FINAL REPORT

ASSESSMENT OF TRAWL INDUCED INCIDENTAL MORTALITY ON PRE-RECRUIT SAUCER SCALLOPS

FIRDC Project DAQ 3Z

M.C.L. Dredge

Southern Fisheries Centre

Deception Bay 4508

1) PROJECT TITLE

Assessment of trawl induced incidental mortality on pre-recruit saucer scallops.

2) OBJECTIVES

(i) To assess the level of mortality and injury caused by trawling upon saucer scallops smaller than the present minimum legal size (90 mm).

(ii) To set up a yield model which quantifies the loss attributable to trawl-induced mortality of juvenile scallops.

(iii) If significant mortality upon such scallops is demonstrated, help develop management techniques consistent with minimising this source of mortality.

(iv) Describe habitat requirements of settling juveniles and determine if this habitat is at risk from trawling.

3) PROPOSAL

There has been increasing concern over the future of the central Queensland scallop fishery, as fishing effort continues to increase and catch rates decline. While several management measures, based upon research findings, have been taken recently, there is one aspect of the fishery which requires further study. This is a detailed evaluation of the extent of trawl-induced mortality on pre-recruit (i.e. less than 85 mm) saucer scallops. The numbers of scallops in a range of size classes and on a range of substrates which survive trawling will be estimated from a series of seeding and tagging experiments. Habitat preferences of settling scallops will be examined to evaluate potential trawl-induced damage to habitat as well as to scallops themselves.

4) NAME OF PERSONS RESPONSIBLE FOR PROGRAMME

Mr R.G. Pearson, Director, Fisheries Research Branch, Queensland Department of Primary Industries.

5) QUALIFICATIONS OF STAFF TO BE EMPLOYED ON THE PROGRAMME

Mr M Dredge, M.Sc., B.Econ., Fisheries Laboratory, Burnett Heads, Queensland
Mr C Lupton, Dip. Ag. Sci.
Mr B Barr

6) JUSTIFICATION, INCLUDING PRACTICAL APPLICATION

The Queensland fishery for saucer scallop, *Amusium balloti*, is under stress. Catches have declined in past years, effort directed at the stock has increased threefold (Dredge, 1989). Current economic conditions in the fishery allow fishing to continue when the density of animals on the bottom is less than 1 per 150 square metres. At this density, the effectiveness of broadcast spawning may be impaired. The situation has been fairly widely recognised in the fishery and steps to ensure that a breeding population remains from year to year are being taken.

The condition of the scallop stock may be exacerbated by incidental trawl-induced mortality upon juvenile animals. Saucer scallops spawn between May and September and grow rapidly. Spat (scallops of 30 - 60 mm shell height) can normally be found in trawl catches between September and November each year, in large numbers. They normally recruit into the fishery at an age of 6 to 9 months, when they attain a shell height of 90 mm. Beds of juvenile scallops sometimes overlap those of older (1+) animals which are fished. Consequently, juveniles may be either trawled over or picked up and returned to the bottom prior to their attaining legal size. This situation typically occurs in the period September-December, when effort directed at the scallop stock is at a relatively high level. Preliminary studies (Dredge 1989, attached) show that trawling may cause significant mortality on juvenile scallops. This preliminary work needs to be carried on to a point of giving a quantitative assessment of mortality before management strategies for the fishery are adapted to cope with this problem.

A pilot project designed to demonstrate the effectiveness of 8 mm video cameras for measuring scallop density has been completed. Results of this initial experiment aimed at assessing trawl-induced mortality, using both this equipment and a tagging study, suggest that:

(1) scallops in the size regime 55-75 mm may suffer trawl-induced mortality;

(2) tagging experiments give more reliable data on trawl-induced mortality than do direct (video) observations.

Habitat requirements of very young saucer scallops have not been described. Whilst the byssal phase of *Amusium* is of limited duration, if in fact it does occur, the young may require some specific material or environment to trigger spatfall. If such an environmental requirement exists, and can be disturbed by fishing activities, there is further reason for altering management practices.

7) LOCATION OF OPERATION

Field work will take place on the main Queensland scallop grounds between 22°S and 25°S. Data analysis and writing up will be carried out by staff based at the Burnett Heads Fisheries Laboratory.

8) PROPOSAL IN DETAIL, INCLUDING PROCEDURES

Beds of juvenile scallop (size range 30-60 mm) can normally be found in depths of 25-45 m in the period between September and November. The research proposal calls for a series of beds to be identified, hopefully by the local fishing fleet. In each experiment, buoys will be set out and tagged, measured juveniles will be released on the beds. The area will then be trawled over, using conventional scallop trawling equipment. More tagged scallops will be released, providing an untrawled control group. Recovery rates from the control and treatment (trawled) groups will be compared. Size specific recovery rates will be examined. Video monitoring equipment will be used to compare the abundance and density of dead and obviously disturbed scallops on scallop beds prior to trawling.

After trawl-induced mortality has been measured, a yield model incorporating growth, mortality and yield per recruit under varying fishing strategies will be constructed. Past experience suggests a computer spreadsheet can be adapted for such a purpose. A series of management measures including gear restrictions and closed seasons will be simulated on the model, with the aim of achieving optimum production from the stock. Advice based on the model will be supplied to the Queensland Fish Management Authority for its ongoing management review.

