catch	No. of pots	Line average Catch	No. of pots	Pot before Catch	No. of pots	Pot after Catch	No. of pots	Average Catch per Pot — Average catch/pot/day Trial Pot	Line Average	Pot Before	Pot After
PA												
ND												
RB												
SF												
GP	0	3	13	3	13	3	30	3	0.0	4.3	4.3	10.0
PN	5	6	29.5	6	23	6	47	6	0.8	4.9	3.8	7.8
HD	15	7	38	7	68	7	53	7	2.1	5.4	9.7	7.6
MP												
TOTAL	20	16	80.5	16	104	16	130	16				
AVERAGE/POT	1.3		5.0		6.5		8.1		1.0	4.9	6.0	8.5

Undersize Lobsters

PARTICIPANT	Trial pot Catch	No. of pots	Line average Catch	No. of pots	Pot before Catch	No. of pots	Pot after Catch	No. of pots	Average catch/pot/day Trial Pot	Line Average	Pot Before	Pot After
PA												
ND												
RB												
SF												
GP	0	3	3	3	1	3	5	3	0.0	1.0	0.3	1.7
PN	17	6	42	6	44	6	44	6	2.8	7.0	7.3	7.3
HD	4	7	9	7	9	7	7	7	0.6	1.3	1.3	1.0
MP												
TOTAL	21	16	54	16	54	16	56	16				
AVERAGE/POT	1.3		3.4		3.4		3.5		1.1	3.1	3.0	3.3

	Bait stability % recovered
PA	
ND	
RB	
SF	
GP	10
PN	3
HD	24
MP	
TOTAL	37
AVERAGE	12

6.1.8 BAIT 99/07

This trial was essentially a repeat of trial 99/06. Modifications were made to the attracting bait in the method of enzyme treatment based in part on the findings from trial 99/05. Details are set out below.. It was expected that this bait would be relatively unstable but might have a higher level of attractability. The holding bait was again based on minced fish. A further modification was an increase in the drying temperature.

Formulation

	Bait 99/07H	Bait 99/07A
Ground wheat	450 grams	450 grams
Ground lupinseed	450 grams	450 grams
Wheat gluten	100 grams	100 grams
Betaine	10 grams	10 grams
Minced fish	800 grams (wet weight)	
Enzyme treated fish *		800 grams (wet weight)

* Minced whole sardine reduced to pH 4.6 with Phosphoric Acid and treated with 0.2% protease at 40°C for 24 hours.

Bait produced as approx. 300 gram blocks with a diameter of 100mm.
Drying temperature 140°C.
Baiting Procedure.

Trial pots to be baited with 1 dry holding block in one basket plus one dry attracting block in the other. It was initially planned to use no fish in the trial pot but it was immediately apparent that no lobsters were being caught. It was then decided to add two small sardines or equivalent to the attracting bait basket. No hide or other holding bait used. Standard pots baited with about 2 kg of fish plus either hides or fish heads as holding bait.

Results.

The trial data is reported overleaf.

Comments

a) Acidifying the fish and enzyme treating for a longer period noticeably increased the fluidity of the final product without any noticeable signs of putrefaction.
b) The water stability of the two baits was as predicted and noticeably different from each other.
c) The effectiveness of the trial baits varied between participant. In some instances it was as good as the normal bait (ND and GP) whilst for others it was much inferior (HD). It should be noted that the normal catch rate of size lobsters for HD was much higher than for the other participants. Whether this is of significance with regard to the trial is uncertain.

BAIT 99/07 SUMMARY

Average Catch per Pot

Size Lobsters

PARTICIPANT	Trial pot Catch	No. of pots	Line average Catch	No. of pots	Pot before Catch	No. of pots	Pot after Catch	No. of pots	Average catch/pot/day Trial Pot	Line Average	Pot Before	Pot After
PA	5	7	4	7	21	7	18	7	0.7	0.6	3.0	2.6
ND	25	23	26.5	24	29	24	34	25	1.1	1.1	1.2	1.4
RB												
SF												
GP	12	10	11.5	10	19	10	5	10	1.2	1.2	1.9	0.5
PN	11	11	15	11	11	9	19	11	1.0	1.4	1.2	1.7
HD	1	5	12.5	5	11	5	23	5	0.2	2.5	2.2	4.6
MP	5	6	8.5	6	14	6	7	6	0.8	1.4	2.3	1.2
TOTAL	59	62	78	63	105	61	106	64				
AVERAGE/POT	1.0		1.2		1.7		1.7		0.8	1.4	2.0	2.0

Undersize Lobsters

PARTICIPANT	Trial pot Catch	No. of pots	Line average Catch	No. of pots	Pot before Catch	No. of pots	Pot after Catch	No. of pots	Average catch/pot/day Trial Pot	Line Average	Pot Before	Pot After
PA	7	7			10	7	28	7	1.0		1.4	4.0
ND	47	23	38	24	57	24	48	25	2.0	1.6	2.4	1.9
RB												
SF												
GP	9	10	18.5	10	7	10	13	10	0.9	1.9	0.7	1.3
PN	46	11	43	11	33	9	42	11	4.2	3.9	3.7	3.8
HD	3	5	7.5	5	4	5	10	5	0.6	1.5	0.8	2.0
MP	18	6	30	6	24	6	16	6	3.0	5.0	4.0	2.7
TOTAL	130	62	137	56	135	61	157	64				
AVERAGE/POT	2.1		2.4		2.2		2.5		2.0	2.8	2.2	2.6

	Bait stability % recovered Bait A	Bait H
PA	8	100
ND		79
RB		
SF		
GP	59	100
PN	16	77
HD	45	100
MP		65
TOTAL	128	521
AVERAGE	32	87

6.1.9 BAIT 99/08

A final trial was attempted late in the season but, as can be seen from the results, only two participants were still fishing when the baits were distributed. The format for this trial was as for Trial 99/07. The formulations tested included the addition of limestone to neutralise the acidity of the attracting bait due to the use of Phosphoric Acid.

Researchers note

This trial was conducted concurrently with a trial at Geraldton funded by the Mid- West Development Corporation using similar formulations. This trial is referred to in a separate section (Appendix 6) as the findings are considered to be relevant to this project.

Formulation

	Bait 99/08H	Bait 99/08A
Ground wheat	400 grams	400 grams
Ground lupinseed	250 grams	250 grams
Wheat gluten	150 grams	150 grams
Fine Lime	200 grams	200 grams
Minced fish	600 grams (wet wt.)	200 grams (wet wt.)
Enzyme treated fish *	200 grams (wet wt.)	600 grams (wet wt.)

* Minced whole sardine reduced to pH 4.6 with Phosphoric Acid and treated with 0.2% protease at 40°C for 24 hours.

Bait produced as approx. 300 gram blocks with a diameter of 100mm.

Baiting Procedure.

Trial pots to be baited with 1 dry holding block in one basket and one dry attracting block plus 2 small sardines or equivalent in the other. Standard pots baited with about 2 kg of fish plus either hides or fish heads as holding bait.

Results.

The trial data is reported overleaf.

Comments

a) The addition of the lime did not appear to affect the water stability characteristics of the baits.

b) There is insufficient data to draw any conclusions as to the attractability of the trial baits.

BAIT 99/08 SUMMARY

	Size Lobsters								Average Catch per Pot			
									Average catch/pot/day			
	Trial pot		Line average		Pot before		Pot after		Trial	Line	Pot	Pot
PARTICIPANT	Catch	No. of pots	Catch	No. of pots	Catch	No. of pots	Catch	No. of pots	Pot	Average	Before	After
PA												
ND	2	8	8	8	7	8	10	8	0.3	1.0	0.9	1.3
RB												
SF												
GP	9	8	12.7	10	16	10	11	10	1.1	1.3	1.6	1.1
PN												
HD												
MP												
TOTAL	11	16	20.7	18	23	18	21	18				
AVERAGE/POT	0.7		1.2		1.3		1.2		0.7	1.1	1.2	1.2

	Undersize Lobsters											
									Average catch/pot/day			
	Trial pot		Line average		Pot before		Pot after		Trial	Line	Pot	Pot
PARTICIPANT	Catch	No. of pots	Catch	No. of pots	Catch	No. of pots	Catch	No. of pots	Pot	Average	Before	After
PA												
ND	0	8	0	8	0	8	0	8	0.0	0.0	0.0	0.0
RB												
SF												
GP	10	8	21	10	7	10	13	10	1.3	2.1	0.7	1.3
PN												
HD												
MP												
TOTAL	10	16	21	18	7	18	13	18				
AVERAGE/POT	0.6		1.2		0.4		0.7		0.6	1.1	0.4	0.7

	Bait stability % recovered	
	Bait A	Bait H
PA		
ND		100
RB		
SF		
GP	59	100
PN		
HD		
MP		
TOTAL	59	200
AVERAGE	15	33

6.2 CONCLUSIONS FROM THE 1999/2000 POT TRIALS.

This series of trials was set up to test a number of bait formulations with different water stability and leaching characteristics as well as attractants, in order to determine if any could be used to completely replace the fish and ''hocks and hides'' currently used. The project also required that different sizes and shapes of baits be investigated with regard to their effect on water stability and attractability.

As the data clearly show, none of the dry bait tested consistently performed as well as the traditional bait in terms of the numbers of lobsters caught. This would suggest that the dry baits did not contain a suitable attractant or, if the attractant was present, it was not released from the bait.

A feature of this series of trials was the high degree of variability in both catch rate for trial and control pots and, for the dry baits, in water stability. This variability existed on a day to day basis and between trial participants. It is probable that this is a feature of the industry and is superimposed on the generally recognised 'high catch ' and 'low catch' periods. This variability produces data sets that are very difficult to analyse for anything but gross variations, however there were a number of general conclusions that could be drawn from this series of trials.

a) The method of bait production used throughout this project is suitable for producing baits with sufficient water stability for use under commercial conditions.
b) Very stable baits, suitable as holding baits, can be produced and will last for a number of days in the pot.
c) Baits with a lesser degree of water stability but, by inference, a higher protein leach rate, can also be produced. Baits made to these formulations could be used as a carrier for any specific lobster attractant that may be identified from future research work.
d) When used in conjunction with a small amount of fish, suitably formulated dry baits can perform satisfactorily in most instances. In a minority of cases this approach was not successful and no explanation can be given for this.
e) Based on the test data available there is further development work required, particularly with regard to attractants, before commercially acceptable dry baits can be produced that replace the fish component of the current baiting regime.
f) The use of dry holding baits to replace 'hocks and hides' is a distinct possibility and if, as tested in this project, part of the fish used is also replaced, it is projected that there would be no increase in bait costs.
g) Despite the inclusion of enzyme treated fish in the dry bait to increase the protein leach rate, these baits were shown not to be as attractive as fish. This indicates that the actual attractant in the fish is either altered by the processing of the bait or is not leaching out with the remainder of the soluble protein. Chemical identification of such attractants was outside the scope of this project.

h) There was no indication that Betaine, shown in some work to be a possible attractant for crustacea feeds, had any positive influence on the attractability of lobster baits under commercial fishing conditions.

i) There was no reduction in water stability when the size of the individual baits was increased from 100 grams to 300 grams dry weight when other processing conditions are constant. It is recommended that, for practical considerations a slightly high drying temperature is used for the larger baits to ensure that the residual moisture content is no higher than 8%.

7.0 BENEFITS

Although the project was not successful in producing dry baits that could completely replace the fish currently used, success was achieved in producing baits which were suitable as a partial replacement. The marketing of dry bait as a substitute for the holding bait and at least half the fish currently used by the Western Rock Lobster Industry would have a number of benefits to both the industry and the marine environment.

Even a partial replacement of the fish used would lead to a significant reduction in the amount of frozen, imported fish required. Importation could be more carefully controlled with a ban on importation from geographic areas of known higher disease risk. Although the dry baits would contain fish products, the project demonstrated that the manufacturing process effectively eliminated disease organisms and so any suspect fish could be used for dry bait manufacture.

As dry baits do not require refrigerated storage there would be a reduced demand for freezer space both on shore and on board the fishing vessels. This would be a significant cost saving to the industry.

By using available by-catch and other waste fish products in dry bait manufacture, it is possible that the reduced amount of fish used directly as bait could be sourced locally. This would greatly reduce the possibility of introducing exotic diseases into the local marine environment, a factor that is of concern to both Government and industry bodies particularly following sardine kills along large sections of the southern Australian coastline in recent years.

The initial project application identified the WA Grains and Vegetable Industry as being possible beneficiaries from this project as it could develop a new market for by-products. The flexibility in possible bait formulations demonstrated during the course of the project confirms this, although, due to the relatively small tonnage of bait required per season, this is likely to be a minor benefit.

During the course of the project it was shown that enzyme treated fish was likely to play a major role in any commercial bait produced. This product could be produced from either by-catch or fish waste, eg. from filleting. As much of this is currently considered as a waste product, its use would remove the current cost of disposal and, possibly, add value to the product.

As dry baits do not require any specialised storage and packaging, the reduction in the 900,000 bait cartons used annually as stated in the application, would be achieved. Baits, particularly on board vessel, could be stored in permanent containers thus eliminating the need for any disposable packaging.

A final beneficiary of this project would be any future research body investigating crustacea attractants. Prior to the commencement of this project the major encountered in the production of an artificial bait was one of water stability. This problem was resolved and information is contained with this report as to how a bait can be produced with the required degree of water stability balanced with controlled leaching.

8.0 FURTHER DEVELOPMENT

This project was initiated in an attempt to develop an alternative bait for Western Rock Lobster, the current bait being used consisting of a mix of fish as the attracting bait and 'hocks and hides' or fish heads as the holding bait. The requirements were that the bait should be-

a) Dry, and therefore capable of being stored without refrigeration.

b) Sufficiently water stable to remain in the pot for up to 3 days.

c) Free from pathogens so as not to introduce exotic diseases into the fishery. This is an ongoing potential danger from the use of frozen fish, much of which is imported.

d) Capable of attracting lobsters to the same degree as the fish currently used.

The project was successful in demonstrating how requirements a), b) and c) can be met and details are give in the relevant sections of this report. Less success was achieved in the area of attractability and no dry baits were developed which proved to be as attractive as fish.

Further work is required in the identification of lobster attractants which are effective in commercial fishing operations. The indications from this project are that this would require sophisticated analytical techniques to identify the chemical composition of the individual attractants. The use of enzyme treated fish to produce a mixture of water soluble amino acids and peptides did not produce a satisfactory level of attraction.

It is also recommended that further work is conducted to develop a trial protocol which accurately measures the effectiveness of proposed attractants. In this project the use of captive lobsters provided very little verifiable data (see Appendix 5) and this is the experience of other researchers. It may also be that the use of comparative pot trials, where the trial pots only form a small percentage of the pot line, undervalue the effectiveness of the test baits as suggested in Appendix 6 (Geraldton bait project).

If pot trials are used it may be necessary to bait all the pots in an area with the test bait for an extended period. In this way any effect of an acquired preference for fish is reduced or eliminated. It is important to realise that all the commercial trials reported in this project were conducted using standard pots which cannot be escape-proof. This means that lobsters can, and almost certainly do, enter and leave pots a number of times before they are caught thus, possibly, acquiring a preference for the traditional baits used.

In all sea trials there was a high level of variability in all the parameters recorded for both trial and control pots. This variability occurred between pots in close proximity, on a day to day basis and between participants. In order to obtain the maximum amount of verifiable information from any future bait development trials, this variability need to be investigated and the reasons for it discovered.

9.0 CONCLUSIONS

The project consisted of a number of individual sections and this report is structured in an identical fashion. Conclusions and discussions are included at the end of each individual test and/or at the end of each section. This section will summarise the overall findings of the report.

Water Stability.

It has been consistently demonstrated that a dry, water stable bait can be made from a wide range of ingredients using relatively simple, inexpensive equipment. The small scale production required by the project can be increased to full commercial production using 'off the shelf' equipment. This would enable dry baits to be produced that are cost competitive with the baits currently in use.

Whilst larger scale production may require slight changes to the manufacturing process it is very probable that the finding with regard to drying conditions, size and shape would be valid.

Leaching Rate.

For a bait to be successful it must not only contain a suitable attractant, but this attractant must move from the bait into the surrounding water. As research indicates that the most probable chaemoattractants for lobsters are water soluble, proteinaceous materials, the project concentrated on determining the protein leaching characteristics of a number of different baits. It was concluded that, overall, factors improving the water stability reduced the rate at which protein was leached from the bait. This implies that a commercially viable bait will always be a compromise between attractability and water stability unless a specific compound can be identified that is water soluble and effective at a very low inclusion rate.

From work conducted on both water stability and leaching it appears likely that a dry bait programme would mirror the current bait technique of having an attracting bait with limited water stability and a much more stable holding bait.

The inclusion of fish which had been treated either chemically or enzymatically treated to contain a high proportion of water-soluble protein enable bait to be formulated with varying levels of water stability but other factors such as the use of certain binders and the drying temperature modified this effect.

