

**Aquafin CRC - Southern Bluefin Tuna Aquaculture
Subprogram: Infrastructure Management, Service Delivery
and Technical Support**

Dr J. Buchanan



Project No. 2000/219 & 2001/252

2000/219 & 2001/252: Aquafin CRC - Southern Bluefin Tuna Aquaculture Subprogram: Infrastructure Management, Service Delivery and Technical Support.

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OBJECTIVES:

1. Provide and maintain a managed (staff and budgets) facility as required by other project PI's undertaking small scale, experimental, high risk and/or novel research and development activities requiring live SBT.
2. Ensure, to the level of resources available, that the research facility and procedures are world best practice scientifically as well as from an industry perspective.
3. To coordinate and therefore optimise the use of the limited resources available for research and development requiring live SBT in a managed research environment, through the development of an agreed project Annual Operating Plan.
4. To complete, in consultation with other project PI's, the planned research and development activities designated in the project Annual Operating Plan, providing the agreed outputs (generally data) in an orderly and timely manner.

OUTCOMES ACHIEVED

The direct outcomes of this project were:

- 1) The delivery of a successful experimental service to project principal investigators utilising live SBT in a controlled and managed experimental environment.
- 2) The provision of appropriate samples and/or data to project principal investigators reliant on this service.
- 3) Improved understanding of the behaviour of SBT associated with advances in feed development and farm husbandry practices affecting product quality.

The long-term outcomes of the two key projects relying in large part on the services of this project include:

- 1) A more sustainable tuna farming industry through reduced reliance on baitfish and a single nutrient source for production.
- 2) An enhanced understanding of SBT responses to nutritional inputs and feeding behaviour.
- 3) A suitable manufactured feed that meets the criteria of "easy to handle, easy to store, highly acceptable and efficiently utilised".
- 4) Improved understanding of SBT product quality leading to better farm management practices resulting in enhanced product quality and higher market prices.

NON TECHNICAL SUMMARY:

The project provided scientific and technical support to research projects involving live Southern Bluefin Tuna (SBT) under controlled conditions. These were primarily conducted by the Aquafin CRC and FRDC and managed through the SBT Aquaculture Subprogram. Four experiments were undertaken in relation to SBT product quality (FRDC No. 2001-248) and nutrition (FRDC No. 2001-249), three on the Tuna Research Farm and one on the Stehr Group commercial farm. Support was also given to a range of other projects, including ones associated with “bait fish composition” (FRDC No. 2000-221), “commercial pilot-scale manufactured feed trials” (FRDC No. 2001-201), “environment: farm waste characterisation” (FRDC No. 2001-103) and “health: development of cell lines for virology” (FRDC No. 2001-200). The experiments were successfully completed in accordance with the annual operating plan finalised with the SBT Aquaculture Subprogram Steering Committee. The support by this project to the others was gratefully acknowledged by the principal investigators of each project. Results and outcomes from the experiments are presented in the final report of each of the associated projects, rather than in this report.

In the conduct of the above specified experiments, this project utilised 259 live SBT in multiple 12m diameter experimental pontoons and one 32m diameter holding pontoon, as well as provided support to complete the experiment using 72 SBT maintained on the Stehr Group commercial farm. Tuna harvested after early experiments had not reached market size and prices were poor. Tuna harvest following later experiments had been able to reach close to industry-standard condition and received much higher prices. Significant mortalities occurred early in the season mainly due to seal attacks, which previously had not been a problem, and also due to some stress related bacterial infections. Improved electric fencing was installed to minimise the seal attack problem.

Relocation of the Tuna Research Farm to more waters seaward of Boston Bay is recommended to minimise health issues, enhance production and better represent commercial farm conditions, an important element in facilitating the acceptance of research results by commercial SBT farmers.

KEYWORDS: Southern Bluefin Tuna, Aquaculture.

ACKNOWLEDGEMENTS:

This project was completed as part of the Aquafin CRC. Financial support from the Fisheries Research and Development Corporation and the South Australian Government is also gratefully acknowledged. Brenton Ebert, Richard Morrison, Michael Bartsch and Beverly Stephens played a vital role in the completion of this project.