Substrate and bottom topography of areas in which spatfall of *Amusium* occurs regularly will be examined using bottom grabs and videos. A range of spat catchers, adapted from Tasmanian and Japanese versions, will be set out in an attempt to identify what physical environment induces *Amusium* to spat out.

RESULTS

The original proposal called for beds of juvenile scallops to be located but remain unfished. Buoys were to be laid out to form grids, and density of scallops in the grids was to be measured, using video camera recordings. The scallops were to be subjected to heavy trawling in trial grids. Survival of scallops in these grids was to be compared to survival in control areas. Tagged scallops were to be released in the test and control areas, and recovery rates from the two sets compared to see if a differences in survival rates could be detected. Direct observations on the reaction of juvenile scallops to trawl gear, and on factors contributing to incidental mortality were to be made using a high resolution video system.

Once an estimate of trawl induced loss of juvenile scallops to particular beds had been made, the results were to be applied to a yield model of the fishery. This model would incorporate a range of fishing intensities during the period when juveniles were vulnerable (August - January), an estimate of the natural mortality rate for saucer scallops (Dredge 1985), and a range of ratios of 0+ (juveniles) to 1+ (fished) scallops. A Thomson and Bell harvest model set up on a spreadsheet was to form the basis of the model. Output was to be in terms of an estimate of yield under varying seasonal constraints in the fishery.

A preliminary experiment along these lines was conducted in late 1987, using DPI funds. A rectangular area, 200 m by 800 m, known to support a population of juvenile scallops, was carefully measured out and buoyed. Repeated measurements of scallop density were made by towing an 8mm video camera through the longitudinal axis of the trial area. Approximately 450 tagged scallops were then released in the test area. After 24 hours the area was trawled with sufficient intensity to cover the entire grid. This trawling carried out with conventional trawl gear, with the codend left open. Following trawling, a further set of video recordings were made to monitor scallop density. A further 450 scallops, which had not been subjected to the test trawling, were released. Results, which were delivered to the Australasian Scallop Workshop (Dredge 1988, copy enclosed), were inconclusive. They included (A) While there were differences in the recovery rates of trawled and untrawled tagged scallops, the difference was significant only at the 10% probability level. (B) Scallop densities were reduced after trawling, as registered from video camera recordings. The reduction in density may have been caused by trawl induced mortality, or through scallops scattering from the path of the trawl. (C) A disturbing feature of the experiment was the amount of variability in counts of scallop abundance between observers watching video playbacks.

The original FIRTA application called for field work to begin in 1988. Delays in the funds being allocated resulted in the project being delayed until 1989 (with FIRTA approval).

The first component of the project called for a study on trawl induced mortality being conducted through the use of a high resolution, real time video system. CSIRO Division of Fisheries owned such a system and agreed to make it available for this trial. The system and its operator (Dick Martin, CSIRO Division of Fisheries) were brought to Bundaberg to participate in observational and experimental "destructive" trawling work in October 1989.

The video camera and its associated lights and housing were set up on board the R.V. "Gwendoline May" over a four day period: while the vessel had on board facilities for this type of operation, a fair deal of fine tuning and fitting up was required. Upon completion of fitting out, the system was taken out to 20 fathom ground in Hervey Bay to commence work. Unfortunately, either the shaking it had received while travelling from Hobart to Bundaberg or some form of fitting up problems caused the system to malfunction - both the focus and tilt-pan facilities were inoperative. It proved impossible to repair them on-site, and eventually the whole system was returned to Hobart to be repaired. Given the costs associated with moving the system and operator around (the camera and associated equipment weighed about half a tonne), we were unable to repeat the trial.

In the mean time, we attempted to conduct the trial using less sophisticated systems (Sony 8 mm video Handicams in housings), using recorded signals. These trials were also unsuccessful, as we were unable to locate sufficient juvenile scallops in the relatively shallow water depths attainable with the Handicam systems.

Given the facts that we were unable to observe the effects of trawl gear on juvenile scallops, and that we had devoted the best part of three weeks field time trying to conduct observations and locate sufficient numbers of juvenile scallops to carry out tagging work (both unsuccessfully), we reluctantly decided to abandon the project. This decision was influenced to some degree by the heavy workload faced by myself as principal investigator, particularly in the light of a pending transfer, either to Cairns or Deception Bay.

Having reached a decision to abandon the project, FIRTA was notified, and the balance of project funds (the major proportion of allocated funds) were returned to FIRTA.

A similar project was undertaken in 1991-2, using Queensland D.P.I funds. In this project, we conducted an assessment of scallop mortality as a function of time that (undersized) scallops were left exposed to open air after being captured. The experiment was simple: scallops were taken by trawl and dumped on a sorting tray. At intervals of 15 minutes, from time zero, a given number of scallops (40 - 50) were taken from the sorting tray, put into continuously running water, and tagged. They were then transplanted to a major fishing ground, where there was a high likelihood of reasonable recoveries being made. The difference between recoveries from different treatments was assumed to be a reflection of differential survival as a function of time exposed to air. The experiment was successful and the experimental results were quite conclusive. Saucer scallops could be exposed to air for up to about two hours before suffering significant mortalities (see attached article). It appears, then, that tagging studies can be used to detect differential survival of scallops under differing treatments, as was suggested in the initial project proposal.