Disease control.

A major criticism of the use of fish as a lobster bait is the potential for the introduction of exotic diseases into the fishery. Much of the fish currently used is imported frozen and no truly effective quarantine is possible. Bacteriological work conducted on dry baits made as specified section 5.5 of this report, demonstrated that all baits produced were effectively sterile despite very high plate counts for certain of the ingredients used.

Further testing showed little, if any, increase in plate count after storage in normal warehouse conditions for up to 9 months. There was also no detection of spore forming bacteria.

It can be concluded, therefore, that there is little risk of disease transmission through the use of correctly processed dry baits.

Attractability

Despite extensive pot trials used to test developments in water stability and leaching characteristics developed under laboratory conditions, a complete replacement for fish as the major attractant used in the Western Rock Lobster industry was not discovered. The early pot trials during 1996 and 1997 confirmed findings that a dry bait with a satisfactory level of water stability could be produced but in both instances the catch rate was unsatisfactory.

Following these trials, laboratory work concentrated on producing a bait that contained fish processed so as to increase the amount of water soluble protein present. It could be demonstrated that water soluble protein leaches from dry baits and it was anticipated that this leachate would contain the attractant present in the original fish. This approach was adopted as there was no real evidence in the literature of a proven attractant suitable for use in lobster bait .

Pot trials conducted during the 1999/2000 season tested various baits containing enzymatically treated fish and, whilst these were shown to release water soluble proteins into the water, they were ineffective in attracting lobsters when compared to fish. Some success was achieved in replacing the holding baits currently used as well as some of the fish and this could be beneficial to the industry.

It may be possible that the trials protocol used for all pot trials may contribute to the lack of success in formulating an effective dry bait. As reported in Appendix 5, lobsters quickly ‘learn’ to accept or reject certain feeds or additives. It is possible. Therefore, that lobsters on the sea bead have been conditioned to accept fish when presented in pots. The use of an alternative bait in a minority of pots might not be a fair method of appraising their potential effectiveness in a situation where fish is not present as a competitive bait. Also there would need to be a conditioning period allowed for the new baits to reach maximum effectiveness (see section 9 of this report).

Overall it is concluded from this project that further work is required to identify chemicals that are effective as lobster attractants but, once identified, the basic formulations and method of bait production developed by this project would produce a suitable, water stable carrier.

10.0 REFERENCES

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Personal Communication - S. Percival - Ocean baits

APPENDIX 1 - INTELLECTUAL PROPERTY

Under the terms of the FRDC Project 96/337 (section C7), FRDC retains a 72.7% right in the value of the intellectual property generated by this project.

At the start of the project, it was known that the process of mincing and drying appeared to generate water stability in the bait. The process was developed under a previous project (FRDC Project 94/061), and is almost certainly in the public domain.

The process of developing a water stable product using plant proteins is well known.

However, as this project proceeded, it became clear that its success would be dependant on product formulation, possibly in addition to manufacturing refinements. A successful bait will rely on a combination of ingredients plus leaching rate plus rate of breakdown of the bait. And, while the Principal Investigator has proceeded to address the possibilities systematically, the extent or specification of such intellectual property as there may be, has not yet been identified.

The Applicant approached the FRDC in September 1997, to establish whether there were any preferred models for commercialisation of developments of a project such as this one. It appeared that there were not, but that the FRDC would prefer a scheme under which its royalty or licence payments, if any, were to be channelled into an entity or fund which might provide resources for ongoing research.

The ownership of any intellectual property is specified within the contract, and clearly the Parties must both be involved in the decision on to how this property (if any) should be used.

In the Applicant's experience, and if it were possible to identify a combination of process/ingredients which might be successful, then licensing a potential manufacturer, or setting appropriate royalties would, probably be the best objective.

However, if the 'intellectual property' is represented merely by a formulation, it would be very difficult to protect in practice. The use of standard ingredients would probably be detectable in analysis, and modest variations in percentages, or the use of alternative ingredients might be impossible to prevent. Whether application for a patent would be advisable or effective, would be open to debate. This would particularly be so, if the formulation and method could be inferred from the Report published by the FRDC. The situation would be different, however, if the 'intellectual property' to be protected, were to be concerned with a new technology, or a specific modification to process or equipment.

At subsequent meetings with the FRDC it has been determined that all results achieved during work funded by FRDC project 96/337 and its extension (1999/373) be published, made available to any interested parties, and regarded as being “in the public domain”.

APPENDIX 2 - STAFF INVOLVED IN THE PROJECT

M J Hoxey and Associates	Mr M J Hoxey
Western Australia Fishing Industry Council	Mr R Stevens
The Food Centre of Western Australia (Inc)	Dr B J Hoole Ms J Tam Ms C Hughes

APPENDIX 3 - SEA TRIALS

A3.1 WATER STABILITY TRIALS, OCTOBER - NOVEMBER 1996*

Dry baits were tested under commercial conditions to determine if the bait would withstand two days in a lobster pot in the ocean. The first sea trials on the dry baits were inconclusive. The extruded product, produced to simulate a cost effective manufacture, disappeared from the bait savers within 24 hours, making comparison with the control (fish) bait impossible.

A second trial, conducted over four days, with pots pulled three times, demonstrated:

i) That the dry bait would stay in the pots for at least two days

ii) That the control (a prototype dry bait produced privately) generally disappeared within 24 hours

iii) That the control (fish bait) caught significantly greater numbers of lobster than the dry baits tested. However, on numbers caught per kilogram of bait basis the results were more even.

iv) After two days in the water the dry bait appeared to lose its effectiveness.

Introduction

For dry baits to be effective they must last at least as long as fish bait when put in pots in the ocean. Only when this is achieved can the questions of attractants and the cost of production of the baits be addressed.

As a dry bait formula that appeared to be water stable had been produced well before schedule, it was decided to test this bait for durability in sea trials in commercial rock lobster pots.

Methods

Trial 1
One hundred and sixty pots were 'soaked' without bait for one week in the ocean near Lancelin, WA (approximately 120 km north of Perth).

The pots were lifted in two groups of eighty and baited on successive days with 200 grams of

* This report was prepared by the Co-investigator, Mr Richard Stevens of The WA Fishing Industry Council (Inc)

dry bait per pot, in three recipes, with 2 kg of fish (Australian salmon heads *Arripis trutta* and north sea herring, *Clupea harengus*) as a control.

Pots were split into four lines of twenty on each day and set north and south of Lancelin in 10 to 20 metres of water. Gaps of approximately 500 meters were left between pots to ensure no interaction between them. The pots were set at the discretion of the skipper, a commercial fishermen of 20 years experience, in locations designed to maximise the catch of the rock lobster. The trial therefore simulated commercial conditions.

The bait was produced as an 8mm extrusion, dried and allowed to break naturally into variable sized pellets from 1cm to 3 cm long.

The baits were distributed sequentially through the pots, with every fourth pot being a control (fish). The pots were pulled once, at a 2 day interval, and the number of rock lobsters in each pot counted. The condition and quality of the remaining bait was recorded, with samples to be taken for dry weight analysis, and leaching of active ingredient analysis.

Trial 2

Eight pots were soaked, unbaited , for five days, in a location North of Lancelin.

Pots were baited with the most promising formula of dry bait from Trials 1. The bait was formed into approximately 100 gram biscuits and two, five and ten biscuits treatments used in the trial.

A prototype commercial dry bait brick weighed 750 grams in three recipes was used as one control, and 2 kg of fish (as for trial 1) as a second control.

The eighty pots were baited in groups of twenty. The first, second and third pots contained two, five and ten biscuits respectively, with every fourth pot being the dry bait control and every fifth pot the fish control. There were thus four replicates in each line of pots, and the order was reversed in the second and fourth lines. The pots were pulled after two days, re-baited as before, re-set and pulled gain the following day.

The pots with 2 and 5 biscuits were then re-baited, the pots with 10 biscuits were not re-baited. The dry bait controls were double baited, and the fish control re-baited. In all cases (except the fish control) any remaining bait was left in the pot. The pots were pulled again the following day. On each day the number of lobsters caught in each pot was recorded and the amount and condition of remaining bait noted.

Results

The results of the first trials, while dramatic, were inconclusive as no bait was left in 118 of the 120 test pots and less than 10% of the original quantity in the only two pots that contained bait. It was noted that the mesh size in the bait basket was 12mm, so whether the 8mm extrusion was eaten, dissolved or simply lost through the meshes was unknown. Therefore the experiment was repeated using larger, and larger quantities of, baits using the recipe that was the best of the three baits trialed.

The results of the second trial experiment were further analysed by Dr Nick Caputi of the Fisheries Department of WA using the SAS General Linear Models Procedure, for significance. The raw data shows that the control (fish) caught significantly greater number of lobster than any of the trial baits. There was no significant difference between days, position of the pots, or location of the baited pots within the trial.

In terms of number of lobster per kilogram of bait employed there was no significant difference between the trial baits and the control (fish). When the 10 biscuit trial was not re-baited, there was a significant drop in the catch by this treatment. The control dry baits significantly underperformed compared to the trial baits in both number caught, and the numbers per kilogram of bait.

Bait remained in the 2,5 and 10 biscuit trials after both one and two days submersion. Bait remained in all of the pots containing 10 baits when these pots were pulled having been re-set *without* being re-baited the day before.

The control dry baits, pots, however, contained no residue after one or two days in the water, and had residual bait after one day only when double baited.

Conclusion

The results of the first trial were inconclusive.

An extruded product is easier and less costly to manufacture than a pressed one but clearly the extruded plate holes must be of greater diameter than the mesh size of the bait basket.

The results of the second trial showed that even in small quantities (2 x 100g biscuits) the bait would remain in a pot, in the ocean for at least two days and that rock lobster would enter the pot so baited.

In simple numbers of lobster pots, the control (fish) out-caught the dry baits. On a kilo for kilo basis, the dry bait trialed were closer to the effectiveness of fish bait in the control pots.

It should be stressed that the purpose of this trial was not attract lobster but to test the durability of the bait.

A3.2 DRY BAIT TRIAL 1997

Dry baits were tested under commercial conditions to determine if the bait would compete successfully with frozen fish bait. The first sea trials were conducted in four separate locations, with two trial baits, one commercially produced dry bait, with frozen fish bait as a control.

A second trial, conducted over four days with 160 pot pulls, demonstrated

1. That the dry baits would stay in the pots for at least three days
2. That the control (a prototype dry bait produced privately) caught fewer lobster than either of the trial formulations.
3. The control (fish bait) caught significantly greater numbers of lobster than the dry baits tested.

In trials conducted in 1996 dry baits were shown to last at least as long as fish bait when put in pots in the ocean. During 1997 the questions of attractants and the cost of production of the baits were addressed.

Two dry baits, formulated for water stability and attractiveness to lobster in pilot scale laboratory trials were produced. These were tested against fish bait and a commercially available dry bait for durability and 'catchability' in sea trials using commercial rock lobster pots.

Methods

Trial 1

Eight pots were 'soaked' for one week in the ocean near each of the following ports in Western Australia in October/November 1997.

1. Kalbarri (approximately 600km north of Fremantle)
2. Dongara (approximately 400km north of Fremantle)
3. Lancelin ((approximately 120km north of Fremantle)
4. Fremantle

The pots were lifted daily and baited either with 300 grams of dry bait (in one of two recipes), or one brick' of commercial dry bait (approximately 750g), or with 2 kg of fish (Australian Salmon head *Arripis trutta* and North Sea Herring, *Clupea harengus)*

Pots were set in one group of eight on each day, with approximately 500 meters between pots to ensure no interaction between pots. The pots were set at the discretion of the skippers, each a commercial fisherman of over 20 years experience, in locations designed to maximise the catch of the rock lobster. The trial therefore simulated commercial conditions.

The trial baits were produced in a hamburger mould and dried to about 100g. Three of these baits were used in each pot.

The baits were distributed sequentially through the pots, with every third pot containing the commercial bait, and every fourth pot being a control (fish). The pots were pulled daily for between six and eight days, depending on locations, and the number of rock lobster in each pot counted.

Trial 2

Two hundred pots were soaked for five days and set in a location North of Lancelin.

Pots were baited as in trial 1. The prototype commercial dry bait weighing 750 grams was used as one control, and 2kg of fish (as for trial 1) as a second.

The pots were baited in groups of twenty with every first pot the fish control and every second pot being the dry bait control. The pots were pulled after one (120 pots) or (80 pots) days. On each day the number of lobsters caught in each pot was recorded and the amount and condition of remaining bait noted.

Results

The results of the first trials were conclusive. The trial was therefore terminated.

The raw data from the second experiment shows that the control (fish) caught significantly greater number of lobster than any of the trial baits. There was no significant difference between days, position of the pots, or location of the baited pots within the trial.

In terms of number of lobster per kilogram of bait employed there was a smaller difference, but the control (fish) remained significantly better. The control dry baits significantly underperformed compared to the trial baits in both numbers caught, and numbers per kilogram of bait.

Bait remained in the trial pots after one and two and three days submerged. The control dry baits was perfectly preserved, and developed a slimy surface.

Dry bait trial November 1997

5/11/97				
Pot	Fish bait	Bait # 1	Bait # 2	Bait # 3
1	21		1	3
2	2			1
3	2			
4	3			
5	3		3	1
6				1
7	4	1		
8	1		1	
9	5			2
10	1		1	
Sub Total	*42*	*1*	*6*	*8*
11	17		2	1
12	30			
13	12			2
14	10	1	2	
15	9		1	1
16	9		2	1
17	6		2	4
18	2		2	1
19	20			
20	10		1	
Sub Total	*125*	*1*	*12*	*10*
21	11		2	3
22	7		1	2
23	9		1	1
24	6		1	
25	8	2		
26	7			1
27	3			
28	13			1
29	10		1	
30	3			2
Sub Total	*77*	*2*	*6*	*10*
TOTAL	244	4	24	28
Average/Pot	8.1333333	0.133333	0.8	0.933333
Av/Pot/Night	6.1	0.1	0.6	0.7

Dry bait trial November
1997

6/11/97				
Pot	Fish bait	Bait # 1	Bait # 2	Bait # 3
1	1			
2	8		1	
3	16			
4	1			
5	5			
6				
7	2			
8				1
9	2		1	
10	6			
Sub Total	41	0	2	1
11	1			2
12	9			
13	8		1	1
14	2		6	1
15	11	1		
16	19	1		1
17	15			
18	15		2	
19	11			2
20	38			
Sub Total	129	2	9	7
TOTAL	170	2	11	8
Average/Pot	8.5	0.1	0.55	0.4
Av/Pot/Night	4.25	0.05	0.275	0.2

Dry bait trial November 1997
Kalbarri

Date	Fish Bait	Bait # 1	Bait # 2	Bait # 3	
25-Oct	53	2	10	3	
	21	7	31	3	
Sub Total	74	9	41	6	
26-Oct	38	12	13	5	
	46	7	10	4	
Sub Total	84	19	23	9	
27-Oct	40	0	16	12	
	64	5	17	4	
Sub Total	104	5	33	16	
28-Oct	80	7	2	16	
	67	0	16	1	
Sub Total	147	7	18	17	
29-Oct	44	2	8	4	
	46	19	2	7	
Sub Total	90	21	10	11	
30-Oct	66	12	6	10	
	67	2	0	15	
Sub Total	133	14	6	25	
TOTAL	**632**	**75**	**131**	**84**	**Kalbarri**
Average	52.67	6.25	10.92	7.00	
Av/Pot/Night	52.67	6.25	10.92	7.00	

Dongara					
Date	Fish Bait	Bait # 1	Bait # 2	Bait # 3	
25-Oct	34	0	11	11	
	42	8	31	19	
Sub Total	76	8	42	30	
26-Oct	22	3	2	12	
	24	3	16	6	
Sub Total	46	6	18	18	
27-Oct	14	0	10	0	
	13	2	24	7	
Sub Total	27	2	34	7	
28-Oct	41	6	12	5	
	43	0	12	14	
Sub Total	84	6	24	19	
31-Oct	28	4	7	0	
	27	9	6	12	
Sub Total	55	13	13	12	
1-Nov	36	3	13	8	
	31	1	13	5	
Sub Total	67	4	26	13	
2-Nov	38	0	1	7	
	15	9	3	8	
Sub Total	53	9	4	15	
3-Nov	24	0	8	2	
	18	6	13	4	
Sub Total	42	6	21	6	
TOTAL	**355**	**39**	**157**	**99**	**Dongara**
Average	22.19	2.44	9.81	6.19	
Av/Pot/Night	17.75	1.95	7.85	4.95	

Lancelin

Date	Fish Bait	Bait # 1	Bait # 2	Bait # 3	
25-Oct	7	1	0	2	
	7	1	1	0	
Sub Total	14	2	1	2	
26-Oct	11	0	4	2	
	4	1	0	0	
Sub Total	15	1	4	2	
27-Oct	4	0	4	0	
	8	0	7	0	
Sub Total	12	0	11	0	
28-Oct	15	0	0	2	
	18	1	0	0	
Sub Total	33	1	0	2	
29-Oct	23	0	0	0	
	45	0	1	0	
Sub Total	68	0	1	0	
30-Oct	14	1	1	3	
	10	0	0	0	
Sub Total	24	1	1	3	
31-Oct	4	0	3	0	
	5	0	0	4	
Sub Total	9	0	3	4	
TOTAL	**175**	**5**	**21**	**13**	**Lancelin**
Average	12.5	0.36	1.5	0.93	
Av/Pot/Night	12.5	0.25	1.05	0.65	

Fremantle					
Date	Fish Bait	Bait # 1	Bait # 2	Bait # 3	
25-Oct	1	0	0	0	
	5	0	0	0	
Sub Total	6	0	0	0	
26-Oct	3	1	0	3	
	6	0	1	1	
Sub Total	9	1	1	4	
27-Oct	6	0	0	0	
	12	0	0	0	
Sub Total	18	0	0	0	
28-Oct	16	0	0	0	
	5	0	0	0	
Sub Total	21	0	0	0	
29-Oct			0	0	
	7	0	0	0	
Sub Total	7	0	0	0	
30-Oct			0	0	
	2	0	0	0	
Sub Total	2	0	0	0	
31-Oct		0	1	2	
	2	0	0	0	
Sub Total	2	0	1	2	
TOTAL	**65**	**1**	**2**	**6**	**Fremantle**
Average	5.91	0.07	0.14	0.43	
Av/Pot/Night	5.91	0.07	0.14	0.43	

Conclusion

The results of the second trial showed that even in small quantities (3 x 75g biscuits), bait would remain in a pots, in the ocean for at least three days, and that rock lobster would enter the pot so baited.