BACKGROUND:

The southern bluefin tuna (SBT) aquaculture industry has grown to be worth \$302 million since its inception in 1990 (Knight, 2002). It is now a major regional employer in South Australia (Econsearch, 1999). As nearly 100% of the available SBT quota is now being utilised for aquaculture, further growth opportunities for the industry will depend in the short to medium term on longer holding of tuna, improving growth rate, improved survival rates and value adding of product. The Cooperative Research Centre for Sustainable Aquaculture of Finfish (Aquafin CRC), Fisheries Research and Development Corporation (FRDC) and the Southern Bluefin Tuna Aquaculture Subprogram address these industry research priorities through a range of projects.

This project provided the infrastructure, expertise and scientific support to conduct the research associated with a number of the other projects that involve live, or recently live, tuna. In doing this, this project co-ordinated field activities, minimised duplication of infrastructure and enabled researchers with specific expertise in particular scientific disciplines, but not located in Port Lincoln, to actively participate. Experimental data from each of the supported projects are analysed and reported by the principal investigator of the relevant project.

NEED:

This project is essential for cost effective and cohesive research and development (R&D) aimed at meeting the priority needs of the highly successful SBT aquaculture industry. While the industry has developed rapidly since its initiation in 1990, R&D is a pivotal requirement to underpin its development and assure the long-term sustainability of the industry. This project is focused on maintaining an offshore SBT R&D capability.

It involves providing services to support:

- research activities undertaken on and around offshore commercial tuna farms;
- managing and coordinating the infrastructure for small scale, experimental, high risk and/or novel research and development activities utilising live SBT and more controlled conditions; and
- management of the tuna aquaculture component of the SARDI onshore facilities at the Lincoln Marine Sciences Centre (LMSC) and other locations in Port Lincoln.

OBJECTIVES:

1. Provide and maintain a managed (staff and budgets) facility, as required by other project PI's undertaking small scale, experimental, high risk and/or novel research and development activities requiring live SBT.
2. Ensure, to the level of resources available, that the research facility and procedures are world best practice scientifically as well as from an industry perspective.
3. To coordinate and therefore optimise the use of the limited resources available for research and development requiring live SBT in a managed research environment, through the development of an agreed project Annual Operating Plan.
4. To complete, in consultation with other project PI's, the planned research and development activities designated in the project Annual Operating Plan, providing the agreed outputs (generally data) in an orderly and timely manner.

METHODS:

An overview of Tuna Research Farm (TRF) operations are described here; details of the methods associated with individual experiments are presented in the final reports for the relevant projects.

This project supported the SBT Aquaculture Subprogram by maintaining and conducting, in association with other project PIs, controlled small-scale experiments with live SBT. The yearly research cycle involved three parts, preparing and setting up the research farm for the season, conducting the agreed experiments documented in the Annual Operating Plan whilst maintaining the SBT and infrastructure as well as marketing the SBT harvested, and finally documenting and disseminating the outcomes of the designated research.

Setting-up for experiments was conducted in October to December with preparation and deployment of infrastructure. Nets and pontoons were cleaned and repaired, and vessels and vehicles serviced. One 32m diameter pontoon and seven 12m pontoons were deployed. Anchors, feed storage and handling equipment were also prepared.

Approximately 5.5 tonnes of SBT quota, provided by the TBOASA, were delivered by a commercial tuna farmer in early February. These tuna were then maintained on the TRF until no longer needed for experimental purposes.

SBT were maintained according to the protocols of the individual experiments. Feeding involved the delivery, defrosting and weighing of feeds onshore, and feeding the SBT in the pontoons twice daily at sea, with the amount of feed fed weighed and documented. During experiments, contracted divers inspected nets and recovered any SBT mortalities. At the end of most experiments SBT were harvested, weighed and sampled before being marketed. SBT were processed commercially and sent to Japan as fresh chilled product. Funds from their sale were used to offset the costs of research; they formed a significant component of the annual TRF budget.

The post-experimental period involves the collation, reporting and dissemination of data and outcomes.

RESULTS/DISCUSSION (OVERVIEW OF EXPERIMENTS COMPLETED)

PREFERENCE EXPERIMENT

The preference trial was completed during March 2002 to the pre-schedule provided by Dr Robert van Barneveld, Barneveld Nutrition (Co-Principal Investigator of project: FRDC No. 2001-249). The experimental procedures for intensive preference comparisons were the same as used in 2001. Five pontoons were set up, each with five SBT, to evaluate their preference for five natural aqua-product pellet coatings/attractants applied to pellets provided by Skretting Australia at SARDI's Australasian Experimental Stockfeed Extrusion Centre. Good pellet apparent intakes were maintained by the SBT throughout this experiment, though five unexplained mortalities occurred towards the end of the trial. All diets were well accepted; the differences between them were not as clearly apparent as during a similar trial looking at other treatments the previous year. The data were forwarded to Dr Robert van Barneveld, who is overseeing their detailed analysis and interpretation.