Debriefing

The fact that the objectives of this project were not met is something I'm not proud of. The process of failure, however, is part of learning, and it may be instructive to look at what caused the failure of this project.

1) Organisation and planning

Resources directed towards the project were always going to be pretty light on - in hindsight it is obvious that when the project was being done the principle investigator (me) was over-committed. As a consequence, operational plans, including timetables and logistic allocations were poorly prepared, there were no contingency plans in the event of equipment failure or non-availability of scallops, and insufficient staff resources directed towards the project. The more detailed planning process, with milestones, now required by F.R.D.C. should act to prevent such inadequate planning. Small scale projects of this type can sometimes be run successfully and very cost-effectively, but they have to be treated as high risk because of the absence of back-up and joint planning resources.

2) Preliminary field surveys

Our inability to complete the project was severely hampered due to our inability to locate substantial beds of juvenile scallops at a time when they are normally readily available. Such natural year to year variability should have been anticipated and planned for, and preliminary surveys for beds of scallop spat should have been conducted prior to the main project being commenced.

3) Use of complex field equipment

Murphy's law was invented by Irish fisheries scientists. There are so many damned things which can go at sea, and they generally choose the most inappropriate times to do so. When one is playing about with very complex equipment, like the real time, high resolution mobile camera equipment used in this project, it is asking too much to hope that the stuff will arrive from Hobart and operate immediately. It certainly didn't in this case. Again in hind sight, the sorts of breakdowns which occurred should have been anticipated and pre-empted by bringing the gear to the experimental site earlier and spending more time getting it prepared.

4) Project objectives

When revisiting project objectives after a period of some years since the original application was developed, I was struck by their extent and complexity. It was being wildly ambitious to think that a small project on a small budget could achieve all of these objectives, and they should have been scaled down to cover incidental mortality and possible management implications only.

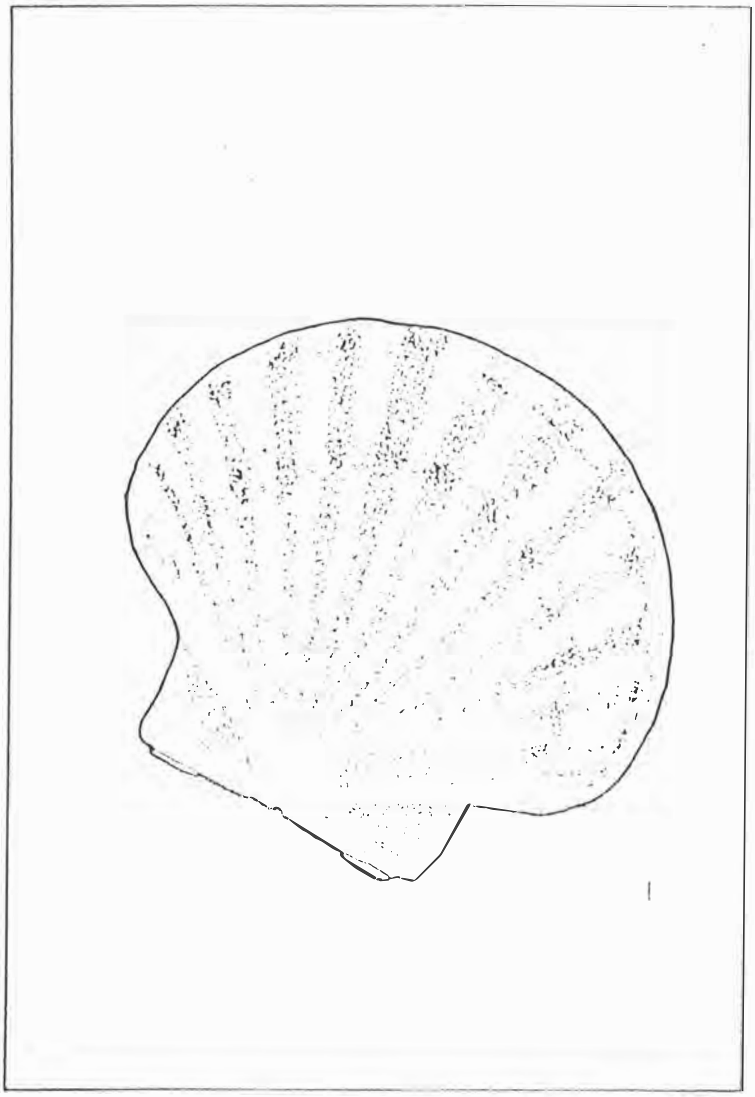
Literature Cited

Dredge, M.C.L. (1985) Estimates of natural mortality and yield per recruit for *Amusium japonicum balloti* Bernardi (Pectinidae) based on tag recoveries. J. Shellfish Res. 5, 103-9.