In simple numbers of lobster pot the control (fish) out-caught the dry baits. On a kilo for kilo basis, the dry baits trialed compared favourably with the fish control pots. However, it should be noted that a dry bait came out well ahead.

It should be stressed that the purpose of this trial was to attract lobster not to test the economics of the bait.

A3.3 SEA TRIALS 1998-1999

During 1996 and 1997, sea trials had been undertaken on a 'one hit' basis, where a number of pots were baited, left for one to three days, harvested and the results recorded. In retrospect, this method gave no opportunity to make changes or to try new formulations.

Through 1997 and 1998 tank and laboratory trials had suggested a number of different formulation, process variations and ingredient modifications. It was necessary to trial some of these under normal, commercial fishing conditions.

It was decided that, instead of the 'one hit' sea trials of previous years, individual pots would be hired for the whole season. This method offered the potential of varying the baits throughout the season, with an on-going comparison with catches in the remaining pots operated by the vessels concerned.

Three pots were secured and used to test the manufactured baits.

When these pot trials were being planned it was anticipated that acidified fish hydrolysate and enzyme treated fish would be used to replace part of the fish content of the baits. It was discovered early in the trial that, even at a low level of substitution, the water stability of the bait blocks was adversely affected to such an extent that little or no bait remained after 24 hours. Further laboratory work was planned to investigate ways of overcoming this problem.

The sea trial continued using a range of baits with the fish waste varying from 20% to 35% of the bait based on the dry matter content and the bait used in conjunction with fish. In all cases 3 x 100g baits were used together with about 1 kg of fish. This is half the normal fish bait used and no holding bait such as hocks and hides were used in the trial pots.

The results obtained are set out below and demonstrate that at all the tested levels of fish waste, inclusions were satisfactory and produced no detectible difference in catch rate. For this reason the results are displayed as one data set. It was concluded from these trials that the test baits were suitable as a partial replacement for the current baiting procedure of using about 2 kg of fish and a holding bait of hocks and hides or a similar product.

Whilst there is no accurate information on the cost of the test baits to the industry it is estimated that the three 100g baits used would cost in the region of $0.90. The value of the fish replaced is about $1.00 and the holding bait about $0.40. This shows that the use of the trial baits would at least be no more expensive that the current baits used.

Whilst this trial was in progress there was pressure on the industry to replace the use of hocks and hides with an effective alternative. This pressure came from European lobster importers fearful that hair, frequently found in the digestive tract lobsters where hocks and hides are used, would be considered as a potential carrier of BSE (mad cow disease). The results reported suggest that the trial baits would make a suitable alternative.

BAIT TRIAL - LANCELIN 1998-1999
Catch per pot of size lobsters

Date	Trial Pot	Line Average	Trial bait remaining
13/12/98	1	5	Nil
14/12/98	1	5	Nil
15/12/98	0	9	20%
16/12/98	1	9.5	30%
17/12/98	0	10	10%
18/12/98	1	7	Nil
19/12/98	1	5	Nil
20/12/98	1	6	Nil
21/12/98	2	7.6	70%
22/12/98	9	9.8	70%
23/12/98	7	11.2	70%
24/12/98	4	8.3	70%
26/12/98	6	11.3	70%
27/12/98	2	6.9	70%
29/12/98	6	8.7	70%
5/1/99	2	2.3	70%
2/02/99	1	1.5	Nil
3/2/99	1	1.5	Nil
4/2/99	1	1.3	Nil
5/2/99	2	1.7	Nil
6/2/99	0	1.4	Nil
7/2/99	1	1.5	Nil
8/2/99	4	1.5	Nil
9/2/99	2	1.2	50%
10/2/99	1	1.3	50%
11/2/99	0	1.5	50%
Total	57	137	
Average	2.2	5.3	

BAIT TRIAL - LANCELIN 1998-1999
Catch per pot of undersize lobsters

Date	Trial Pot	Line Average	Trial bait remaining
13/12/98	3	7	Nil
14/12/98	5	6	Nil
15/12/98	0	5	20%
16/12/98	0	3	30%
17/12/98	2	2	10%
18/12/98	0	0.3	Nil
19/12/98	4	0.3	Nil
20/12/98	6	0.5	Nil
21/12/98	3	1	70%
22/12/98	4	1.5	70%
23/12/98	1	2	70%
24/12/98	3	1.5	70%
26/12/98	3	5	70%
27/12/98	2	4	70%
29/12/98	3	4.5	70%
5/1/99	1	2	70%
2/02/99	2	4	Nil
3/2/99	1	4	Nil
4/2/99	4	4	Nil
5/2/99	2	4	Nil
6/2/99	1	4	Nil
7/2/99	4	4	Nil
8/2/99	2	4	Nil
9/2/99	1	4	50%
10/2/99	0	4	50%
11/2/99	0	5	50%
Total	57	86.6	
Average	2.2	3.3	

The above data relates to pots where 3 blocks with no holding bait (fish heads) and the fish reduce to half level (about 650g).

BAIT TRIAL - DONGARA - 1998-1999
Catch per pot of size lobsters

Date	Pot before	Trial pot	Pot after	Line Avg	Trial bait remaining
24/11/98	0	0	1	0.5	Nil
25/11/98	1	0	0	1.5	Nil
26/11/98	1	0	2	1	Nil

TRIAL - DONGARA - 1998-1999
Catch per pot of size lobsters

Date	Pot before	Trial pot	Pot after	Line Avg	Trial bait remaining
24/11/98	2	0	8	5	Nil
25/11/98	4	0	0	7	Nil
26/11/98	1	0	1	4	Nil

Note. This was the first sea trial using bait containing enzyme treated fish. The baits proved to be instable in water and the trial was abandoned

Catch per pot of size lobsters

Date	Pot before	Trial pot	Pot after	Line Avg	Trial bait remaining
23/12/98	2	2	0	4	No loss
24/12/98	2	2	6	5	50%
26/12/98	0	6	3	5	Nil
27/12/98	0	1	3	1	No loss
29/12/98	2	3	2	3	Nil
30/12/98	1	2	3	1	Nil
31/12/98	1	2	2	3	Nil
24/1/99	1	0	2	0.5	50%
25/1/99	0	0	0	0.2	No Loss
26/1/99	1	1	0	0.25	No loss
4/2/99	5	4	3	4	No loss
7/2/99	4	3	8	3	No loss
9/2/99	3	2	1	2.5	No Loss
11/2/99	0	0	0	6	No Loss
12/2/99	5	5	0	2	No Loss
13/2/99	4	3	1	4	No Loss
14/2/99	3	2	0	2.5	No Loss
15/2/99	9	16	9	9	No Loss
16/2/99	4	3	10	4	No Loss
17/2/99	2	1	0	2	No Loss
18/2/99	8	0	0	2.5	No Loss
19/2/99	1	1	0	1	No Loss
21/2/99	3	2	5	2.5	50%

Catch per pot of undersize lobsters

Date	Pot before	Trial pot	Pot after	Line Avg	Trial bait remaining
23/12/98	20	12	6	15	No loss
24/12/98	20	30	30	20	50%
26/12/98	20	30	20	20	Nil
27/12/98	12	1	9	10	No loss
29/12/98	45	40	40	40	Nil
30/12/98	20	30	31	20	Nil
31/12/98	60	55	60	30	Nil
24/1/99	1	3	3	2	50%
25/1/99	3	2	1	1	No loss
26/1/99	2	2	0	1	No loss
4/2/99	6	6	8	6	No loss
7/2/99	5	4	9	4	No loss
9/2/99	4	5	5	2	No loss
11/2/99	0	0	0	0	No loss
12/2/99	15	15	15	15	No loss
13/2/99	3	0	1	3	No loss
14/2/99	2	1	0	1	No loss
15/2/99	6	1	5	2	No loss
16/2/99	4	1	3	1	No loss
17/2/99	1	0	0	1	No loss
18/2/99	2	0	0	0.5	No loss
19/2/99	2	1	0	1	No loss
21/2/99	1	0	1	0.5	50%

22/2/99	4	0	1	1	50%
23/2/99	0	0	5	1	No Loss
24/2/99	3	4	2	1.5	No Loss
25/2/99	3	0	2	0.5	No Loss
2/3/99	3	5	3	3	No Loss
3/3/99	0	0	0	2	No Loss
4/3/99	11	1	3	3	No Loss
5/3/99	4	0	2	2	No Loss
6/3/99	1	0	2	1	No Loss
7/3/99	7	6	1	2	No Loss
8/3/99	0	0	2	2.5	No Loss
9/3/99	2	0	0	2	No Loss
10/3/99	2	4	4	4.5	No Loss
11/3/99	0	5	3	4	No Loss
12/3/99	2	3	1	2	No Loss
13/3/99	5	2	3	4	No Loss
14/3/99	6	1	3	2.5	No Loss
15/3/99	7	5	5	5	No Loss
16/3/99	3	6	7	4	No Loss
17/3/99	7	15	13	5.5	No Loss
18/3/99	13	5	0	3	No Loss
19/3/99	8	6	4	8	No Loss
20/3/99	2	4	18	6	No Loss
Total	**154**	**133**	**142**	**137.95**	
Average	**3.35**	**2.89**	**3.09**	**3.00**	

22/2/99	1	0	0	0.5	50%
23/2/99	1	1	1	0.5	No loss
24/2/99	0	1	0	0.5	No loss
25/2/99	3	0	5	1	No loss
2/3/99	1	0	1	1	No loss
3/3/99	0	0	0	0	No loss
4/3/99	0	6	0	1	No loss
5/3/99	3	0	2	0.75	No loss
6/3/99	1	0	0	0	No loss
7/3/99	0	1	1	8	No loss
8/3/99	0	0	0	10	No loss
9/3/99	0	0	0	8	No loss
10/3/99	0	1	2	1	No loss
11/3/99	0	2	0	0.5	No loss
12/3/99	1	0	1	0	No loss
13/3/99	1	2	1	1	No loss
14/3/99	0	0	0	0.5	No loss
15/3/99	0	1	0	1	No loss
16/3/99	0	0	0	1	No loss
17/3/99	1	2	1	1	No loss
18/3/99	1	1	0	0	No loss
19/3/99	4	1	4	2	No loss
20/3/99	1	3	10	2	No loss
Total	**273**	**261**	**276**	**237.25**	
Average	**5.93**	**5.67**	**6.00**	**5.16**	

The above data relate to pots where 3 blocks of trial bait, approx 100g each replaces the hocks and hides plus 50%, about 1 kg of fish.