DRIER PELLETT EXPERIMENT

Following the completion of the preference trial, four pontoons with ten SBT in each were set up on the TRF in April 2002, to a pre-schedule supplied by Dr Robert van Barneveld and Dr Craig Foster, Skretting Australia, (Co-Principal Investigators of project: FRDC No. 2001-249). The experiment was to compare apparent feed intakes of SBT fed the standard commercial 20mm pellet as compared to a much drier 20mm pellet (both supplied by Skretting Australia). Apparent intake was compared over a four-week period of closely monitored feeding. Overall, apparent intakes were quite low (~400g/tuna/day) in this period, though there were no SBT mortalities in these pontoons. The data have been forwarded to Dr Robert van Barneveld who is overseeing their detailed analysis and interpretation.

HARVEST STRESS SHELF-LIFE EXPERIMENT

Forty SBT were harvested at the end of the drier pellet trial and ten at the commencement of the vitamin trial. During these harvests an opportunistic experiment, that met with their project objectives, was conducted by Dr Philip Thomas (Principal Investigator of project FRDC No. 2001-248) and Trent D'Antignana, a PhD student, characterising the relationships between harvest stress, resting, tissue glycogen levels and the subsequent shelf life of tuna.

HARVEST STRESS COMMERCIAL TUNA EXPERIMENT

Project staff negotiated with the Stehr Group (involved in project FRDC No. 2001-201) for the "harvest stress commercial tuna experiment" experiment to be undertaken with SBT research quota held in two commercial tuna pontoons. The pre-schedule for the experiment was supplied by Dr Philip Thomas (FRDC No. 2001-248). The SBT were fed in a commercial manner from the time they were stocked, either on pellets (one pontoon), or on baitfish (the other pontoon). A Stehr Group company vessel, manned by company staff and researchers, undertook the harvest of 72 SBT with a mean live weight of 31.6kg on two occasions, one week apart, in June (figure1). These tuna had been pre-sold to the Stehr Group at \$15/kg with the low price reflecting the costs associated with the company feeding the tuna and providing the harvest vessel. The data are being collated, analysed and reported by Dr Philip Thomas.

SPECIFIC FACTOR VITAMIN EXPERIMENT

The "specific factor vitamin experiment" pre-schedule was provided by Dr Philip Thomas (FRDC No. 2001-248) with commencement on the TRF in late May and completion in late August. SBT were held in one of six 12m diameter pontoons and maintained on one of three experimental diets (supplied by Skretting Australia), fed twice-daily six days per week. The SBT were transferred for the first time into the 12m diameter pontoons by a swim-through method, which resulted in lower stress levels in the tuna as indicated by feeding rates (ie. a less pronounced post-handling drop in apparent feed intake than usually observed) and low mortalities. However, the disadvantage of this method was that tuna could not be weighed and tagged so no growth rate data were available for this experiment. The SBT harvest was successfully completed with the collection of flesh samples from each fish. The data are being collated, analysed and reported by Dr Philip Thomas.

ANTIFOULING TRIAL

A commercially-available net antifouling product, of interest to a number of commercial SBT farmers, was supplied by Watty Australia and tested for its effectiveness following a pre-schedule provided by Prof. Anthony Cheshire (Principal Investigator of project FRDC No. 2001-103). The product was applied to three tuna nets and these were compared with three paired controls by measuring percentage cover of dominant fouling organisms at three times during the season. The product was sourced and the nets deployed on the TRF by staff of this project (No. 2001-252). The

diver recording the percent cover also generally operated from a TRF vessel. Data collation, analysis and reporting are being completed by staff from project 2001-103.

ADDITIONAL SCIENTIFIC SUPPORT

Additionally, three SBT were harvested for samples for Mark Crane, CSIRO (Principal Investigator of project FRDC No. 2001-200) for development of cell lines for virology.