Dredge, M.C.L. (1988) Trawl-induced mortality of juvenile saucer scallops *Amusium jaonicum balloti* Bernardi measured from video recordings and tag recoveries. In Dredge, M.C.L., Zacharin, W. and Joll, L.M. (eds.) "Proceedings of the Australasian Scallop Workshop." Tasmanian Government Printer.

Dredge, M.C.L. and J. Robins-Troeger (1993) Preliminary results from 1991 scallop tagging programme. Queensland Fisherman, January 1993.

Proceedings of the Australasian Scallop Workshop



Edited by: M.L.C. Dredge, W.F. Zacharin and L.M. Joll

TRAWL-INDUCED MORTALITY OF JUVENILE SAUCER SCALLOPS, *AMUSIUM JAPONICUM BALLOTI* BERNARDI, MEASURED FROM VIDEO RECORDINGS AND TAG RECOVERIES.

M. Dredge
Queensland Department of Primary Industries
Fisheries Laboratory, Burnett Heads
Queensland 4670

Abstract

Incidental gear-induced mortality of scallops, which can be significant in dredge fisheries, has not been previously described in equivalent trawl fisheries. Video camera recordings of scallop abundance and analysis of tag recovery data were used to evaluate the effects of trawling in a trial area occupied by juvenile saucer scallops, Amusium japonicum balloti. Results from the video recordings were inconclusive. There was significant variation in counts of scallop abundance between video film observers. A decline in scallop abundance after the trail area had been trawled may have been caused by scattering rather than trawl-induced mortality of the juveniles. Results from a tagging experiment were more conclusive, with returns from scallops that had been subjected to trawling being lower than those from an untrawled control. The tagging study also gave information on size specific mortality/vulnerability which could not be obtained from video recordings.

Introduction

The Queensland trawl fishery for scallops (*Amusium japonicum balloti* Bernardi) developed rapidly between 1977 and 1987. Effective effort directed at the stock increased by a factor of 14 during this period, while catch rates declined consistently. Total annual landings have declined since 1983 (Dredge 1988). Trawl-induced mortality of pre-recruit scallops may have been a factor contributing to this decline. The fishery now operates for 12 months a year, taking animals larger than 90 mm shell height (S.H.), the legal size limit. The trawls used in this fishery are normally made from 90 - 120 ply 75 - 87 mm mesh. Consequently scallops smaller than the legal size are vulnerable to capture.

Quantitative data on age composition of animals in the fishery are not available, but late 0+ and early 1+ animals are thought to make up a large proportion of landings. *Amusium japonicum balloti* spawns during winter and spring (Dredge 1981), and young of year scallops can be found in trawl catches from July onwards each year. These juveniles may occupy the same geographic location as older scallops, and be subject to fishing operations. Juveniles in the path of trawl gear may be passed over by the otter boards or ground chain of the trawl if they do not swim in response to the trawl gear's presence. Those that do swim either pass through the meshes of the trawl or are retained, brought to the surface, and subsequently discarded. Scallops which survive this process are characterised by a prominent ring or banding on the shell's surface (Joll 1988) (Figure 1), the location of which indicates the scallop's size when caught.

Incidental mortality of scallops in dredge fisheries can be significant (Naidu 1988). Equivalent trawl-induced mortality of juvenile scallops has not been previously described. But if incidental mortality is appreciable, there is justification for attempting to reduce it, given the potential loss to the fishery.

This paper reports an introductory study on the effects of trawling on juvenile scallops. Two techniques were used to assess survival of juvenile scallops in an area subjected to trawling. Underwater video camera recordings were used to estimate pre- and post-trawl scallop density in a trial area. Return rates from a scallop population that was subjected to trawling have been compared to those from an a less heavily trawled controlled population in order to assess trawl-induced mortality. The quality of results from these two techniques has been compared.

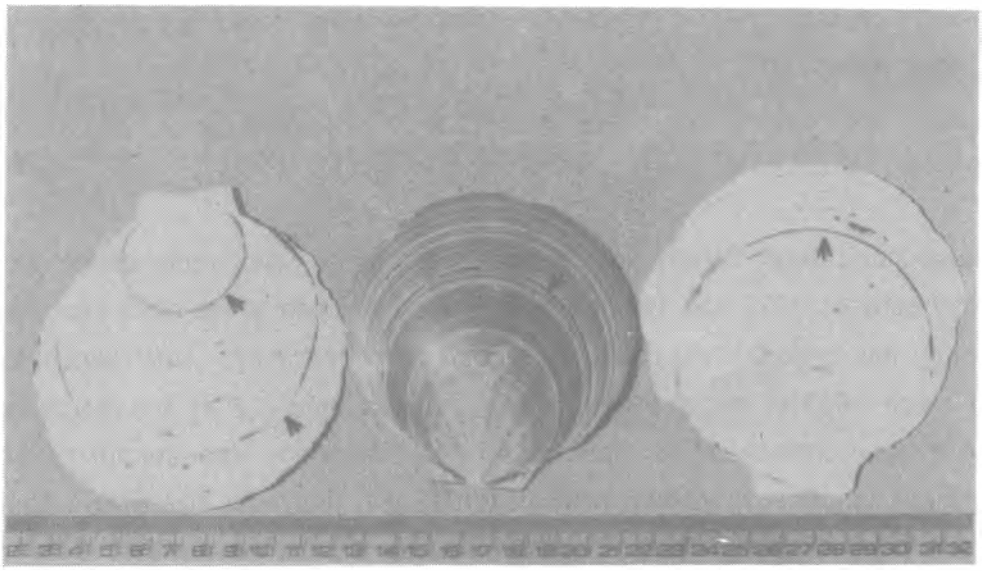


Figure 1. Left and right valves of *A. japonicum balloti*, showing scarring and pigment flares caused by trawl gear.