A3.4 DATA SHEETS FOR LOBSTER BAIT TRIALS 1999/2000

DATA SHEET FOR LOBSTER BAIT TRIAL 1999/00

OPERATORS NAME	H D

Date	Date	Bait	Bait	Bait	Bait	Trial Pot Catch		Bait Stability	Line Average		Previous Pot		Next Pot		
Set	Pulled	Code	Quantity	Code	Quantity	Size	Undersize	% Remaining	Size	Undersize	Size	Undersize	Size	Undersize	Depth
5-Dec-99	6-Dec-99	99/01	3 blocks	Fish		0	0	66	11.3	5.3	13	9	13	5	12
6-Dec-99	7-Dec-99					15	6	50	11	5	13	6	26	5	8
7-Dec-99	8-Dec-99					1	0	60	2	3	4	3	2	1	5
8-Dec-99	9-Dec-99					1	1	75	4	4	5	7	6	5	26
9-Dec-99	10-Dec-99					3	1	50	5	4	4	3	7	3	26
10-Dec-99	11-Dec-99					7	5	50	5	7	8	9	5	2	26
11-Dec-99	12-Dec-99					1	1	80	5	9	17	9	2	4	26
12-Dec-99	13-Dec-99					5	7	70	6	12	4	7	12	16	26
13-Dec-99	14-Dec-99					6	9	60	5	10	6	16	5	12	26
TOTAL						39	30		54.3	59.3	74	69	78	53	
AVERAGE						4.3	3.3		6.0	6.6	8.2	7.7	8.7	5.9	
14-Dec-99	15-Dec-99	99/02	2 blocks	Fish		9	5	60	5	8	7	14	4	16	26
15-Dec-99	16-Dec-99					5	5	65	5	7	6	16	5	8	26
16-Dec-99	17-Dec-99					4	7	65	5	9	7	10	10	11	25
17-Dec-99	18-Dec-99					8	15	60	10	15	9	16	16	15	26
19-Dec-99	20-Dec-99					10	15	100	10	14	4	8	11	19	26
20-Dec-99	21-Dec-99					7	11	75	9	14	12	8	18	16	26
21-Dec-99	22-Dec-99					3	12	100	9	12	8	9	15	22	27
22-Dec-99	23-Dec-99					9	19	90	9	15	5	9	13	21	27
23-Dec-99	24-Dec-99					4	8	100	8	12	7	16	9	19	27
24-Dec-99	25-Dec-99					20	29	80	15	25	19	26	11	33	27
26-Dec-99	27-Jan-00					9	18	95	8	18	9	19	5	13	26
27-Dec-99	28-Jan-00					14	18	80	8	17	10	22	9	20	26
28-Dec-99	29-Jan-00					10	17	90	10	19	6	17	13	25	26
29-Dec-99	30-Jan-00					3	12	90	5	17	2	16	3	15	26
30-Dec-99	31-Jan-00					4	13	95	6	14	5	13	8	12	26
31-Dec-99	2-Jan-00					15	19	80	10	20	8	11	12	15	65
2-Jan-00	3-Jan-00					2	18	95	6	20	7	37	5	11	66
3-Jan-00	4-Jan-00					5	32	90	7	35	7	38	7	36	76
4-Jan-00	5-Jan-00					3	42	90	6	40	5	32	9	34	78
5-Jan-00	6-Jan-00					3	42	90	6	41	5	35	9	32	76
6-Jan-00	7-Jan-00					3	36	90	5	35	6	24	8	54	76
7-Jan-00	8-Jan-00					3	0	95	6	1	10	1	4	0	83
8-Jan-00	10-Jan-00					0	0	98	3	1	5	0	2	0	86
10-Jan-00	13-Jan-00					7	4	80	4	4	4	2	5	7	86
13-Jan-00	14-Jan-00					3	1	90	3	2	2	1	4	1	24
15-Jan-00	16-Jan-00					6	3	90	2	8	3	6	5	7	8
16-Jan-00	17-Jan-00					1	5	95	3	5	6	3	3	8	4
17-Jan-00	18-Jan-00					2	2	95	2	3	2	4	2	2	4
TOTAL						172	408		185	431	186	413	225	472	
AVERAGE						6.1	14.6		6.6	15.4	6.6	14.8	8.0	16.9	
22-Jan-00	23-Jan-00	99/03	3 blocks			octopus		80	1	4	2	10	1	8	4
23-Jan-00	24-Jan-00					0	1	50	1	3	3	3	0	2	4
24-Jan-00	25-Jan-00					2	0	50	1	3	0	2	1	3	4
25-Jan-00	26-Jan-00					3	1	50	1.5	3	1	3	2	1	4
26-Jan-00	27-Jan-00					1	4	75	1.5	4	3	3	octopus		3
27-Jan-00	28-Jan-00					octopus		90	1	2	0	2	3	1	3
28-Jan-00	29-Jan-00					1	0	80	1	2	0	2	1	3	3
29-Jan-00	30-Jan-00					2	2	90	1	2	0	0	1	0	4
30-Jan-00	31-Jan-00					0	3	95	1.5	5	1	8	0	7	8
31-Jan-00	1-Feb-00					octopus		100	2	6	3	8	0	3	7
1-Feb-00	2-Feb-00					1	0	80	1	4	1	2	1	4	10
2-Feb-00	3-Feb-00					0	0	100	1	1	0	1	2	1	18
3-Feb-00	4-Feb-00					0	0	95	1.5	3	3	2	6	6	13
4-Feb-00	5-Feb-00					1	4	80	1.5	3	0	2	2	2	5
TOTAL						11	15		17.5	45	17	48	20	41	
AVERAGE						1.0	1.4		1.3	3.2	1.2	3.4	1.5	3.2	
7-Feb-00	8-Feb-00	99/04	1			1	0	100	2	2	0	1	5	3	2
8-Feb-00	9-Feb-00		1			1	0	95	1	1	0	1	1	2	3
9-Feb-00	10-Feb-00		1			3	2	80	3	3	5	3	0	0	3
12-Feb-00	13-Feb-00		2			1	0	90	1.5	2	0	3	1	0	2
13-Feb-00	14-Feb-00		2			1	0	90	1.5	3	0	1	3	2	2
14-Feb-00	15-Feb-00		2			0	0	100	2	2	0	1	1	0	2
15-Feb-00	16-Feb-00		2			2	4	90	1.5	2	0	2	1	1	3
16-Feb-00	17-Feb-00		1			0	1	20	1.8	2	0	0	4	0	2
17-Feb-00	18-Feb-00		2			1	0	20	1.5	1	0	2	1	2	2
18-Feb-00	19-Feb-00		1			3	2	50	2	2	1	0	3	1	4
19-Feb-00	20-Feb-00		0			1	0	50	1.5	1.5	2	1	0	1	3
TOTAL						14	9		19.3	21.5	8	15	20	12	
AVERAGE						1.3	0.8		1.8	2.0	0.7	1.4	1.8	1.1	
20-Feb-00	21-Feb-00	99/05	2	Fish		1	1	50	1.5	1.5	0	1	3	1	3
21-Feb-00	22-Feb-00		2			3	3	40	1.8	1.8	0	3	2	2	5
22-Feb-00	23-Feb-00		2			4	0	50	2	1	3	1	3	0	12
23-Feb-00	24-Feb-00		2			octopus		60	2.5	2	3	5	2	1	6
24-Feb-00	25-Feb-00		2			3	1	40	2	2	2	1	3	3	5
25-Feb-00	26-Feb-00		2			3	0	50	3	2	2	4	2	3	6
26-Feb-00	27-Feb-00		2			8	2	10	3	2	3	2	5	2	3
27-Feb-00	28-Feb-00		1			4	6	20	2	2	2	3	1	6	4
28-Feb-00	29-Feb-00		1			3	1	10	3.5	3	8	2	5	7	3
TOTAL						29	14		21.3	17.3	23	22	26	25	
AVERAGE						3.6	1.8		2.4	1.9	2.6	2.4	2.9	2.8	
31-Mar-00	1-Apr-00	99/06		No fish		0	0	15	2	1	1	1	3	0	28
1-Apr-00	2-Apr-00			No fish		0	0	40	5	1	5	0	1	0	28
2-Apr-00	3-Apr-00			No fish		0	0	30	5	1	13	2	0	0	28
3-Apr-00	5-Apr-00			With fish		6	0	25	5	1	16	0	14	0	28
5-Apr-00	6-Apr-00			With fish		9	4	10	10	2	16	3	18	2	28
6-Apr-00	7-Apr-00			No fish		0	0	20	6	2	11	1	13	2	28
7-Apr-00	8-Apr-00			No fish		0	0	30	5	1	6	2	4	3	28
TOTAL						15	4		38	9	68	9	53	7	
AVERAGE						2.1	0.6		5.4	1.3	9.7	1.3	7.6	1.0	
6-May-00	9-May-00	99/07	2+2	Fish	1	1	3	30	3	2	2	0	15	8	28
9-May-00	12-May-00				1	0	0	60	4	2	6	2	0	0	27
12-May-00	15-May-00				2	0	0	50	3	1	0	0	6	1	28
15-May-00	19-May-00				2	octopus		40	1	1	0	0	2	1	27
19-May-00	23-May-00				2	0	0	40	1	1	2	1	0	0	26
23-May-00	25-May-00				2	0	0	50	0.5	0.5	1	1	0	0	28
TOTAL						1	3		12.5	7.5	11	4	23	10	
AVERAGE						0.2	0.6		2.1	1.3	1.8	0.7	3.8	1.7	

DATA SHEET FOR LOBSTER BAIT TRIAL 1999/00

OPERATORS NAME	N D

Date Set	Date Pulled	Bait Code	Bait Quantity	Bait Code	Bait Quantity	Trial Pot Catch Size	Undersize	Bait Stability %Remaining	Line Average Size	Undersize	Previous Pot Size	Undersize	Next Pot Size	Undersize	Depth
6-Dec-99	7-Dec-99	Blue mac	0.5 kg	99-01	3 blocks	2	2	50	2	6	Trial pot was first pot		2	8	10
7-Dec-99	8-Dec-99		1			3	6	50	4	6	0	6	6	7	8
8-Dec-99	9-Dec-99		1			octopus		50	3.5	7	4	13	3	7	10
9-Dec-99	10-Dec-99		1			4	4	75	5	8	4	3	10	14	25
10-Dec-99	11-Dec-99		1.5			8	9	80	8	4	2	7	5	6	25
11-Dec-99	12-Dec-99		1.5			4	12	80	6	9	4	7	10	7	25
13-Dec-99	14-Dec-99		1.5			2	8	80	8	10	Trial pot was first pot		2	10	25
14-Dec-99	15-Dec-99		1.5			4	7	80	4	7	4	7	8	18	25
15-Dec-99	16-Dec-99		1.5			5	18	80	10	18	15	37	16	26	12
16-Dec-99	17-Dec-99		1.5			2	10	80	11	20	9	27	19	21	12
17-Dec-99	18-Dec-99		1.5			0	7	80	3	13	2	19	43	9	24
18-Dec-99	19-Dec-99		1.5			13	12	80	8	8	4	8	7	8	14
19-Dec-99	20-Dec-99		1.5			17	17	80	10	10	15	8	17	12	12
20-Dec-99	21-Dec-99		1.5			12	18	80	13	17	12	24	14	21	12
21-Dec-99	22-Dec-99		1.5			17	23	10	15	20	12	19	11	19	11
TOTAL						93	153		110.5	163	87	185	173	193	250
AVERAGE						6.6	10.9		7.4	10.9	6.7	14.2	11.5	12.9	
22-Dec-99	23-Dec-99	Fish	2 Kg	99/02		9	13	95	10	13	9	13	2	7	12
23-Dec-99	24-Dec-99	Fish	2 Kg	99/02		3	8	95	8	15	12	10	1	4	12
24-Dec-99	26-Oct-00	Fish	2 Kg	99/02		11	11	95	10	15	12	11	15	9	12
26-Dec-99	27-Dec-99	Fish	2 Kg	99/02		10	23	95	12	15	12	15	Trial pot was last pot		21
27-Dec-99	28-Dec-99	Fish	2 Kg	99/02		10	15	95	10	12	11	12	13	15	21
28-Dec-99	29-Dec-99	Fish	2 Kg	99/02		10	12	95	8	10	6	9	11	14	22
29-Dec-99	30-Dec-99	Fish	2 Kg	99/02		5	11	95	8	10	10	6	17	10	24
30-Dec-99	31-Dec-99	Fish	2 Kg	99/02		1	5	80	8	8	1	5	24	21	24
31-Dec-99	2-Jan-00	Fish	2 Kg	99/02		8	10	90	12	10	17	16	7	9	24
2-Jan-00	3-Jan-00	Fish	2 Kg	99/02		7	9	95	4	8	4	9	9	16	24
3-Jan-00	4-Jan-00	Fish	2 Kg	99/02		9	27	95	6	30	9	34	7	40	72
4-Jan-00	5-Jan-00	Fish	2 Kg	99/02		7	35	95	9	30			9	44	72
5-Jan-00	6-Jan-00	Fish	2 Kg	99/02		8	38	95	9	30	8	32	10	27	78
8-Jan-00	9-Jan-00	Fish	2 Kg	99/02		0	0	95	1	0	5	0	0	0	86
9-Jan-00	11-Jan-00	Fish	2 Kg	99/02		4	3	80	4	3	8	2	4	4	
11-Jan-00	12-Jan-00	Fish	2 Kg	99/02		5	3	95	3	3	2	1	3	3	28
12-Jan-00	13-Jan-00	Fish	2 Kg	99/02		0	0	80	3	2	3	1	12	1	28
13-Jan-00	14-Jan-00	Fish	2 Kg	99/02		0	0	80	3	1	2	3	3	1	28
14-Jan-00	15-Jan-00	Fish	2 Kg	99/02		0	1	80	3	1	4	6	1	1	26
15-Jan-00	16-Jan-00	Fish	2 Kg	99/02		2	1	90	0.5	6	0	1	0	6	28
16-Jan-00	17-Jan-00	Fish	2 Kg	99/02		2	1	95	0.5	6	0	1	0	6	5
17-Jan-00	18-Jan-00	Fish	2 Kg	99/02		2	5	95	1	3	4	4	2	3	5
TOTAL						113	231		133	231	139	191	150	241	
AVERAGE						5.1	10.5		6.0	10.5	6.6	9.1	6.8	11.0	
18-Jan-00	19-Jan-00	Fish		99/03		2	5		1	5	5	5	1	5	6
19-Jan-00	20-Jan-00	Fish		99/03		3	10	20	2	5	6	2	1	3	4
20-Jan-00	21-Jan-00	Fish		99/03		0	2	70	1	2	0	1	0	2	4
21-Jan-00	23-Jan-00	Fish		99/03		1	1	70	1.5	2	0	0	3	0	4
23-Jan-00	24-Jan-00	Fish		99/03		0	0	60	1.5	3	5	2	1	0	4
24-Jan-00	25-Jan-00	Fish		99/03		0	0	60	1	3	1	3	0	0	4
25-Jan-00	26-Jan-00	Fish		99/03		0	0	60	1	3	1	5	0	0	4
26-Jan-00	27-Jan-00	Fish		99/03		1	4	80	0.5	5	1	5	0	1	5
27-Jan-00	28-Jan-00	Fish		99/03		0	1	80	0.5	2	1	2	0	0	6
28-Jan-00	29-Jan-00	Fish		99/03		0	3	80	1	2	0	1	1	3	6
29-Jan-00	30-Jan-00	Fish		99/03		0	7	80	1	2	0	0	1	8	6
30-Jan-00	31-Jan-00	Fish		99/03		0	3	80	1	3	0	4	0	2	6
31-Jan-00	1-Feb-00	Fish		99/03		1	3	80	2	4	octopus		1	0	6
1-Feb-00	2-Feb-00	Fish		99/03		1	1	80	2	3	1	2	0	3	5
2-Feb-00	3-Feb-00	Fish		99/03		0	1	80	2	6	4	1	2	5	5
3-Feb-00	4-Feb-00	Fish		99/03		0	1		1	2	0	1	0	0	6
4-Feb-00	5-Feb-00	Fish		99/03		0	0		1	1.5	1	3	1	3	6
TOTAL						9	42		21	53.5	26	37	12	35	
AVERAGE						0.5	2.5		1.2	3.1	1.6	2.3	0.7	2.1	
5-Feb-00	6-Feb-00	Fish		99/04		1	1		1	4	Trial pot was first pot		0	1	6
6-Feb-00	7-Feb-00			99/04		2	2	90	1	2	0	0	2	3	2
7-Feb-00	8-Feb-00			99/04		4	1	10	2	3	0	2	4	6	2
8-Feb-00	9-Feb-00			99/04		2	1	10	1	2	2	5	1	0	2
9-Feb-00	10-Feb-00			99/04		0	1	15	0.5	2	0	1	0	3	3
10-Feb-00	11-Feb-00			99/04		0	1	20	1	1	2	2	0	0	4
11-Feb-00	12-Feb-00			99/04		2	3	20	1	1	2	2	Trial pot was last pot		3
12-Feb-00	13-Feb-00			99/04		2	1	20	1	1.5	2	4	1	2	4
13-Feb-00	14-Feb-00			99/04		0	7	20	1	1	1	2	0	2	2
14-Feb-00	15-Feb-00			99/04		3	6	20	1.5	3	3	4	0	2	2
15-Feb-00	16-Feb-00			99/04		0	2	20	1	2	0	1	0	2	4
16-Feb-00	17-Feb-00			99/04		3	0	20	2	1	2	1	3	1	4
17-Feb-00	18-Feb-00			99/04		1	0	15	3	2	2	0	0	1	10
18-Feb-00	19-Feb-00			99/04		3	0	20	2	2	3	2	1	1	8
19-Feb-00	20-Feb-00			99/04		3	2	0	1	3	Trial pot was first pot		3	3	13
20-Feb-00	21-Feb-00			99/04		1	0	30	2	2	2	0	Trial pot was last pot		8
21-Feb-00	22-Feb-00			99/04		2	1	30	1	2	2	0	2	0	6
22-Feb-00	23-Feb-00			99/04		2	1	70	2	4	3	7	4	2	6
TOTAL						31	30		25	38.5	26	33	21	29	
AVERAGE						1.7	1.7		1.4	2.1	1.6	2.1	1.3	1.8	
23-Feb-00	24-Feb-00	Fish		99/05		2	3	70	2	2	Trial pot was first pot		0	0	7
24-Feb-00	25-Feb-00			99/05		1	1	80	1	1	0	0	0	0	8
25-Feb-00	26-Feb-00			99/05		4	0	70	3	0	1	0	2	0	14
26-Feb-00	27-Feb-00			99/05		0	0	70	2	0	1	0	0	0	14
27-Feb-00	28-Feb-00			99/05		1	1	70	5	3	7	4	7	3	7
28-Feb-00	29-Feb-00			99/05		3	4	70	3	4	3	2	1	5	8
29-Feb-00	1-Mar-00			99/05		2	0	70	2.5	3	8	2	0	2	8
1-Mar-00	2-Mar-00			99/05		3	2	70	0.5	0	0	1	Trial pot was last pot		8
2-Mar-00	3-Mar-00			99/05		13	2	70	1	0	4	0	7	0	8
3-Mar-00	4-Mar-00			99/05		0	1	70	1	0	0	0	Trial pot was last pot		8
4-Mar-00	5-Mar-00			99/05		7	6	70	2	3	2	0	2	4	12
5-Mar-00	6-Mar-00			99/05		6	3	0	4	2	3	2	4	2	30
TOTAL						42	23		27	18	29	11	23	16	
AVERAGE						3.5	1.9		2.3	1.5	2.6	1.0	2.3	1.6	
6-May-00	7-May-00	Fish	1.5 kg	99/07		0	0	80	2	5	1	3	1	1	13
7-May-00	8-May-00	Fish	1.5 kg	99/07		3	8	70	1	1	2	5	0	0	14
8-May-00	9-May-00	Fish	1.5 kg	99/07		5	5	10	3	4	1	1	2	4	3
9-May-00	10-May-00	Fish	1.5 kg	99/07		1	1	50	1	1	3	1	Trial pot was last pot		4
10-May-00	11-May-00	Fish	1.0 kg	99/07		3	0	50	1	2	2	2	0	1	4
11-May-00	12-May-00	Fish	1.0 kg	99/07		1	1	50	0.5	1	1	0	0	1	4
12-May-00	13-May-00	Fish	1.0 kg	99/07		1	16	50	2	5	2	15	4	17	12
13-May-00	14-May-00	Fish	1.0 kg	99/07		0	3	50	1	1	1	10	1	1	7
14-May-00	15-May-00	Fish	1.0 kg	99/07		0	0	50	1	2	1	2	3	0	5
15-May-00	16-May-00	Fish	1.0 kg	99/07		5	7	100	1	3	1	2	1	0	5
16-May-00	17-May-00	Fish	1.0 kg	99/07		0	0	100	1	1	1	1	0	5	7
17-May-00	18-May-00	Fish	1.0 kg	99/07		0	0	100	0.5	0.5	1	0	0	0	12
18-May-00	20-May-00	Fish	1.0 kg	99/07		0	0	100	0	1	0	1	0	4	6
20-May-00	22-May-00	Fish	1.0 kg	99/07		0	0	100	0	1	0	1	0	0	6
22-May-00	23-May-00	Fish	1.0 kg	99/07		0	2	100	Full line not set				2	1	5
23-May-00	24-May-00	Fish	1.0 kg	99/07		0	1	100	1	1.5	0	0	6	6	4
24-May-00	25-May-00	Fish	1.0 kg	99/07		2	0	100	1	0	0	2	0	0	4
25-May-00	26-May-00	Fish	1.0 kg	99/07		octopus		100	1	1	1	4	1	2	4
26-May-00	27-May-00	Fish	1.0 kg	99/07		0	0	100	1	1	1	2	0	1	4
27-May-00	28-May-00	Fish	1.0 kg	99/07		0	0	100	1	2	1	1	1	0	4
28-May-00	29-May-00	Fish	1.0 kg	99/07		0	0	100	1	1	3	1	1	3	4
29-May-00	30-May-00	Fish	1.0 kg	99/07		1	3	80	1	3	1	3	1	1	4
30-May-00	31-May-00	Fish	1.0 kg	99/07		octopus		80	1.5	0	1	0	0	0	15
1-Jun-00	2-Jun-00	Fish	1.0 kg	99/07		2	0	80	2	0	4	0	10	0	15
2-Jun-00	3-Jun-00	Fish	1.0 kg	99/07		1	0	80	1	0	0	0	0	0	13
TOTAL						25	47		26.5	38	29	57	34	48	
AVERAGE						1.1	2.0		1.1	1.6	1.2	2.4	1.4	1.9	