The staff of this project also continued to monitor the Stehr Group-Skretting commercial pilot-scale manufactured feed trials (Hagen Stehr AO, Principal Investigator of project FRDC No. 2001-201) on an ad-hoc basis, with staff observing feeding and recording harvest data as allowed by the company. Data collection, collation, analysis and reporting are being completed by staff from project 2001-201.

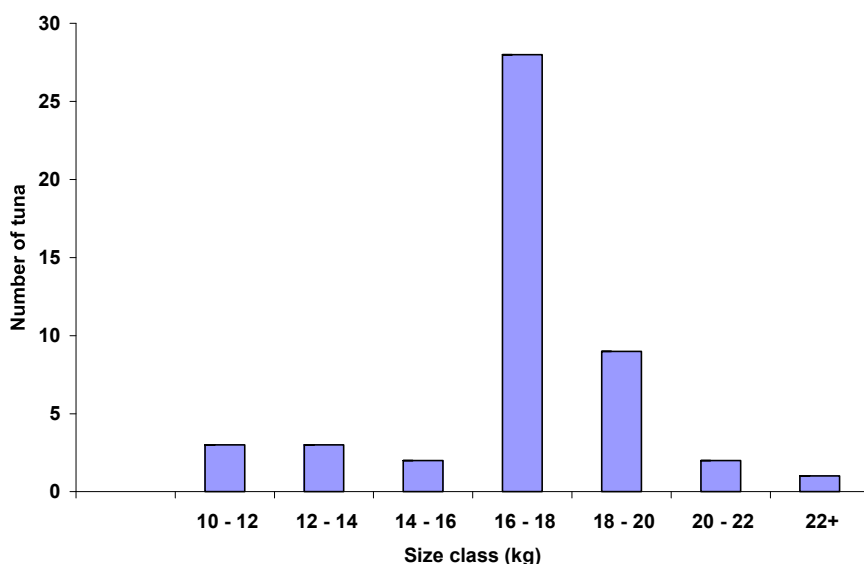
Assistance was also provided in terms of vessels and staff for the collection of environmental samples for projects 2001-103 and 2001-104 (Prof. Anthony Cheshire, Principal Investigator of both). Some nutritional and sample submission support was also given to the baitfish project (Mr David Ellis, Principal Investigator of project FRDC No. 2000-221).

OVERVIEW OF SBT PERFORMANCE ON THE TUNA RESEARCH FARM DURING 2002

TUNA HARVEST DATA

SBT were harvested from the TRF in May and August 2002 and a further harvest was undertaken in June 2002 of SBT that had been held on the Stehr Group commercial farm. SBT were not tagged so growth of individual fish could not be determined and as such only harvest weights and conditions were recorded.

Figure 1. Tuna liveweight distribution from first harvest

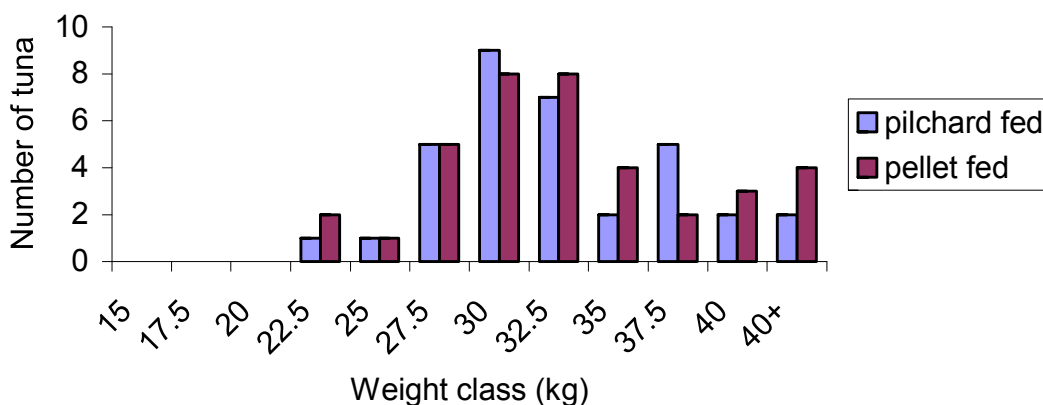


The first harvest was undertaken at the commencement of the specific vitamin experiment for a baseline assessment of the size and condition of SBT. A total of 47 tuna were harvested in May with a mean whole weight of 17.1 ± 2.3 kg (figure 1) and a condition index of 18.3 ± 1.0 (mean \pm one standard deviation). The particularly small size of the tuna and low condition index was reflected in

the poor prices received at market with a mean under 1000 yen/kg. Almost all the SBT provided to the TRF this year appeared at the time of transfer (by necessity a double transfer into a research holding pontoon) to be substantially smaller than last year, despite a similar initial AFMA determined starting weight (average of only 40 fish from the tow). This apparent initial small size, possibly (fish were not tagged this year to minimise handling stress) slower growth due to the well documented lower summer-autumn water temperatures, and known later conditioning of pellet fed SBT, probably explain the small mean size recorded at this harvest.