Materials and Methods

Trial Site

A rectangular trial site, 800 by 250 m, located at 23°42'E, was buoyed at each corner with the aid of gyrocompass bearings and radar-measured distances. Depth at the site was 26 m, and the substrate was a uniform mud-sand mixture. Juvenile scallops in the size range 30 - 80 mm S.H. had been found in the area during a preliminary search.

Pre-treatment

A total of 446 scallops in the size range 35 - 81 mm trawled from an area well away from the test site was measured (S.H., to the nearest mm), tagged with coded Dymo-tape labels glued to the shell's surface, and released in the trial site on 11/11/87.

The night after this release took place (12/11/87), ten counts of scallop abundance were made in the trial site. An 8 mm colour video camera housed in a water-tight casing, mounted on a 3.0 m wide beam trawl frame and illuminated by a 250 watt, 240 volt light source was used to record scallop abundance. The camera and frame were towed over the 800 m axis of the trial area at speeds of 40 - 50 m min^{-1}. On completion of each pass, the camera was retrieved, the video tape replaced, and a new run commenced. The film was viewed by two observers immediately after the completion of each run, and a further three observers, working independently, following completion of field work. Observers were asked to count all scallops seen, and note numbers of dead shell and living animals.

Treatment

Immediately after the completion of the initial series of video counts, the trial area was trawled using commercial scallop trawl gear with open cod ends. The trawl equipment consisted of a pair of 18 m headrope length Seibenhausen nets made of 90 thread by 400 denier net. A nine mm short link chain connected to the footrope by 120 mm long drop links was used as ground-gear. The nets were spread by 2.1 x 1.2 m flat otter boards, and towed at a speed of 5.4 km $hour^{-1}$ (three knots). Trawling was carried for 1.5 hours at night and then repeated 12 hours later, during daylight hours. Trawling was distributed evenly over the trial site. There was sufficient effort expended to cover the site on each of the two occasions that trawling trials took place.

Post-treatment

Three hours after trawling had been completed on the test area, ten more counts of scallop abundance were made with the video camera system. On the day after this second set of video recordings of scallop density were obtained (14/11/87), a control group of 448 scallops was tagged and released in the trial site. Tagged scallops were recaptured by the research vessel and by commercial trawlers which worked in the trial area within six months of experimental work being completed. Each recaptured scallop was identified by its coding and measured.

Data Analysis

Estimates of scallop abundance made from video camera observations were compared using split-plot analysis (Cochran and Cox 1957), with pre- and post-trawling abundance being treated as one source of variation, and inter-observer variation as a second.

Size composition of tagged scallops released in the test area before and after trawling were compared using t tests after size frequency data had been examined for skewness. A multi-dimensional log-linear analysis of deviance (GENSTAT) was used to examine the effects of size at release and treatment (trawling) effects upon recapture rates. Time at liberty for recaptured scallops from the control and treated groups was compared using a t test.

Results

Abundance measurements using video recordings

Summaries of the 20 sets of counts made by four observers are given in Table 1. There were significant differences in counts of scallop abundance both as functions of treatments (before and after trawling) ($F=5.69$, $P<0.05$) and between observers ($F=57.90$, $P<0.01$). There was a significant decrease in the number of scallops recorded by all observers following trawling of the test site.

Counts of dead scallops and scallop shells recorded from video camera tapes are summarised in Table 2. These counts were significantly skewed, and so were transformed [log e (x+1)] for further split-plot analysis. There was no significant difference in numbers of dead shell observed before and after trawling ($F=0.18$, $P>0.10$) but the difference between observers was significant ($F=29.14$, $P<0.01$). All observers noted that there was no way of judging whether scallops had been recently killed from their appearance on the video image.

Table 1. Mean (standard error) of scallop counts from ten sets of video camera observations before and after trawling.

Observer number	Before trawling	After Trawling
1*	33.2 (3.34)	24.4 (2.51)
2	41.4 (3.34)	32.3 (3.63)
3	50.6 (4.56)	31.1 (3.74)
4	27.5 (2.35)	14.1 (2.16)

* Two observers counting together.

Table 2. Mean (standard error) of dead scallop shell from ten sets of observations before and after trawling.

Observer number	Before trawling	After Trawling
1*	0	0.6 (0.43)
2	1.4 (0.70)	1.7 (0.73)
3	1.1 (0.79)	1.7 (1.10)
4	4.0 (0.60)	3.2 (1.31)

* Two observers counting together.