DATA SHEET FOR LOBSTER BAIT TRIAL 1999/00
1999/00
DATA SHEET FOR LOBSTER BAIT TRIAL
1999/00

OPERATORS NAME	R B

Date	**Date**	**Bait**	**Bait**	**Bait**	**Bait**	**Trial Pot Catch**		**Bait Stability**	**Line Average**			**Previous Pot**		**Next Pot**	
Set	**Pulled**	**Code**	**Quantity**	**Code**	**Quantity**	**Size**	**Undersize**	**% Remaining**	**Size**	**Undersize**	**Size**	**Undersize**	**Size**	**Under size**	**Depth**
5-Dec-99	6-Dec-99	99-01	3 blocks	Fish		5	4	50	3	4	11	4	4	3	11
6-Dec-99	7-Dec-99	99-01				0	3	70	2	5	4	8	3	9	11
7-Dec-99	8-Dec-99	99-01				6	10	0	5	15	4	15	3	41	4
8-Dec-99	9-Dec-99	99-01				3	3	0	4	15	5	10	3	6	4
9-Dec-99	10-Dec-99	99-01				1	3	50	2.5	12	4	6	1	6	4
14-Dec-99	15-Dec-99	99-01				0	1	90	2	5	3	5	1	2	15
15-Dec-99	16-Dec-99	99-01				0	0	100	4	0	10	0	1	0	9
16-Dec-99	17-Dec-99	99-01				0	2	75	5	6	6	6	3	7	11
17-Dec-99	18-Dec-99	99-01				0	2	100	3	7	7	4	2	4	12
19-Dec-99	20-Dec-99	99-01				4	5	80	3	5	0	1	6	1	10
21-Dec-99	22-Dec-99	99-01				6	3	0	5	5	6	5	6	2	11
22-Dec-99	23-Dec-99	99-01				4	0	50	6	5	8	3	7	1	11
23-Dec-99	24-Dec-99	99-01				0	0	40	5	5	11	2	6	2	11
26-Dec-99	27-Dec-99	99-01				2	5	50	3	10	3	11	4	9	12
27-Dec-99	28-Dec-99	99-01				2	3	100	2	2	1	1	2	0	22
TOTAL						33	44		54.5	101	83	81	52	93	
AVERAGE						2.2	2.9		3.6	6.7	5.5	5.4	3.5	6.2	
28-Dec-00	29-Dec-00	99/02	3			3	0	100	3	6	6	3	0	3	14
31-Dec-00	2-Jan-00	99/02	3			5	0	100	3	1	4	1	2	1	26
2-Jan-00	3-Jan-00	99/02	3			1	2	100	2	2	6	3	4	1	26
3-Jan-00	4-Jan-00	99/02	3			6	2	100	6	5	3	4	8	3	26
4-Jan-00	5-Jan-00	99/02				0	0	100	4	3	4	0	6	3	26
TOTAL						15	4		18	17	23	11	20	11	
AVERAGE						3.0	0.8		3.6	3.4	4.6	2.2	4	2.2	
1-Feb-00	2-Feb-00	99/03	3			7	3	0	5	5	0	3	0	3	12
3-Feb-00	4-Feb-00	99/03	3			3	4	10	5	7	10	3	0	2	12
4-Feb-00	5-Feb-00	99/03	3			0	0	0	2	1	2	1	0	1	15
5-Feb-00	6-Feb-00	99/03	3			3	1	50	1	6	4	7	1	3	8
8-Feb-00	9-Feb-00	99/03	3			0	0	100	1	2	0	0	0	1	14
9-Feb-00	11-Feb-00	99/03	3			2	0	0	2.5	2	2	1	5	0	16
11-Feb-00	12-Feb-00	99/03	3			0	2	50	4	6	1	1	10	3	15
12-Feb-00	13-Feb-00	99/03	3			1	5	50	6	6	2	6	3	4	15
TOTAL						16	15		26.5	35	21	22	19	17	
AVERAGE						2.0	1.9		3.3	4.4	2.6	2.8	2.4	2.1	
13-Feb-00	14-Feb-00	99/04	1			10	1	0	6	8	14	8	7	5	15
14-Feb-00	15-Feb-00	99/04	1			3	1	0	6	5	8	1	2	0	11
15-Feb-00	16-Feb-00	99/04	1			3	0	50	4	5	3	7	2	0	14
16-Feb-00	17-Feb-00	99/04	1			3	10	0	5	8	0	0	0	4	15
17-Feb-00	18-Feb-00	99/04	1			0	0	80	0.5	10	0	4	2	8	15
20-Feb-00	21-Feb-00	99/04	1			2	0	100	4	5	1	0	3	0	15
21-Feb-00	22-Feb-00	99/04	1			1	6	80	3	3	4	3	0	2	14
22-Feb-00	23-Feb-00	99/04	1			7	8	0	4	8		5	6	17	14
26-Feb-00	27-Mar-00	99/04	1			2	10	50	1	10		16	0	7	9
27-Feb-00	28-Mar-00	99/04	1			9	6	0	6	8		3	6	2	15
28-Feb-00	29-Mar-00	99/04	1			4	2	50	3	4		3	6	2	9
2-Mar-00	3-Mar-00	99/04	1			0	0	100	1	0		0	1	0	18
3-Mar-00	4-Mar-00	99/04	1			3	0	50	7	4		5	7	3	16
4-Mar-00	5-Mar-00	99/04	1			8	2	50	3	3		3	0	2	22
5-Mar-00	6-Mar-00	99/04	1			4	2	50	5	5		7	3	7	16
TOTAL						59	48		58.5	86	30	65	45	59	
AVERAGE						3.9	3.2		3.9	5.7			3.0	3.9	

DATA SHEET FOR LOBSTER BAIT TRIAL
1999/00

OPERATORS NAME	P A

Date	Date	Bait	Bait	Bait	Bait	Trial Pot Catch		Bait Stability	Line Average		Previous Pot		Next Pot		
Set	Pulled	Code	Quantity	Code	Quantity	Size	Undersize	% Remaining	Size	Undersize	Size	Undersize	Size	Undersize	Depth
12-Dec-99	13-Dec-99	Salmon	0.5 kg	99/01	3 blocks	3	15	0	6.5		8	21	10	12	21
13-Dec-99	14-Dec-99	Salmon	0.5	99/01	3	2	3	60	6.5		12	12	2	3	21
14-Dec-99	15-Dec-99	Salmon	0.5	99/01	3	6	13	0	7.5		11	13	12	8	21
15-Dec-99	16-Dec-99	Salmon	0.5	99/01	3	3	2	20	9		8	15	8	3	20
16-Dec-99	17-Dec-99	Salmon	0.5	99/01	3	0	5	10	8		6	3	14	16	21
17-Dec-99	18-Dec-99	Salmon	0.5	99/01	3	5	9	0	8		1	12	8	6	22
18-Dec-99	19-Dec-99	Salmon	0.5	99/01	3	2	2	0	6		5	3	3	5	23
19-Dec-99	20-Dec-99	Salmon	0.5	99/01	3	2	6	20	2		0	6	3	5	28
20-Dec-99	21-Dec-99	Salmon	0.5	99/01	3	0	3	60	3		3	11	4	8	27
21-Dec-99	22-Dec-99	Salmon	0.5	99/01	3	0	0	10	3		2	2	4	2	27
TOTAL						23	58		59.5		56	98	68	68	
AVERAGE						2.3	5.8		6.0		5.6	9.8	6.8	6.8	
23-Dec-00	24-Dec-00	Salmon	0.5	99/02	2	0	0	95	1		0	4	0	1	23
24-Dec-00	26-Dec-00	Salmon	0.5	99/02	2	10	6	10	6		8	5	9	2	27
26-Dec-00	27-Dec-00	Salmon	0.5	99/02	2	0	2	100	2		1	8	2	5	29
27-Dec-00	28-Dec-00	Salmon	0.5	99/02	2	2	4	100	3		2	1	2	8	23
28-Dec-00	29-Dec-00	Salmon	0.5	99/02	2	0	3	80	2		1	8	1	10	22
29-Dec-00	30-Dec-00	Salmon	0.5	99/02	2	1	1	50	3		2	6	4	0	26
30-Dec-00	31-Dec-00	Salmon	0.5	99/02	2	0	0	100	3		1	26	5	5	32
31-Dec-00	1-Jan-01	Salmon	0.5	99/02	2	2	2	100	3		5	9	4	1	29
1-Jan-01	2-Jan-01	Salmon	0.5	99/02	2	1	2	100	3		1	11	7	9	31
2-Jan-01	3-Jan-01	Salmon	0.5	99/02	2	0	6	90	12		18	60	10	30	76
3-Jan-01	4-Jan-01	Salmon	0.5	99/02	2	1	48	60	6		7	60	8	60	79
4-Jan-01	5-Jan-01	Salmon	0.5	99/02	2	1	30	90	3		4	50	3	50	78
5-Jan-00	7-Jan-00	Salmon	0.5	99/02	2	pot lost			5		6	8	6	1	31
8-Jan-00	10-Jan-00	Salmon	0.5	99/02	2	0	18	75	1		0	12	2	15	27
10-Jan-00	12-Jan-00	Salmon	0.5	99/02	2	0	0	50	1		0	4	2	1	26
TOTAL						18	122		54		56	272	65	198	
AVERAGE						1.3	8.7		3.6		3.7	18.1	4.3	13.2	
3-Feb-00	4-Feb-00	O Roughy		99/03	2	0	0	50	1		0	3	2	7	5
4-Feb-00	5-Feb-00	O Roughy		99/03	2	0	1	50	1		1	0	0	1	5
5-Feb-00	6-Feb-00	O Roughy		99/03	2	0	1	50	0.5		0	2	0	0	17
6-Feb-00	7-Feb-00	O Roughy		99/03	2	2	0	0	0.5		1	0	2	4	8
7-Feb-00	8-Feb-00	O Roughy		99/03	2	0	0	0	1		3	2	0	0	8
8-Feb-00	9-Feb-00	O Roughy		99/03	2	0	2	0	1		1	1	0	2	6
9-Feb-00	10-Feb-00	O Roughy		99/03	2	0	1	0	1		4	1	1	3	4
10-Feb-00	11-Feb-00	O Roughy		99/03	2	1	1	10	1		0	1	1	0	6
11-Feb-00	12-Feb-00	O Roughy		99/03	2	0	0	0	1.5				4	1	7
12-Feb-00	13-Feb-00	O Roughy		99/03	2	4	1	0	1.5		0	3	3	5	7
13-Feb-00	14-Feb-00	O Roughy		99/03	2	0	0	0	1		1	0	0	3	7
14-Feb-00	15-Feb-00	O Roughy		99/03	2	3	3	0	1		0	0	1	0	4
15-Feb-00	16-Feb-00	O Roughy		99/03	2	octopus		0	1.5		1	0	3	0	5
16-Feb-00	17-Feb-00	O Roughy		99/03	2	0	2	0	1		0	1	3	2	6
17-Feb-00	18-Feb-00	O Roughy		99/03	2	0	1	0	0.5		0	3	0	2	6
18-Feb-00	19-Feb-00	O Roughy		99/03	2	2	2	50	2		3	0	0	0	16
TOTAL						12	15		17		15	17	20	30	
AVERAGE						0.8	1		1.1		1.0	1.1	1.3	1.9	
19-Feb-00	20-Feb-00	O Roughy		99/05	2	1	0	80	0.5		0	0	0	0	18
20-Feb-00	21-Feb-00	O Roughy		99/05	2	0	1	80	1		1	0	1	0	18
21-Feb-00	22-Feb-00	O Roughy		99/05	2	3	0	100	2		4	0	3	0	17
22-Feb-00	23-Feb-00	O Roughy		99/05	2	0	0	80	2		1	0	2	0	17
23-Feb-00	24-Feb-00	O Roughy		99/05	2	0	0	80	2		1	0	2	0	17
24-Feb-00	25-Feb-00	O Roughy		99/05	2	1	0	60	1.5		0	2	0	0	17
25-Feb-00	26-Feb-00	O Roughy		99/05	2	2	4	80	1		1	0	0	3	18
26-Feb-00	27-Feb-00	O Roughy		99/05	2	3	0	80	1		6	1	3	0	18
27-Feb-00	28-Feb-00	O Roughy		99/05	2	1	0	80	0.5		1	0	3	1	18
28-Feb-00	29-Feb-00	O Roughy		99/05	2	2	0	40	1.5		0	0	4	1	19
29-Feb-00	1-Mar-00	O Roughy		99/05	2	0	0	20	3		0	0	2	1	21
1-Mar-00	2-Mar-00	O Roughy		99/05	2	2	0	0	7		8	0	0	2	21
TOTAL						15	5		23		23	3	20	8	
AVERAGE						1.3	0.4		1.9		1.9	0.3	1.7	0.7	
6-May-00	7-May-00	O Roughy		99/07		1	0	15			4	1	1	1	8
7-May-00	8-May-00	O Roughy		99/07		0	0	20			1	1	3	2	9
8-May-00	9-May-00	O Roughy		99/07		2	1	20			8	5	4	2	6
9-May-00	10-May-00	O Roughy		99/07		0	3	0			2	1	2	4	8
10-May-00	11-May-00	O Roughy		99/07		0	1	0			3	0	2	6	6
11-May-00	12-May-00	O Roughy		99/07		1	2	0			2	0	4	12	17
12-May-00	13-May-00	O Roughy		99/07		1	0	0			1	2	2	1	7
TOTAL						5	7				21	10	18	28	
AVERAGE						0.8	1.2				3.5	1.7	3.0	4.7	