Seventy-two SBT were harvested in June from two commercial pontoons for the harvest stress-commercial tuna experiment. These tuna had been maintained by the Stehr Group and were jointly harvested by company employees and research staff. At harvest their mean live-weight was 31.7kg and their mean condition index 23.5. The weight distribution is shown in figure 2. Market price information was not available as these fish were pre-sold to the Stehr Group as part of the agreement to hold the experiment on their commercial SBT farm.

Figure 2. Carcass weight distribution of tuna harvested on the Stehr Group commercial farm for the harvest stress-commercial tuna experiment



The third major harvest of SBT occurred in August. These were tuna from the specific factor vitamin experiment undertaken on the TRF. These harvested SBT, with a mean weight of 24.4kg and a mean condition index of 23.5 (table 1), were in much better condition than those harvested earlier in the year. They had a similar mean condition index as the commercially grown tuna harvested at this time by the Stehr Group. While growth rate could not be measured, as these tuna were not tagged in this experiment, a condition index such as this suggests good performance. A total of 130 tuna were harvested over two days and the average prices received for these were 2000 yen/kg and 2250 yen/kg for the respective shipments.

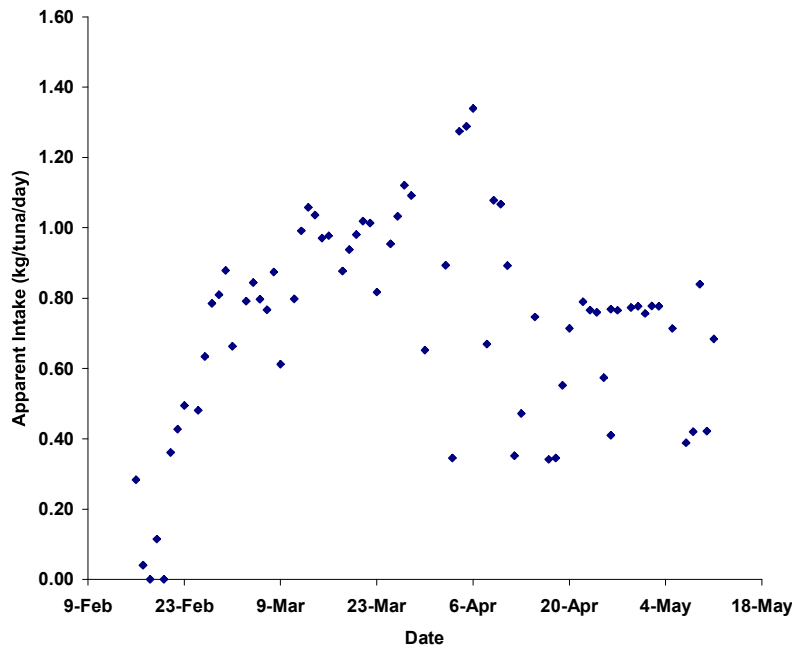
Table 1 August harvest

	Weight (kg whole)	Length (m)	Condition index
Average±SD	24.4±3.31	1.01±0.04	23.5±1.4
Maximum	39.3	1.18	26.7
Minimum	13.4	0.87	19