Table 3. Summary of scallop tag returns.

	Control		Trawled	
Time out (days)	Number released	Number recaptured	Number released	Number recaptured
0-30		0		0
31-60		43		21
61-90		26		20
91-120		7		7
121-150		5		7
151-180		0		3
Total	448	81	446	58

Table 4. Analysis of deviance between treatments and size groups for tag returns.

	Residual df	deviance	Change df	Chi-square
Initial model	17	35.67		
Modifications to model				
Size	9	7.66	8	28.01**
Treatment	8	4.43	1	3.23*
Treatment by size	0	0.00	8	4.43NS

* P< 0.10
** P< 0.01

Tag Returns

There was no significant difference between the size compositions of tagged control and treated (trawled) scallops. (t=1.70, P>0.10). A total of 139 tagged scallops (15.5% of those released) were recaptured. Summaries of tag returns, in terms of numbers returned from the control and treated (trawled) groups against time at liberty are given in Table 3. Results from the analysis of deviance are summarised in Table 4. There was a highly significant difference in the rate of return as a function of size at release (P<0.001), while the interactive (size-treatment) term was statistically non-significant (P>0.5). The much higher return rate of larger scallops (Figure 2) may reflect higher survival rates or increased vulnerability of larger scallops to trawl gear.

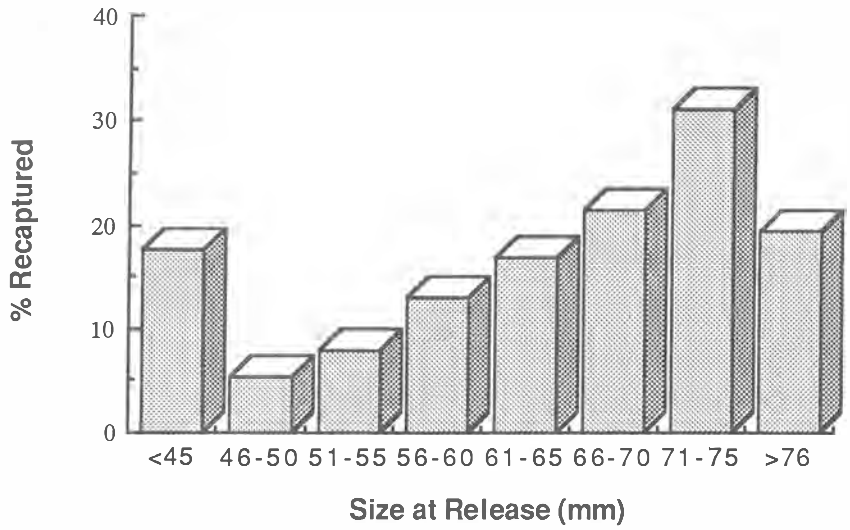


Figure 2. Recapture rate of tagged scallops (%) as a function of size at release (S.H., mm).

The difference in tag return rate between the control and trawled group was significant only at the 0.10 probability level ($P=0.077$). The difference in time at liberty was significantly different ($t=2.71$, $P<0.05$), with the average time at liberty for the control group being 57.9 days, and for the trawled group being 76.2 days.

Discussion

The two techniques used to assess trawl-induced mortality generated superficially similar results in that both techniques suggest that trawling over juvenile scallops reduced survival. These results need qualification. While results derived from video camera observations indicated that there were fewer live scallops in the test area following trawling, there was no commensurate increase in the number of dead scallops observed. This may have been a consequence of the observers' inability to distinguish between recently killed scallops and older shell remains on the video film image. Equally, the reduction in numbers may have been due to the trawl gear moving scallops away from the trial area. Scallops may have been temporarily held in the wings or body of the net during the trawling operations, and dropped from the net outside the test area. Scallops on the periphery of the trial area may have moved from the area in response to repeated trawling nearby. The difference in average time at liberty between trawled and untrawled tagged scallops suggests there was some difference in behaviour or vulnerability between the two groups. These alternative hypotheses cannot be tested using available data. The significant variation in counts of scallop abundance between observers in these trials gives rise to concern over the accuracy of quantitative data obtained from video camera recordings.

The tag return data gave a far less qualified indication that trawling may induce some mortality on juvenile scallops, although the significance of the probability level associated with the difference in recovery rates was marginal. There are no obvious reasons why returns from the trawled group of scallops would be lower than from the control group other than through treatment (trawling) effects. Tagging data also gave some additional data on the differential survival or vulnerability of scallops as a function of their size at release. The higher recovery rate of larger sized scallops suggests that smaller animals may be most vulnerable to trawl induced mortality, or less vulnerable to trawl gear.

While video cameras have a great deal to offer in the way of mapping local (fine-scale) distribution of scallops, and *in situ* behavioural studies, there are difficulties associated with their operation in the field. The problem of variation between observer's skill or experience level has been discussed. The equipment is not easy to use in the field. Handling a three metre bean trawl frame heavy enough to keep the camera and casing on the bottom during filming involves the use of a substantial boat, fitted with a good winch. In the present trials, an 18 m research trawler was used. The boat was extremely difficult to control at the very low speeds required for effective filming. Consequently, near calm weather was required for field operations. The camera and underwater casing, while reasonably robust, were designed to be hand-held and therefore had to be handled with a great deal of care when being deployed. The costs, in terms of boat time and labour, should be considered carefully before underwater video cameras are considered as a tool for field observations.