DATA SHEET FOR LOBSTER BAIT
TRIAL 1999/00

OPERATORS NAME	SF

Date	Date	Bait	Bait	Bait	Bait	Trial Pot Catch		Bait Stability	Line Average		Previous Pot		Next Pot		
Set	Pulled	Code	Quantity	Code	Quantity	Size	Undersize	% Remaining	Size	Undersize	Size	Undersize	Size	Undersize	Depth
9-Dec-99	10-Dec-99	99-01	3 blocks	Fish		2	4	60	5	8	2	7	7	6	7
10-Dec-99	11-Dec-99					5	11	80	9	10	7	12	8	19	10
11-Dec-99	12-Dec-99					1	4	70	3	6	5	12	4	17	10
12-Dec-99	13-Dec-99					2	5	40	5	10	5	19	Trial pot was last pot		10
13-Dec-99	14-Dec-99					5	5	75	5	10	5	16	1	5	5
14-Dec-99	15-Dec-99					0	3	80	3	6	4	4	5	2	5
15-Dec-99	16-Dec-99					1	0	80	3	4	1	1	12	1	16
16-Dec-99	17-Dec-99					6	2	80	4	7	3	2	8	6	16
17-Dec-99	18-Dec-99					not recorded		90	2	4	3	1	0	1	8
18-Dec-99	19-Dec-99					3	0	70	4	4	1	0	1	0	5
19-Dec-99	20-Dec-99					0	3	70	2	10	not recorded		0	1	16
20-Dec-99	21-Dec-99					2	1	80	9	6	8	3	Trial pot was last pot		8
21-Dec-99	22-Dec-99					4	0	60	9	15	not recorded		Trial pot was last pot		8
22-Dec-99	23-Dec-99					octopus		50	6	5	5	8	11	1	8
23-Dec-99	24-Dec-99					7	3		6	10	2	5	7	5	8
TOTAL						38	41		75	115	51	90	64	64	
AVERAGE						2.9	3.2		5.0	7.7	3.9	6.9	5.3	5.3	
24-Dec-99	26-Dec-99	99/02	2	Fish		4	2	70	7	7	7	3	11	3	8
26-Dec-99	27-Dec-99	99/02	2	Fish		8	7	98	13	12	11	12	16	20	16
27-Dec-99	28-Dec-99	99/02	2	Fish		7	4	98	12	9	15	4	14	8	17
28-Dec-99	29-Dec-99	99/02	2	Fish		4	1	98	6	8	16	3	8	7	17
29-Dec-99	30-Dec-99	99/02	2	Fish		3	1	90	5	6	4	5	Trial pot was last pot		26
30-Dec-99	31-Dec-99	99/02	2	Fish		3	2	90	7	10	0	1	4	1	26
31-Dec-99	2-Jan-00	99/02	2	Fish		5	2	50	8	11	14	1	7	5	26
2-Jan-00	3-Jan-00	99/02	2	Fish		3	7	70	7	9	10	9	9	10	26
3-Jan-00	4-Jan-00	99/02	2	Fish		6	2	70	5	10	3	16	1	12	26
4-Jan-00	5-Jan-00	99/02	2	Fish		13	12	70	7.5	16	11	22	8	25	52
5-Jan-00	6-Jan-00	99/02	2	Fish		5	18	80	7.5	20	10	30	4	29	54
6-Jan-00	7-Jan-00	99/02	2	Fish		0	0	95	4	1	11	1	1	1	24
7-Jan-00	8-Jan-00	99/02	2	Fish		1	0	95	3	1	6	0	3	1	27
8-Jan-00	9-Jan-00	99/02	2	Fish		3	3	90	3	2	1	1	3	0	20
9-Jan-00	10-Jan-00	99/02	2	Fish		3	1	90	4	2	1	1	3	1	21
10-Jan-00	12-Jan-00	99/02	2	Fish		1	4	90	4	3	8	4	3	1	24
12-Jan-00	13-Jan-00	99/02	2	Fish		2	15	90	5	15	16	34	3	33	5
13-Jan-00	14-Jan-00	99/02	2	Fish		3	8	95	2	17	2	35	1	22	5
14-Jan-00	15-Jan-00	99/02	2	Fish		0	7	95			1	7	1	16	5
15-Jan-00	16-Jan-00	99/02	2	Fish		1	7	90	3	6	4	12	6	8	5
16-Jan-00	17-Jan-00	99/02	2	Fish		9	7	80	6	6	2	4	5	8	6
17-Jan-00	18-Jan-00	99/02	2	Fish				95			3	4	Trial pot was last pot		5
18-Jan-00	19-Jan-00	99/02	2	Fish		4	2	85	4	6	3	0	Trial pot was last pot		
21-Jan-00	24-Jan-00	99/02	2	Fish		3	1	90			4	5	3	1	4
24-Jan-00	25-Jan-00	99/02	2	Fish		2	5	95			5	2	1	1	4
TOTAL						93	118		123	177	168	216	115	213	
AVERAGE						6.2	7.9		8.2	11.8	11.2	14.4	8.2	15.2	
25-Jan-00	26-Jan-00	99/03	3			0	0	90			5	10	2	7	4
26-Jan-00	27-Jan-00	99/03	3			1	3	35							4
27-Jan-00	29-Jan-00	99/03	3			0	0	20			1	2			2
29-Jan-00	30-Jan-00	99/03	3			0	0	30							3
30-Jan-00	31-Jan-00	99/03	3			0	0	30			3	13			8
31-Jan-00	1-Feb-00	99/03	3			0	0	50			4	5	2	3	10
1-Feb-00	2-Feb-00	99/03	3			5	5	40					0	2	9
2-Feb-00	3-Feb-00	99/03	3			3	1	50							3
3-Feb-00	4-Feb-00	99/03	3			0	1	30			1	1			4
4-Feb-00	5-Feb-00	99/03	3			3	0	30			3	2	2	1	4
5-Feb-00	6-Feb-00	99/03	3			3	2	30			1	1	7	3	4
6-Feb-00	7-Feb-00	99/03	3			0	0	60			2	1	2	1	3
7-Feb-00	8-Feb-00	99/03	3			1	3	0			2	0	1	1	3
8-Feb-00	9-Feb-00	99/03	3			1	3	40			3	3	3	1	5
9-Feb-00	10-Feb-00	99/03	3			2	3	0			2	1	2	3	5
TOTAL						19	21				27	39	21	22	
AVERAGE						1.3	1.4				2.5	3.5	2.3	2.4	

DATA SHEET FOR LOBSTER
BAIT TRIAL 1999/00

OPERATORS NAME	G P

Date	Date	Bait	Bait	Bait	Bait	Trial Pot Catch		Bait Stability	Line Average		Previous Pot		Next Pot		
Set	Pulled	Code	Quantity	Code	Quantity	Size	Undersize	% Remaining	Size	Undersize	Size	Undersize	Size	Undersize	Depth
4-Dec-99	5-Dec-99	99-01	3 blocks	Fish		0	4	100	0.75	5	0	2	0	7	35
5-Dec-99	6-Dec-99	99-01	3	Fish		3	8	0	2.5	9	7	15	2	1	35
6-Dec-99	7-Dec-99	99-01	3	Fish		0	2	100	1	8	1	10	1	3	37
7-Dec-99	8-Dec-99	99-01	3	Fish		1	2	50	5	10	1	2	3	4	48
8-Dec-99	9-Dec-99	99-01	3	Fish		4	8	0	8	20	8	8	5	11	48
9-Dec-99	10-Dec-99	99-01	3	Fish		5	2	50	5	15	5	4	4	2	48
10-Dec-99	11-Dec-99	99-01	3	Fish		5	9	50	4	7	4	2	4	3	50
11-Dec-99	12-Dec-99	99-01	3	Fish		0	0	50	1.5	2.5	2	1	0	0	50
12-Dec-99	13-Dec-99	99-01	3	Fish		2	1	0	5	6	2	1	9	22	48
13-Dec-99	14-Dec-99	99-01	3	Fish		0	1	50	3	8	7	12	3	30	48
14-Dec-99	15-Dec-99	99-01	3	Fish		0	7	25	3	10	2	6	0	1	54
15-Dec-99	16-Dec-99	99-01	3	Fish		3	4	0	5	3	8	1	7	9	54
16-Dec-99	17-Dec-99	99-01	3	Fish		2	4	50	3.5	5	8	8	5	9	53
17-Dec-99	18-Dec-99	99-01	3	Fish		1	4	25	4	5	6	0	4	2	52
18-Dec-99	19-Dec-99	99-01	3	Fish		3	5	0	4	4	1	1	2	0	50
19-Dec-99	20-Dec-99	99-01	3	Fish		0	2	50	3	3	0	0	2	3	51
20-Dec-99	21-Dec-99	99-01	3	Fish		0	2	25	5	10	1	4	11	11	57
21-Dec-99	22-Dec-99	99-01	3	Fish		6	4	25	5	4	7	7	5	6	87
22-Dec-99	23-Dec-99	99-01	3	Fish		2	10	25	3	5	1	4	7	9	114
TOTAL						37	79		71.25	139.5	71	88	74	133	
AVERAGE						1.9	4.2		3.8	7.3	3.7	4.6	3.9	7.0	
23-Dec-99	24-Dec-99	99/02	3			0	0	50	2	4	4	10	4	17	130
24-Dec-99	26-Dec-99	99/02	3			4	18	33	3	6	2	11	5	11	130
26-Sep-99	27-Dec-99	99/02	3			1	3	75	4	10	1	10	1	25	118
27-Dec-99	28-Dec-99	99/02	3			0	4	66	6	10	6	12	3	15	114
28-Dec-99	29-Dec-99	99/02	3			4	21	33	6	20	7	30	7	24	134
29-Dec-99	30-Dec-99	99/02	3			6	35	0	8	30	14	29	10	51	130
30-Dec-99	31-Dec-99	99/02	3			3	12	100	5	40	5	42	4	35	131
31-Dec-99	2-Jan-00	99/02	3			1	2	66	4	10	0	4	7	14	135
2-Jan-00	3-Jan-00	99/02	3			2	10	66	4	30	6	22	3	41	133
3-Jan-00	4-Jan-00	99/02	3			1	26	66	3	20	5	24	2	21	133
4-Jan-00	5-Jan-00	99/02	3			0	8	50	1	6	0	7	0	4	130
5-Jan-00	8-Jan-00	99/02	3			2	27	50	5	10	6	34	13	29	131
8-Jan-00	10-Jan-00	99/02	3			0	35	66	4	40	4	33	4	40	129
10-Jan-00	13-Jan-00	99/02	3			3	10	33	2	10	0	18	1	3	130
13-Jan-00	15-Jan-00	99/02	3			0	0	100	1	8	1	10	2	5	134
15-Jan-00	18-Jan-00	99/02	3			2	1	66	2	3	8	4	2	2	102
18-Jan-00	20-Jan-00	99/02	3			0	0	50	1	1	1	0	0	2	100
TOTAL						29	212		61	258	70	300	68	339	
AVERAGE						1.7	12.5		3.6	15.2	4.1	17.6	4.0	19.9	
20-Jan-00	22-Jan-00	99/03				0	0	50	1	1	0	1	0	0	85
22-Jan-00	28-Jan-00	99/03				0	0	50	1	1	0	0	0	0	70
28-Jan-00	29-Jan-00	99/03				0	2	100	0	3	0	0	0	0	33
29-Jan-00	30-Jan-00	99/03				1	1	100	1	2	0	2	1	1	20
30-Jan-00	31-Jan-00	99/03				1	5	50	1.5	3	2	10	1	7	18
31-Jan-00	1-Feb-00	99/03				0	3	0	1.5	2.5	3	9	2	6	18
1-Feb-00	2-Feb-00	99/03				2	1	0	1	2	2	9	3	5	18
2-Feb-00	3-Feb-00	99/03				0	2	33	1.5	1.5	5	4	1	5	18
3-Feb-00	4-Feb-00	99/03				0	0	0	1.5	2	3	5	0	5	16
4-Feb-00	5-Feb-00	99/03				0	3	50	0.5	1.5	0	1	0	10	15
5-Feb-00	6-Feb-00	99/03				0	0	0	1	2	1	7	0	3	15
6-Feb-00	7-Feb-00	99/03				5	1	100	2	2	3	2	0	1	15
7-Feb-00	8-Feb-00	99/03				1	2	66	1.5	2	0	7	7	8	15
8-Feb-00	9-Feb-00	99/03				0	0	66	1.5	2	1	1	3	3	15
10-Feb-00	11-Feb-00	99/03				0	0	50	0	0	0	0	0	0	164
11-Feb-00	12-Feb-00	99/03				10	2	50	10	1.5	10	3	15	8	115
TOTAL						20	22		26.5	29	30	61	33	62	
AVERAGE						1.3	1.4		1.7	1.8	1.9	3.8	2.1	3.9	
12-Feb-00	13-Feb-00	99/04				5	3	66	2	2.5	7	5	6	5	116
13-Feb-00	14-Feb-00	99/04				3	2	100	3	1	4	5	1	2	116
14-Feb-00	15-Feb-00	99/04				3	1	100	3	2	1	7	1	3	93
15-Feb-00	16-Feb-00	99/04				0	2	100	1.5	1.5	0	0	3	0	97
16-Feb-00	17-Feb-00	99/04				0	0	66	1.5	2	0	2	1	1	92
17-Feb-00	18-Feb-00	99/04				0	1	50	1.5	1.5	1	0	2	3	90
18-Feb-00	19-Feb-00	99/04				0	0	50	1	1.5	1	0	0	0	83
19-Feb-00	21-Feb-00	99/04				0	0	50	0.66	0.5	0	1	0	0	90
TOTAL						11	9		14.16	12.5	14	20	14	14	
AVERAGE						1.4	1.1		1.8	1.6	1.8	2.5	1.8	1.8	

DATA SHEET FOR LOBSTER BAIT TRIAL
1999/00

OPERATORS NAME	P N

Date Set	Date Pulled	Bait Code	Bait Quantity	Bait Code	Bait Quantity	Trial Pot Catch Size	Trial Pot Catch Undersize	Bait Stability % Remaining	Line Average Size	Line Average Undersize	Previous Pot Size	Previous Pot Undersize	Next Pot Size	Next Pot Undersize	Depth
8-Dec-99	9-Dec-99	99/01	3 blocks	Fish		1	3	5	5.5	18		13	3	12	6
9-Dec-99	10-Dec-99					2	2	90	4	16	3	9	6	7	6
10-Dec-99	11-Dec-99					0	2	100	2	2	1	1	0	0	6
11-Dec-99	12-Dec-99					3	7	100	4	12	6	13	12	10	10
12-Dec-99	13-Dec-99					7	7	90	8	10	11	11	5	6	10
13-Dec-99	14-Dec-99					10	8	90	12	16	10	16	18	12	12
14-Dec-99	15-Dec-99					7	8	90	6	8	octopus		10	11	12
15-Dec-99	16-Dec-99					7	10	90	9	11	14	13	9	9	12
16-Dec-99	17-Dec-99					16	13	70	10	13	18	22	3	19	12
17-Dec-99	18-Dec-99					5	5	80	8	13	11	15	2	9	11
18-Dec-99	19-Dec-99					7	9	80	6	18	7	15	6	13	11
19-Dec-99	20-Dec-99					2	2	80	5	12	5	8	0	1	12
20-Dec-99	21-Dec-99					6	6	80	8	10	11	13	3	6	11
21-Dec-99	22-Dec-99					7	3	80	8	10	7	8	1	2	12
22-Dec-99	23-Dec-99					octopus		80	5	4	10	10	7	6	12
TOTAL						80	85		100.5	173	114	167	85	123	
AVERAGE						5.7	5.7		6.7	11.5	8.1	11.9	5.7	8.2	
23-Dec-99	24-Dec-99	99/02	2 blocks	Fish		3	6	80	3	6	1	3	1	3	11
24-Dec-99	25-Dec-99					2	6	80	6	8	7	5	8	3	11
26-Dec-99	27-Dec-99					2	2	80	6	10	0	9	8	9	11
27-Dec-99	28-Dec-99					octopus		80	4.5	6	13	8	octopus		16
28-Dec-99	29-Dec-99					3	2	80	10	8	13	9	octopus		22
29-Dec-99	30-Dec-99					8	10	80	7	10	10	12	7	10	22
30-Dec-99	31-Dec-99					1	7	80	4.5	8	7	6	3	6	21
31-Dec-99	3-Jan-00					10	12	80	8	10	10	8	0	5	23
3-Jan-00	4-Jan-00					0	0	100	0.5	1	0	0	0	0	23
4-Jan-00	6-Jan-00					2	3	80	1.5	3	1	4	2	3	23
6-Jan-00	8-Jan-00					1	4	80	1	6	0	0	2	8	24
TOTAL						32	52		52	76	62	64	31	47	
AVERAGE						3.2	5.2		4.7	6.9	5.6	5.8	3.4	5.2	
12-Feb-00	13-Feb-00	99/04	1 block	Fish		0	1	80	0.75	2	1	0	octopus		6
13-Feb-00	14-Feb-00	99/04	1	Fish		0	0	80	1	3	0	0	0	3	6
14-Feb-00	15-Feb-00	99/04	1	Fish		1	4	70	1	3	1	1	2	3	6
15-Feb-00	16-Feb-00	99/04	1	Fish		5	1	85	2.8	2	5	0	octopus		16
16-Feb-00	17-Feb-00	99/04	1	Fish		0	0	75	2.7	0.5	5	0	octopus		16
17-Feb-00	18-Feb-00	99/04	1	Fish		0	1	80	1	0.5	0	0	0	0	16
18-Feb-00	19-Feb-00	99/04	1	Fish		1	0	80	1	3	0	1	2	1	14
19-Feb-00	20-Feb-00	99/04	1	Fish		4	1	80	2	3	3	1	4	3	14
20-Feb-00	21-Feb-00	99/04	1	Fish		0	0	90	1	2	0	1	1	1	14
21-Feb-00	22-Feb-00	99/04	1	Fish		0	0	90	1	0	0	1	1	0	23
22-Feb-00	23-Feb-00	99/04	1	Fish		0	0	90	4	1	11	4	0	1	24
23-Feb-00	24-Feb-00	99/04	1	Fish		0	1	80	3	1	0	0	0	0	24
24-Feb-00	26-Feb-00	99/04	1	Fish		0	0	70	1	0	0	0	0	0	23
26-Feb-00	27-Feb-00	99/04	1	Fish		0	0	70	4	1	0	1	4	2	24
27-Feb-00	28-Feb-00	99/04	1	Fish		0	0	100	2	1	3	1	Trial pot was last pot		24
28-Feb-00	29-Feb-00	99/04	1	Fish		2	2	70	1	1	0	1	Trial pot was last pot		23
29-Feb-00	1-Mar-00	99/04	1	Fish		2	2	20	3	1	7	3	0	0	24
TOTAL						15	13		32.25	25	36	15	14	14	
AVERAGE						0.9	0.8		1.9	1.5	2.1	0.9	1.3	1.3	
1-Mar-00	2-Mar-00	99/05	1	Fish		0	0	20	1	0	0	0	3	2	24
2-Mar-00	3-Mar-00	99/05	1	Fish		0	2	30	3	1	0	1	0	0	24
3-Mar-00	4-Mar-00	99/05	1	Fish		0	0	60	1	1	0	0	0	0	24
4-Mar-00	5-Mar-00	99/05	1	Fish		0	1	50	1	0.25	0	0	1	1	24
6-Mar-00	7-Mar-00	99/05	1	Fish		1	2	20	3	2	7	2	3	1	23
7-Mar-00	11-Mar-00	99/05	1	Fish		octopus		0	2	1	5	2	0	0	23
14-Mar-00	15-Mar-00	99/05	1	Fish		17	5	50	15	8	octopus		18	8	1
15-Mar-00	16-Mar-00	99/05	1	Fish		17	13	50	18	13	23	14	16	15	2
16-Mar-00	17-Mar-00	99/05	1	Fish		2	6	40	7	4	11	8	7	3	5
17-Mar-00	18-Mar-00	99/05	1	Fish		6	11	0	12	5	13	5	11	3	6
18-Mar-00	19-Mar-00	99/05	1	Fish		7	2	0	8	5	11	2	9	3	6
TOTAL						50	42		71	40.25	70	34	68	36	
AVERAGE						5.0	4.2		6.5	3.7	7.0	3.4	6.2	3.3	
31-Mar-00	1-Apr-00	99/06				3	1	0	4	5	0	7	0	3	
1-Apr-00	2-Apr-00					0	5	0	4.5	7	3	5	9	9	
2-Apr-00	3-Apr-00					1	2	15	4	6	4	7	8	11	
3-Apr-00	4-Apr-00					0	5	5	5	7	3	5	8	5	
4-Apr-00	5-Apr-00					1	3	0	6	8	6	7	8	10	
5-Apr-00	6-Apr-00					0	1	0	6	9	7	13	14	6	
TOTAL						5	17		29.5	42	23	44	47	44	
AVERAGE						0.8	2.8		4.9	7.0	3.8	7.3	7.8	7.3	
6-May-00	7-May-00	99/07 H	1	99/0/A	1	1	6	A 0 / H 50	1.5	4	1	3	5	4	6
7-May-00	8-May-00		0		1	0	6	A 20 / H 70	1	4	2	3	0	3	4.5
8-May-00	9-May-00		0		1	1	5	A 30 / H 80	1	3	1	2	0	4	5
9-May-00	10-May-00		1		1	0	3	A 50 / H 70	1.5	3	0	4	4	3	6
10-May-00	11-May-00		0		1	2	3	A 30 / H 80	1	4	0	5	1	2	5
11-May-00	12-May-00		0		1	1	3	A 40 / H 80	2	4	3	4	1	4	2
12-May-00	13-May-00		0		1	0	7	A 0 / H 90	2	4	1	3	2	6	2
13-May-00	14-May-00		1		1	2	5	A 0 / H 100	1.5	4	Trial pot was first pot		1	3	1
14-May-00	15-May-00		1		1	3	3	A 0 / H 70	1	3	Trial pot was first pot		3	6	0.8
15-May-00	16-May-00		0		1	1	2	A 0 / H 80	1.5	4	1	6	1	3	2
16-May-00	17-May-00		0			0	3	A 0 / H 80	1	6	2	3	1	4	2
TOTAL						11	46		15	43	11	33	19	42	
AVERAGE						1.0	4.2		1.4	3.9	1.2	3.7	1.7	3.8	