APPARENT FEED INTAKE

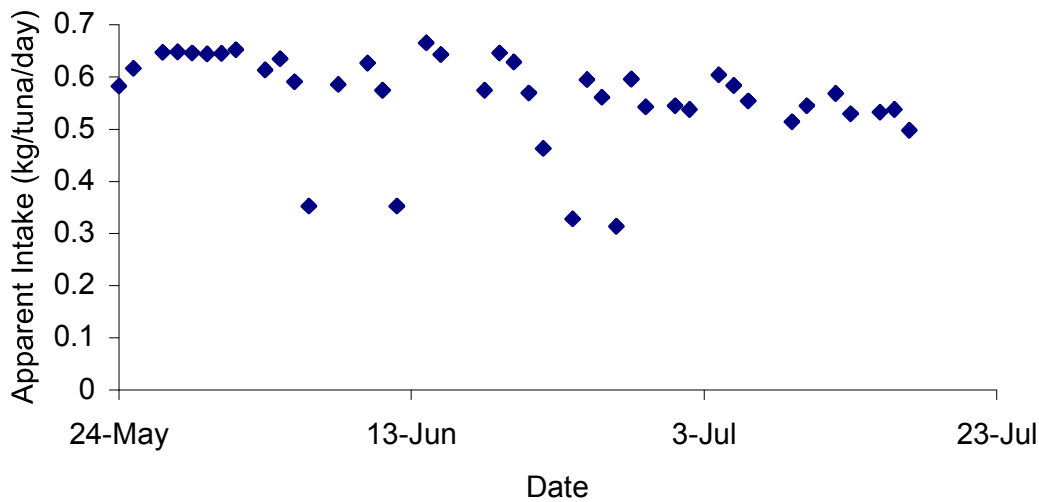
Apparent feed intakes (figure 3) increased rapidly over the first two weeks SBT were held and reached a maximum of 1.25kg/tuna/day at the beginning of April 2002. Apparent intakes then dropped and became much more variable from day to day during April. This variability was particularly evident in the 32m diameter holding pontoon. The low apparent intake values in late April and May reflect that only a single feed was carried out on these days because of poor weather and harvesting activities.

Figure3. Apparent intake of feed for the holding pontoon in 2002



From late May until July apparent feed intake for tuna held in the small (12m diameter) experimental pontoons on the TRF (figure 4) remained relatively stable at 0.5 to 0.7kg/day and vigorous feeding behaviour continued. The four low points on the graph reflect four occasions when rough weather limited feeding to once per day. Despite a substantial drop in water temperature over the whole of this period, only a slight decrease occurred in apparent intake.

Figure 4. Apparent intake of pellets for tuna in 12m pontoons

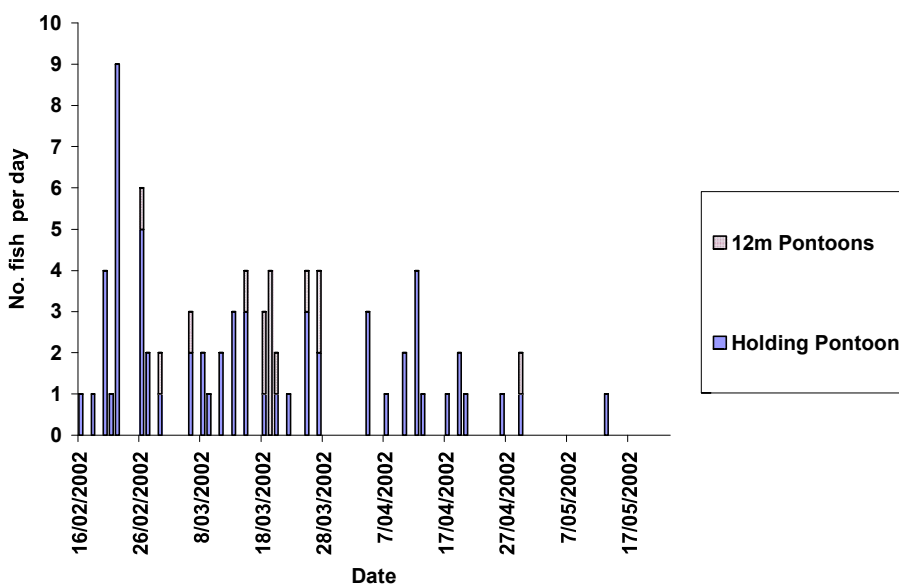


FISH HEALTH

While water temperature declined over the farm season, other water quality parameters remained optimal. Dissolved oxygen one of the most critical parameters remained above 94% saturated at all measurement times. Moderately elevated cell counts (500 cell/L) of the potentially toxic algae, *Chattonella marina*, were recorded in Boston Bay and around the lease site in April – May 2002, but the level remained lower than those reported to cause fish deaths.

There were two primary causes of abnormal fish mortality in 2002. The first was due to attacks by New Zealand fur seals, which caused significant losses very early in the season and from one pontoon immediately prior to the final harvest. Further seal attacks were minimised by installing an electric fence on the pontoons.