To fully quantify the extent of trawl-induced mortality upon juvenile scallops requires additional work. But there is evidence which suggests that fishing practices may need modification if trawl-induced mortality of juveniles is to be minimised in the Queensland scallop fishery.

Acknowledgements

David Mayer's contributions to statistical analyses in this paper are gratefully acknowledged, and I'm indebted to Phil Smith and Paul Leeson, who crewed the R.V. 'Gwendoline May'. Ian Brown and an anonymous referee offered valuable editorial assistance.

References

Cochran, W.G. and G.M. Cox (1957). Experimental Designs, 2nd ed. John Wiley and Sons Inc, New York.

Dredge, M.C.L. (1981). Reproductive biology of the saucer scallop *Amusium japonicum balloti* (Bernardi) in central Queensland waters. *Aust. J. Mar. Freshw. Res.* **32**, 775 - 87.

Dredge, M.C.L. (1988). Recruitment overfishing in a tropical scallop fishery? *J. Shellfish Res.* **7**, 233 - 239.

Joll, L.M. (1988). Daily growth rings in juvenile saucer scallops, *Amusium balloti* (Bernardi). *J. Shellfish Res.* **7**, 73 - 76.

Naidu, K. (1988). Estimating mortality rates in the Icelandic scallop *Chlamys islandica* (Muller). *J. Shellfish Res.* **7**, 61.

Preliminary results from the 1991 scallop tagging programme

QUEENSLAND'S scallop fishery is one of the State's more valuable fisheries resources.

During the past five years, annual landing have varied between about 800 and 1,500 tonnes, with an ex-vessel value fluctuating between about $10 to $18 million.

The bulk of the State's scallop fishery is in waters offshore from Port Clinton to Hervey Bay, and most processing takes place at the ports of Yeppoon, Gladstone, Bundaberg and Hervey Bay.

Scallop fishing and processing generate significant local employment and are a n important source of export revenue. Some 90% of the Queensland scallop catch is exported, largely to South East Asia, where its quality and unique texture command a significant market premium over other scallops.

The scallop resource is fished heavily, and needs careful management, both to ensure that the resource is not over fished and that the value of landing is maximised.

To manage the resource effectively the Queensland Fish Management Authority needs reliable biological data on scallops.

While there has been research work conducted on Queensland's scallop fishery for many years, certain aspects of the target species (*Amusium balloti*) needed to be better understood to meet the needs of managers.

These information requirements included:

- an understanding of stock structure (whether the Queensland scallop fishery is based on a single breeding population or a number of breeding populations);
- better knowledge of growth variation in the target species, particularly in relation to location;
- a re-examination of natural mortality rates; and
- knowledge on the time scallops can be held on deck, out of water, before they suffer excessive mortality.

In September and November 1991, an intensive scallop tagging programme was carried out to develop data on these issues. Approximately 9,500 scallops were tagged and released at six general locations between Hervey Bay and Bowen.

So far almost 2,100 tagged scallops have been returned. This very high rate of return (22%) gives us a very good data base for future work. It also gives some indication as to how heavily the stock is being fished.

There is a considerable amount of analytical work to do before we can disseminate final results from the project. However, results which have so far been developed include information on stock identification,on-board mortality and growth & movement.

Stock Identification

Stock structure was examined using both biochemical genetics studies and transplant experiments.

In the "transplant" experiments, scallops from areas where pale shell predominate were moved to areas where shell is dark, and vice versa.

Results indicate that the Queensland saucer scallop resource consists of a *single* genetic stock. Colour and growth variation seen in the scallops is apparently induced by environmental factors.

On-board mortality

Two experiments designed to obtain information on survival of scallops in relation to time spent out of water were carried out.

In these experiments, a substantial number of scallops (more than 300) were removed from the sorting tray immediately on being spilled from the codend, put into circulating sea water, and subsequently tagged.

Further batches of about 40 scallops per treatment were taken from the tray at 30-minute intervals and treated in the same manner.

Seven batches of scallops were tagged, with the last batch having been left on the sorting tray for three hours without being hosed or otherwise cared for.

Comparative recovery rates from the one experiment which gave meaningful results are given below.

The recovery rates for the different treatments reflect survival of tagged scallops as a function of the time they spent out of water, on the

Time on Tray (min)	Number recovered/ Number released	% Recovery
0	94/341	27.6
30	12/41	29.3
60	15/43	34.9
90	11/45	24.4
120	13/43	30.2
150	5/42	11.9
180	0/42	0

Table 1. *Scallop tag recoveries as a function of time on sorting tray.*

	Hervey Bay	Bustard Head	Barcoo Bank	Yeppoon	Hydrographers Passage	Old Reef
0-49	265	662	134	50	221	164
5.0-9.9	65	4	4	29	2	0
10-19.9	46	10	0	2	0	0
>20	10	0	0	0	0	0

Table 2. *Summary of movement by tagged scallops.*

sorting tray. The experiment was carried out in daylight hours, on a warmish September afternoon.