DATA SHEET FOR LOBSTER BAIT TRIAL
1999/00

OPERATOR S NAME	M P

Date	Date	Bait	Bait	Bait	Bait	Trial Pot Catch			Bait Stability	Line Average		Previous Pot		Next Pot	
Set	Pulled	Code	Quantity	Code	Quantity	Size	Undersize	% Remaining	Size	Undersize	Size	Undersize	Size	Undersize	Depth
4-Dec-99	5-Dec-99	99/01	3	Fish		0	0	5	4	400	5	10	4	17	13
5-Dec-99	6-Dec-99					3	4	5	5	400	6	8	8	14	12
6-Dec-99	7-Dec-99					1	0	5	5	10	4	3	9	12	12
7-Dec-99	8-Dec-99					0	0	5	3	10	3	6	2	2	12
8-Dec-99	9-Dec-99					7	5	5	6	5	8	4	3	2	24
9-Dec-99	10-Dec-99					3	4	0	5	15	6	8	4	4	24
10-Dec-99	11-Dec-99					3	6	0	4	15	2	1	8	10	24
11-Dec-99	12-Dec-99					6	11	5	5	25	6	7	4	4	24
TOTAL						23	30		37	880	40	47	42	65	
AVERAGE						2.9	3.8		4.6	110.0	5.0	5.9	5.3	8.1	
23-Dec-99	24-Dec-99	99/02	2	Fish		1	4	90	5	10	6	7	4	3	42
24-Dec-99	26-Dec-99		2			0	2	95	4.5	10	4	6	10	12	45
26-Dec-99	27-Dec-99		3			2	7	95	5	20	9	17	4	26	70
27-Dec-99	28-Dec-99		3			0	0	85	6	30	4	11	12	14	71
28-Dec-99	29-Dec-99		4			4	11	90	5.5	15	6	14	8	17	71
29-Dec-99	30-Dec-99		4			3	7	85	6	20	9	21	6	19	71
30-Dec-99	31-Dec-99		4			0	0	70	1	2	0	2	2	4	71
31-Dec-99	2-Jan-00		4			1	3	80	6	25	5	21	9	21	72
TOTAL						11	34		39	132	43	99	55	116	
AVERAGE						1.4	4.3		4.9	16.5	5.4	12.4	6.9	14.5	
26-Jan-00	1-Feb-00	99/03	3	Fish		0	0	5	1.5	3	3	1	0	3	42
1-Feb-00	2-Feb-00					0	1	80	1.5	4	2	7	1	3	14
2-Feb-00	3-Feb-00					2	2	60	2	6	1	5	0	2	15
3-Feb-00	4-Feb-00					1	4	90	2	6	0	1	octopus		15
4-Feb-00	5-Feb-00					3	4	95	1.25	4	1	1	5	4	15
5-Feb-00	6-Feb-00					1	2	90	1	4	0	3	1	0	8
6-Feb-00	7-Feb-00					0	1	90	0.5	3	0	0	2	1	10
7-Feb-00	8-Feb-00					1	1	80	0.5	4	1	0	1	1	8
8-Feb-00	9-Feb-00					4	4	90	0.5	2	2	1	3	0	8
9-Feb-00	10-Feb-00					1	2	60	1	4	1	1	0	0	9
TOTAL						13	21		11.75	40	11	20	13	14	
AVERAGE						1.3	2.1		1.2	4.0	1.1	2.0	1.4	1.6	
11-Feb-00	12-Feb-00	99/04	1	Fish		0	0	85	0.75	3	1	0	0	0	16
12-Feb-00	13-Feb-00		21			groper		80	1	3	0	3	1	1	16
13-Feb-00	14-Feb-00		1			0	1	90	0.5	2	0	2	0	4	15
14-Feb-00	15-Feb-00		1			0	0	80	1	2	0	0	1	0	12
15-Feb-00	16-Feb-00		1			0	2	80	0.5	2	1	1	3	2	9
16-Feb-00	17-Feb-00		1			0	0	80	1	4	0	0	1	4	9
17-Feb-00	18-Feb-00		2			1	2	80	1	4	1	4	0	0	8
TOTAL						1	5		5.75	20	3	10	6	11	
AVERAGE						0.2	0.8		0.8	2.9	0.4	1.4	0.9	1.6	
2-Mar-00	3-Mar-00	99/05	1	Fish		0	1	60	5	1	4	0	8	1	18
3-Mar-00	4-Mar-00					1	0	60	4	1	3	1	6	0	18
4-Mar-00	5-Mar-00					0	0	60	5	1	7	1	4	0	18
5-Mar-00	6-Mar-00					1	2	60	10	2	12	1	23	4	18
6-Mar-00	7-Mar-00					0	0	50	5.5	2	3	1	5	0	19
7-Mar-00	8-Mar-00					1	0	50	3	1	3	0	4	0	19
8-Mar-00	9-Mar-00					0	0	50	0.5	0	0	0	0	0	23
TOTAL						3	3		33	8	32	4	50	5	
AVERAGE						0.4	0.4		4.7	1.1	4.6	0.6	7.1	0.7	
19-May-00	20-May-00	99/07	1+1			1	3	H 90	1.5	5	3	6	1	0	5
20-May-00	21-May-00					3	8	H 70	2	6	2	3	1	3	5
21-May-00	22-May-00					0	0	H 60	2	6	4	1	1	2	4
22-May-00	23-May-00					1	7	H 50	1	5	1	8	2	7	5
23-May-00	24-May-00					0	0	H 50	1	4	2	3	1	2	5
24-May-00	25-May-00					0	0	H 70	1	4	2	3	1	2	8
TOTAL						5	18		8.5	30	14	24	7	16	
AVERAGE						0.8	3.0		1.4	5.0	2.3	4.0	1.2	2.7	

APPENDIX 4 - TRIALS IN SOUTH AUSTRALIA, TASMANIA AND DONGARA.

A4.1 SOUTH AUSTRALIA TRIAL

The trial was conducted during 1997.

Due to local contacts a request for small quantities of trial baits was received from fishermen in South Australia. Arrangements were made to conduct a small trial with a commercial fisherman comparing normally baited pots with a small number of pots baited with an artificial bait as a partial replacement for fish.

Normally baited pots contain 1.5 to 2 kg of salmon plus any other fish that is available up to a total of an additional 1 kg. Each pot contains two bait containers which are normally full. The trial pots were baited with 0.5 kg of fish in one container and 3 bait blocks of approx. 100 grams each in the other container. The trial baits consisted of 40% sardine waste, 30% lupins and 30% wheat (on a dry matter basis). They were manufactured using the standard process of forming a semi-moist, pasta type, product using the mincer; pressing into blocks with a hand operated hamburger press and then drying to a final moisture content of less than 10%

The pots were set mid-after noon and pulled the next day at mid-morning as is the standard for this area. Re-baiting of the trial pot consisted of adding the fish and the three bait blocks even though some artificial baits remained for 3 days.

The trial was conducted over 2 x 3 day periods plus one of 2 days using an increased number of pots.

The results of the trial are set out overleaf.

CRAY BAIT TRIAL IN SOUTH AUSTRALIA

	Fish only			Fish plus Bait			
	No. of Pots	Total Crays	Av. Crays/Pot	No. of Pots	Total Crays	Av. Crays/Pot	Increase Crays/Pot
Day 1	43	30	0.70	2	2	1.00	0.30
Day 2	43	28	0.65	2	7	3.50	2.85
Day3	43	67	1.56	2	4	2.00	0.44
Day 1	43	47	1.09	2	3	1.50	0.41
Day 2	43	75	1.74	2	7	3.50	1.76
Day3	44	59	1.34	1	3	3.00	1.66
Day 1	40	65	1.63	5	6	1.20	-0.43
Day 2	40	66	1.65	5	14	2.80	1.15
Total	339	437	1.29	21	46	2.19	0.90

The data show that there was an improvement in catch rate for the pots containing the dry bait for 7 of the eight trial days. Whilst no statistical analysis has been carried out due to the small sample size, it is probable that the difference is real. The average increase of 0.9 lobsters per pot per day represents an increase of almost 70% compared with the normal fish bait.

Comments from the fishermen, which are give some credence by the data, were that the baits appeared to be more attractive after the first day and that they performed relatively better on poor fishing days.

The improvement in the performance of the dry baits as compared to trials in Western Australia is not fully understood but may be due to the fact that no holding bait such as 'hocks and hides' is used in South Australia. There is usually no fish remaining when the pots are pulled and so many lobsters may escape. It is also possible that the difference in the species may be a contributing factor.

In retrospect, following the results of other trials and experience with tank tests, there is evidence that lobsters may become accustomed to the normal baits used in an area. This concept is discussed in the Conclusions section of this report. This may be an alternative explanation for the lower catch in the trial pot for the first day of each trial period.

A4.2 TASMANIAN TRIAL

In mid-1998 a window of opportunity opened to conduct a trial with the co-operation of the Marine Research Laboratories in Tasmania. It was decided to test the emerging evidence that proteins from acid hydrolysed trash fish was likely to leach out of dry bait faster than the non-hydrolysed material previously used. The baits made for this trial had the following composition on a dry matter basis.

Fish meal	10%
*Hydrolysed fish Waste	30%
Lupins	30%
Wheat	30%

*The fish waste was hydrolysed using Hydrochloric Acid.

The protocol for this trial followed the standard used by the Marine Research Labs. where non-escape pots are used, baited and set one day and pulled the next. The standard bait used per pot is a couta head plus two mackerel. For the first week of the trial 3 dry baits of approx. 100 grams each were used as the sole bait present. For the second trial week one mackerel was added to the three dry baits. In all pots the baits were replenished each day.

The Tasmanian Aquaculture and Fisheries Institute provided the following summary of this trial.

"The rock lobster section of the Tasmanian Aquaculture and Fisheries Institute (TAFI) conducts the FR&DC funded project "Assessment of broad scale exploitation rates and biomass estimates for the Tasmanian southern rock lobster fishery". The field component of this project involves sampling the southern rock lobster (*Jasus edwardsii*) from the TAFI vessel "FRV Challenger" at sites representative of the commercial fishery using steel framed, meshed lobster traps. The traps are baited with barracouta (*Thyrsites atun*) heads and whole jack mackerel (*Trachurus declivis*). Sampling is conducted prior to the opening of the commercial season (November), prior to the closure of the female season (March) and just prior to the closure of the male season (July).

During the July 1998 sampling of East coast sites, extra traps were deployed to enable a comparison of traditional baited traps with bait patties.

Methods and results

Bait trials were conducted at a total of five sites on the East coast of Tasmania (figure 1). The first trial consisted of sixty traps set three times. For each set, ten traps were baited with three bait patties in a black plastic bait saver (P1) and fifty traps were baited with traditional bait (T1), (one barracouta head in one bait saver and two jack mackerel in another bait saver). The second trial consisted of sixty traps set four times. For each set, ten traps were baited with three bait patties in one bait saver and one jack mackerel in another bait saver (P2); and fifty traps were baited with traditional bait (T2). All sets were over night and on any occasion the traps were re-set on the same day as being hauled, any remaining bait patty material was left in the bait savers and three new bait patties were added. The ten bait trial traps were distributed randomly throughout the fifty traditionally baited traps.

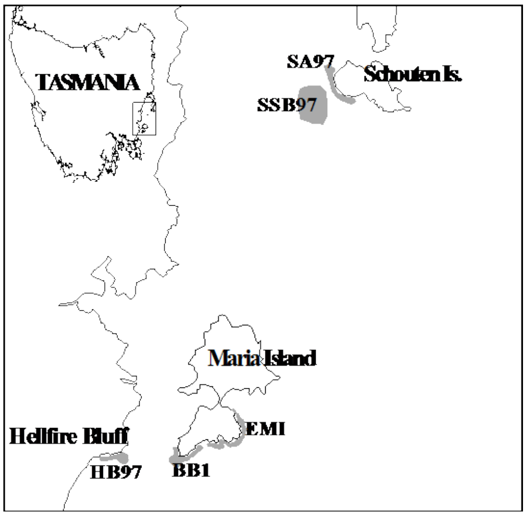


Figure1: Map showing sites sampled on the East coast of Tasmania

For each set the date, time, location and sea conditions were recorded. For each trap the location (latitude and longitude), depth and bait type was recorded. On hauling, the sex and number of legal-sized (greater than 105mm carapace length for females and 110mm for males) and under-sized southern rock lobsters were recorded for each trap. On hauling each patty baited trap, the number of intact patties and the quantity of patty mush was recorded. On hauling the second trial, the condition of the jack mackerel bait was also recorded.

Table 1: Table of lobster trap sets and site codes.

Set Number	1	2	3	1	2	3	4
Bait Type	P1,T1	P1,T1	P1,T1	P2,T2	P2,T2	P2,T2	P2,T2
Site Code	SSB97	SA97	EMI	SSB97	SSB97	BB1	HB97

P1 = Patty bait trial 1 P2 = Patty bait trial 2
T1 = Traditional bait trial 1 T2 = Traditional bait trial 2

Table 2: Table showing the mean number of sized and undersized *J. edwardsii* per pot in trial 1.

Bait Type	Mean U/size	Mean legal size
P1	0.167	0.033
T1	4.798	0.503

Table 3: Table showing the mean number of sized and undersized *J. edwardsii* per pot in trial 2.