Figure 5. Mortalities per day in 2002



High mortalities, not directly caused by seals, were experienced in late March - early April 2002 and autopsies were conducted on four of these SBT by IDEXX VPS (Veterinary Pathology

Services). These autopsies revealed high levels of *Photobacterium damsela* (sn *Vibrio damsela*) in the kidneys and other internal organs. This is a widespread organism, which has been involved in aquaculture fish deaths in a number of countries, but is probably a secondary infection triggered by stress in the SBT. During this period of high mortality feed intakes became much more variable from day to day. By May, mortalities had ceased.

BENEFITS:

The TRF provides a high quality and cost-effective way of maintaining live SBT for the SBT Aquaculture Subprogram, for component experiments of current projects focussed on the environment, nutrition and product quality. It removes duplication of services and infrastructure and provides for increased collaboration and communication. The research on the TRF, and activities on and around commercial farms, also maintain a pool of staff with scientific and technical experience with SBT. The existence of these staff also allows the Subprogram to utilise the expertise of Principal Investigators who are leaders in their disciplines, but who are not located in Port Lincoln or do not have direct field experience in handling live tuna.

Results from experiments conducted on the TRF have directly benefited the tuna industry. Developments in nutrition have supported the development of a commercial pelleted feed, which will provide a more secure and efficient feed source in the long term. Research into product quality will benefit the industry by providing a competitive advantage in the market against overseas-farmed tuna. The environmental research has supported industry applications for lease sites and is vital for ongoing support by state regulatory authorities.

FURTHER DEVELOPMENT (FRDC PROJECT NO. 2002/249):

PREPARATION FOR 2003

A draft Annual Operating Plan for the research services group and TRF was prepared for 2003. As part of the proposal approved by the SBT Aquaculture Subprogram Steering Committee, the TRF will be relocated to waters seaward and outside Boston Bay. This move, and the future involvement of an experienced ex-commercial farm manager (Mr David Ellis, Fishing Industry Services), are expected to significantly improve growth and survival of SBT.

The relocation has also had significant implications in regard to project infrastructure. Following advice from Mr David Ellis, research farm anchors, pontoons and nets have been upgraded or replaced to meet the conditions of a more wave-exposed site. Protection against seals has also been improved.

SARDI has purchased a larger vessel to operate safely in more wave-exposed water. The Breakwater Bay is a 14.5m long steel hull, former crayfishing vessel. Its larger size and greater stability will allow the project to operate in the rougher conditions.

PLANNED OUTCOMES:

The project program was successfully completed as outlined in the Annual Operating Plan. Seven Tuna-briefs (short industry targeted newsletters) were distributed by the project in collaboration with the relevant project Principal Investigators, to inform the tuna industry of research being

undertaken. More detailed outcomes of the experiments conducted on the TRF will be included in the final reports of the associated projects.

CONCLUSION:

This project provided useful research support to a range of projects managed through the SBT Aquaculture Subprogram, and did this in an efficient and cost effective manner. Increased industry involvement in the project, as described in the further developments section, is likely to lead to increased industry support and improved outcomes. Closer industry collaboration will also facilitate faster uptakes of research findings.

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APPENDIX 1

INTELLECTUAL PROPERTY:

No specific outcomes of this research project have been identified to represent intellectual property. However, the experience gained by staff, in managing and researching live SBT and maintaining the associated infrastructure and equipment, is recognised to be of considerable importance to the success of future research projects (loss of past staff has occasionally caused significant set-backs to projects).

APPENDIX 2

STAFF:

Name and affiliation	Position	FTE on project (%)
Department of Primary Industries & Resources SA (SARDI Aquatic Sciences)		
Dr Jeff Buchanan	Senior Research Officer	65
Mr Steven Clarke	Program Leader	*
Mr Brenton Ebert	Technical Officer	100
Mr Richard Morrison	Technical Officer	100
Mr Michael Bartsch	Technical Officer	100
(* time allocated from another project)		
TBOA of SA Inc.		
Mr Brian Jeffriess	President	5
Skretting Australia		
Dr Craig Foster	Feed Research	2.5
Mr Geoff Bayly	Feed Research	2.5
Barneveld Nutrition Pty Ltd		
Dr Robert van Barneveld	Research Nutritionist	3