The data suggest that scallops appeared to be able to withstand up to two hours held out of water, on a sorting tray, without suffering noticeable mortality. After this time, tag returns indicate that mortality was significant.

Growth and movement

Preliminary data scans suggest that there is variation in growth of scallops depending on the area they come from.

Movement data have yet to be fully worked up, but a preliminary scan of the data (Table 2) shows that 89.7% of tag returns for which there was meaningful return data moved less than 5 nautical miles.

Given the inaccuracies associated with identifying where in trawl shot scallops were recaptured, this effectively reflects zero movement.

A further 6.2% of scallops were reported to be recaptured between 5 and 10 n. miles from their release site and 3.5% of tags were reported taken between 10 and 20 n. miles from the release points. (We have regarded the one scallop reported as being recaptured more than 200 n. miles from its release site as reflecting a clerical or navigational error rather than a real movement.)

Tag lottery

Fishermen and processors who returned tagged scallops were awarded lottery tickets rather than the small cash rewards previously offered as incentives.

This process simplifies our paperwork and allows at least two people to have a decent reward in recognition of their support of the tagging programme.

The industry ultimately will be the winner from tag returns, as our understanding of the scallop and its fishery is enhanced.

Winners in the tag lottery were Darryl Lee from Tin Can Bay and Mark Bromhead from Torquay. Our congratulations to the winners, and our thanks to the many fishermen and processors who returned tagged scallops.

Mike Dredge & Julie Robins
Southern Fisheries Centre
Deception Bay

MANAGEMENT ISSUES

When is trolling not trolling?

THERE have been concerns about the use of "float-line" fishing to catch pelagic fish such as mackerel in Marine Park Replenishment Areas. Float-line fishing includes the use of a light floating line or use of a float to suspend a lure, pilchard or other bait on the surface or in the water column (not on the bottom) to attract mackerel and other such fish from an anchored or drifting vessel. The purpose of a Replenishment Area is to "provide for the replenishment of living natural resources in heavily used areas of the Great Barrier Reef Marine Park".

Bramble Reef off Ingham was declared a Replenishment Area on 18 December 1991. It is to remain a Replenishment Area until 31 January 1995. The purpose is to enable the Reef to recover from considerable fishing pressure and the impact of Crown of Thorns. The public participation phase received 41 submissions. It was made clear at the time that trolling would be allowed after the declaration, however trolling was not defined.

The Zoning Plan provides that fishing other than trolling is not permitted in a Replenishment Area. To fish other than by trolling for pelagic fish is an offence under the Great Barrier Reef Marine Park Act 1975 for which the penalty may be a fine of up to $10,000 and the possible forfeiture of vessel and equipment. Trolling is not currently defined for the Central Section of the Marine Park.

Although float-line fishing targets pelagic fish it has several disadvantages. These relate to difficulties in enforcement of fishing restrictions, accidental catch of demersal fish and confusion over type of fishing allowed. As a result there is a need to clarify what constitutes trolling.

Following public complaints and discussions with interest groups the managing agencies have recently spoken with representatives of the commercial and recreational fishing industries about the matter. These discussions confirm the clear understanding in fishing literature and amongst anglers in general that float-line fishing is different to trolling. Therefore the definition in the new Cairns Zoning Plan will be applied throughout the Great Barrier Reef Marine Park under a new regulation to be enacted in the near future. Under the Regulation, trolling will be defined as: "Fishing with a line trailed behind a vessel that is underway but does not include driftfishing when a vessel is adrift."

This will reduce confusion amongst users and it will be easier to monitor and where necessary to enforce compliance. It will also further reduce the possibility of accidental or intentional taking of demersal fish. The approach is necessary to ensure the protection of a valued but diminishing resource. The simple effect is that float-line fishing is not classed as trolling. It is a different form of line fishing and is still allowed wherever line fishing is allowed in the Marine Park (ie General Use A and B and Marine National Park A Zones as well as the General Use, Habitat Protection and Conservation Park Zones in the Cairns Section). If you catch a demersal reef fish when trolling in areas closed to other forms of line fishing, you should return it to the water. People should also note that the trolling at Bramble is only allowed from 1 May each year to 31 January in the following year. Further information can be obtained from any office of the Queensland Department of Environment & Heritage, the Queensland Boating & Fisheries Patrol or the Great Barrier Reef Marine Park Authority.

Darin Honchin
Surveillance & Enforcement Officer
GBRMPA

Pilots for Reef

IT is now compulsory for large ships to carry a pilot when navigating the Great Barrier Reef.

Federal Government legislation means that all vessels of 70 metres or more, and *all* loaded oil tankers, chemical carriers and liquified gas carriers of any size, must now take on a pilot before passing through the inner route (Cape York to Cairns Roads) and through Hydrographers Passage.

The International Maritime Organization also recommends that ships take pilots on board when navigating in Torres Strait and the Great North East Channel.

More details: Marine Park Authority (077 - 81 8811) or Maritime Safety Authority (07 - 835 3660).