Bait Type	Mean U/size	Mean legal size
P2	5.65	0.275
T2	12.071	0.844

Kruskal-Wallis tests of rank sums were performed to establish the statistical significance of the difference between the numbers of lobsters caught in the traditionally baited pots and in the patty baited pots. Tests on both trials 1 and 2 demonstrated that the observed distributions would be unlikely to result from random error (P1<0.001; P2<0.05), indicating that there was an effect of bait type on total catch rate.

Figure 2: Graph showing the mean number of sized *J. edwardsii* per trap (error bars are standard error).

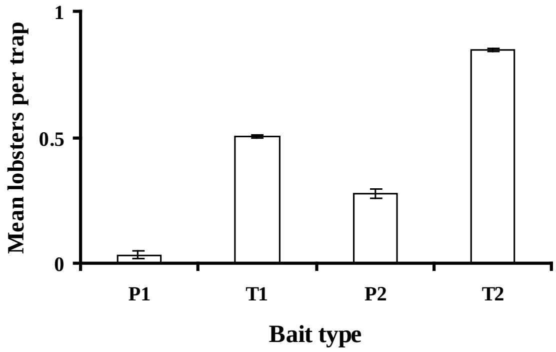
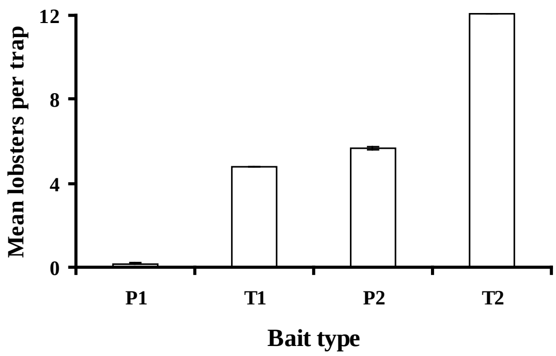


Figure 3: Graph showing the mean number of under-sized *J. edwardsii* per trap (error bars are standard error).



Discussion

The results suggest that bait patties are less effective at attracting and detaining rock lobsters than traditional baits (using steel meshed traps on the East coast of Tasmania). They also suggest that the efficacy of the bait patties are increased if used in conjunction with traditional bait, but that catch rates would still be lower than traditionally baited traps.

Qualitative analysis would suggest that the bait patties do not effect the number or composition of by-catch species. Periodically, sea lice are present in large concentrations at the sites sampled. The lice are particularly destructive of traditional baits. Sea lice were not present in large enough concentrations to allow a comparative analysis of their effects on the two bait types"

Conclusions and Explanations.

Even from the raw data it is evident that the dry baits were not performing to expectations, particularly when used as the sole bait. This work was conducted early in the programme to determine the value of hydrolysing fish and preceded any attractability trials conducted in the tank. From observations reported in the Appendix 5 (Tank Trials), it would seem that a probable reason for the poor catch rate using the dry bait was that the waste fish was hydrolysed using Hydrochloric acid which was shown to have the poorest attractability as compared to other acids used.

A4.3 DONGARA TRIAL

Following the success of the South Australian trial arrangements were made to conduct a similar small trial in the Northern section of the Western Australian fishery. In this trial the dry bait would replace the holding bait of 'hocks and hides' for the first week and then the holding bait plus 50% of the fish normally used.

During the first week the pots were baited with about 2 kg of fish in one bait container and 3 dry baits in the other. During the second week the amount of fish used was reduced to about 1 kg and the dry bait remained the same.

The trial also tested three formulation of dry bait with the following formulations:

	Bait C	Bait A	Bait S
Minced fish	40%	30%	30%
Lupins	30%	30%	30%
Wheat	30%	30%	30%
Abalone Waste		10%	
Shrimp Waste			10%

The results of this trial are set out below.

BAIT TRIAL BY J P.

	FISH + HIDE '70 Pots		FISH + BAIT 'A' 3 Pots		FISH + BAIT 'C' 3 Pots		FISH + BAIT 'S' 3 Pots	
DATE	SIZE	UNDERSIZE	SIZE	UNDERSIZE	SIZE	UNDERSIZE	SIZE	UNDERSIZE
28/02/98	90	177	2	1	4	3	3	2
1/03/98	70	192	2	1	0	5	1	3
2/03/98	103	234	2	4	11	6	4	6
3/03/98	108	219	0	1	1	4	3	10
4/03/98	104	211	2	1	1	0	2	3
5/03/98	155	272	3	4	1	5	3	6
6/03/98	135	248	1	1	2	2	2	1
Sub Total	765	1553	12	13	20	25	18	31
Av/Pot/Wk	10.9	22.2	4.0	4.3	6.7	8.3	6.0	10.3
% of Control			37%	19%	62%	37%	56%	46%

			HALF BAIT		HALF BAIT		HALF BAIT	
7/03/98	99	122	0	0	3	1	4	3
8/03/98	125	198	2	0	1	1	1	0
9/03/98	177	176	6	1	3	1	6	8
10/03/98	167	285	3	7	1	0	6	8
11/03/98	99	273	1	5	1	0	1	0
12/03/98	160	390	8	19	6	23	7	12
13/03/98	137	440	2	19	2	12	3	15
Sub Total	964	1884	22	51	17	38	28	46
Av/Pot/Wk	13.8	26.9	7.3	17.0	5.7	12.7	9.3	15.3
% of Control			53%	63%	41%	47%	67%	57%

Combined								
Av/Pot/Wk	12.4	24.6	5.7	10.7	6.2	10.5	7.7	12.8
% of Control			46%	44%	50%	43%	62%	52%

The results of this trial were disappointing when compared to the South Australian data and a possible explanation of this may lie in a comment from the fishermen that "The bait breaks down far too easily and is gone in 1 to 2 days". These pots were placed in very rough conditions which was certainly a factor although no idea was obtained as to the possible level of predation. In trials to date this was the only one where the water stability of the dry bait had been questioned. Subsequent investigations suggested that the high level of wet fish/abalone waste/shrimp waste increased the moisture content of the bait prior to drying. This was shown to cause fissuring on drying which increases the rate of breakdown of the bait.

Whilst no statistical analysis has been conducted due to the small sample size and the variability of the data, the results suggest the following:

a) Dry baits with limited water stability do not adequately replace the 'hocks and hides' traditionally used in the conditions under which the pots were placed.
b) The dry baits do not show an inferior performance where only half the normal fish level is used.
c) The inclusion of abalone waste, traditionally considered as a very good lobster bait, did not improve dry bait performance.
d) There is a slight suggestion that the use of shrimp waste in the dry bait may improve performance.

APPENDIX 5 - TANK TRIALS

As a result of the data obtained from the water stability testing, particularly from the first sea trial in October/November 1996 it became apparent that the major hurdle to overcome in the development of a dry bait was one of attractability. A review of the literature produced a number of papers suggesting compounds which were considered as attractants for various species of crustacea although none relating directly to the Western Rock Lobster.

Following closer scrutiny of the published papers it was concluded that few, if any. of the so called attractants were consistent in their effect. A decision was made to investigate this important area by installing a small number of lobsters in a tank and assessing the effect of a range of attractants. Although this was not part of the original project it was considered that the required information could not be obtained solely from the projected sea trials.

A black rectangular tank, 3m by 1.8m, with a continuous flow of filtered sea-water was installed at the TAFE Fremantle premises.The tank was fitted with a 4 part sectional lid so that the animals could be kept in darkness when required to mimic natural feeding periods. Some short lengths of 6 inch diameter plastic pipe was placed in the tank to act as 'hides'. 6 lobsters, the survivors from a batch of 10 wild caught animals, that had been pre-conditioned in two other tanks, were put in the experimental tank and allowed to settle in for a period of time.

From a general management perspective it was found that animals under the conditions required feeding once or twice per week. They would feed under relatively low light conditions at any time of day when feed was offered. Attempts to feed more frequently were met with mixed response, an important observation with respect to the conducting of attractability trials.

Once the system had settled down a series of tests using fresh fish, in this case sardines were conducted to establish a base line for assessing the attractability of other test substances or baits. From the results obtained it was concluded that -

a) Unfed lobsters could detect the presence of a fresh, dead fish within seconds of it being placed in the far end of the tank from the test animals. This was deduced from the movement of their antennae which they pointed towards the bait.
b) Most animals would move immediately to the bait but this response was not consistent.
c) On moving the bait to a different position a similar response pattern was observed in general but it was slower and with a greater degree of variability.
d) Subsequent bait moves without allowing the animals to feed reduced the observed response until all animals eventually lost interest.

The above observations indicate that any response to an attractant can be modified or eliminated by repeated exposure to the stimulus without allowing the animals to feed. This observation was confirmed many times when conducting the tank trials and meant that all information from these tests would have to be of an observational nature rather than by the collection of verifiable, firm data.

In the literature, many of the suggested attractants are lipids, in particular fish oil. A series of tests were conducted to confirm or otherwise these observations. They consisted of (a) soaking plastic sponges in cod liver oil, sardine oil or a general mixed fish oil used locally; (b) adding 20% fish oil to baits made from a mix of lupins and wheat, ie no animal protein present; or (c) coating a bait as used in the sea trial of 1996 with fish oil.

In all situations the addition of these baits to the tank of unfed lobsters elicited no response from any of the animals present. It was concluded that lobsters were not attracted to fish oils and it was unlikely that the oil present in the fresh fish was the attractant.

Also in the literature are listed as attractants a number of nitrogenous compounds, mainly amino-acids, soluble peptides etc as well as some more exotic chemicals. From a commercial perspective a number of these compounds, even if they are found to be effective in a bait, would prove to be too expensive to use. For this reason only a limited range of compounds were tested.

The amino-acids lysine and methionine are commonly used in both stockfeed and aquaculture feeds. These were tested individually and in combination by adding to dry baits based on wheat/lupins/fish with no obvious results. As a result of some work being conducted in parallel to these tank trials, there was some doubt as to whether these compounds were leaching from the baits and so not being capable of detection. Further tests were conducted by adsorbing the amino-acids onto plastic sponges, putting them into bait envelopes and placing then in the tank. No response to either amino-acid was obtained. It was concluded that these amino-acids were not attractants for lobster.

One other test conducted that produced a definite negative result occurred when fish was allowed to partially putrify prior to testing. This brief test was conducted as some lobster fisherman believe that, as lobsters are scavengers, they prefer feed that is not fresh. It can be assumed that the reason for rejection in this case was due to the presence of ammonia. There are some references in the literature to support this.

Whilst the work reported above led to definite conclusions, the remainder of the tests conducted required a more subjective assessments of the results obtained.

As this work continued it became apparent that, whilst fresh fish was highly attractive, the same fish incorporated into a dry bait was much less effective. This observation was confirmed by both the 1996 and the 1997 sea trials using baits containing 40% fish on a dry matter basis. This meant that either the attractant was modified by drying or it was not being leached from the bait.

In a attempt to answer the first question trials were conducted using fresh sardines, deep frozen sardines and oven dried Sardines. The latter being fresh fish dried whole in the oven overnight at 95 deg. Celsius. As previously noted, fresh fish was detected almost immediately on placing in the tank. Frozen fish taken from the freezer and immediately placed in the tank was also detected virtually immediately. The dried fish produced a slightly slower response but this was consistent. The conclusion drawn was that the attractive agent present in fresh fish was not destroyed by heating. It was also hypothesised that the substance(s), based on the very rapid response obtained, are water soluble and so can move rapidly from the bait to the lobsters. It would also appear that these are on or close to the skin of the fish hence the ability of deep frozen fish to still attract lobsters.

The remaining work conducted in the tank was in conjunction with the trials investigating leaching characteristics of various baits. Details of this work are in section 5.3 of this report but in summary it can be stated that proteins are normally not leached from dry baits to any significant extent but that water soluble products are. The possibility of processing fish protein to increase the percentage of water soluble compounds such as peptides or individual amino-acids was investigated and at each stage the attractability of such products were tested.

In all instances the individual fish hydrolysates were absorbed into a plastic sponge, placed in a bait envelope and put into the tank. Up to 4 hydrolysates were tested at any one time with records kept as to which baits the animals were attracted to. Experience showed that the initial response was of importance as no feed was actually available and so the lobster would loose interest and move to another bait or even a sponge with no attractant that was put is as a negative control. The observations as a results of the various method of the acid hydrolysis of wet fish waste as regards attractability were as follows.

Hydrolysate using Hydrochloric acid at pH 2 or 4 was poorly accepted.

Hydrolysate using Phosphoric acid at pH 2 or 4 was well accepted.

Hydrolysate using Lactic acid at pH 4 was reasonably accepted.

At this point the number of lobsters surviving was reduced to three. Also the animals were very conditioned to the feeding regime and some doubt was placed on any information relating to preference of products offered. The tank trials were terminated at this point to be replaced with continuous sea trials as reported in section 6 of this report.

Conclusions and Recommendations.

Overall the data obtained from the tank trials was disappointing particularly with regard to reproducability. It was found that the captive lobsters became conditioned to various stimuli including movement, water disturbance, lack of ability to reach feed etc. and when attempting to conduct attractability trials the effect, if any, of the potential attractant was masked or nullified. This finding is in line with other researchers (pers. comm.)when using both simple and more complex tank systems.

It was found that when the captive lobsters were not being subjected to attractability trials they would accept a wide range of dry, pelleted feeds as well as fish. Acceptance of these feeds, however, does not mean that they contain any potential attractants. Researchers in chemoattraction emphasis the point that “Simply put, detection does not equal attraction” (Lee P G and Meyers S P 1996).

Based on experience gained from this project, it is strongly recommended any future work investigating the identification of attractants for crustacea should include alternatives to working with captive animals in tanks.

APPENDIX 6 - GERALDTON BAIT PROJECT

In this project, funded by the Mid-west Development Authority, five pots from a line of about 50 were baited with dry baits only and the catch compared to normally baited pots. The trial took place on seven consecutive days during June 2000 and was timed to coincide with a period of high catch rates in the area (Mid West Development Authority).

The formulations used were identical to those in Trial 8 (section 6) except that the fish used was a by-product from a local processor and consisted mainly of heads and frames.

A summary of the results is given overleaf.

From the data obtained it was concluded that a combination of dry bait only could perform almost as well as traditional baits. These conclusions are at variance with those obtained from the 1999/2000 Bait Trials where there was always a need to use a small amount of fish in conjunction with the dry bait. It is considered unlikely that this result is due to the use of a different fish base for the baits as sardines are commonly use as bait as they are considered to be the most attractive to the lobsters.

One difference between this trial and other trials conducted during the course of this project was the number of trial pots used. In this case it was about 10% of the total pots in the line. This gives the lobsters in the area fished a greater exposure to the dry baits and, as demonstrated in the tank trials, it appears that lobsters rapidly "acclimatise" to different feed or bait constituents. A review of past results of pot trials from this project produced some supporting evidence for this theory and these are listed below.

a) In the South Australia trial (Appendix 4) there was a noticeable increase in the catch rate after day 1 for each period tested. A comment from the fishermen was that the baits appeared to be more attractive after the first day. At the time this was thought to be due to the high degree of water stability of the bait which contained minced fish.

b) In certain instances, most noticeably with participants HD and MP, the first trial day of the 1999/2000 season produced inferior catch rates than on succeeding days with the same bait. These baits were based on enzyme treated fish and so had only limited water stability. As little if any residual bait from two days previous would still be in the pot, the conclusion reached in a) above that the improvement in catch rate after day 1 was due to the high level of water stability does not apply in this instance.

c) In the Geraldton trial reported above, the catch rate of the trial pots was poor on day 1 but much better on succeeding days.

Whilst the evidence for bait "acclimatisation" is only very tentative the implications for future trials are significant as, if proven, it would require a major change to the pot trial protocol used throughout this project (see section 8).

GERALDTON BAIT PROJECT

Week 3 of testing

		Catch	
Date	Pot before	Trial pot	Pot after
22-Jun-00	2	0	1
	1	0	2
	3	1	2
	2	0	1
	2	1	1
Daily Total	10	2	7
23-Jun-00	5	6	0
	6	0	0
	0	0	8
	10	6	7
	0	1	3
Daily Total	21	13	18
24-Jun-00	3	3	2
	2	2	3
	7	7	4
	3	2	2
	3	2	2
Daily Total	18	16	13
25-Jun-00	6	4	16
	6	0	7
	3	7	2
	10	7	4
	7	0	4
Daily Total	32	18	33
26-Jun-00	2	5	0
	7	5	10
	13	11	13
	4	13	15
	7	9	4
Daily Total	33	43	42
27-Jun-00	10	0	0
	0	3	10
	3	4	6
	0	6	13
	6	7	10
Daily Total	19	20	39
28-Jun-00	7	9	20
	6	2	4
	14	2	7
	10	1	4
	2	9	9
Daily Total	39	23	44
TOTAL	172	135	196
AV./POT/Day	4.9	3.9	5.6

Table shows the total catch of lobsters per pot