FINAL F.I.R.T.A. REPORT

FISH ATTRACTING SYSTEM

E.I.R.I.A. FINAL REPORT.

Title of Project : Fish Attracting System.

Name of Applicant : Department of Agriculture, N.S.W.

Division : Division of Fisheries.

Proposal : To study the use of mid-water and surface structures (Fish Aggregating Devices- F.A.D.'s) in attracting commercial species of pelagic fish in economic quantities.

Names of Persons Responsible For the Programme :
Dr. D.D.Francois, Executive Director (Fisheries)
Dr. P.A.Ayres, Chief, Division of Fisheries.
Dr. W.B.Malcolm, Chief Biologist, Division of Fisheries.

Qualifications of Staff to be Employed on the Programme :
John Matthews B.Sc. Biologist
Terry Butcher B.Sc. Technical Officer

Location of Operations : Centre of operations, Fisheries House, 211 Kent St, Sydney. Selected sites for installation of experimental fish aggregators were ocean waters off Port Stephens, Sydney, Jervis Bay, Montagu Island and Eden.

Fish Aggregating Devices (F.A.D.'s) are defined here as moored buoys with a fish attracting device suspended from the mooring line of the buoy. The attracting device simply increases the visual size of the structure, and is usually constructed from light mesh or webbing.

(A) Buoy Design : Three buoy designs have been used, with the designs improving each time to suit the conditions off the New Wales South Coast.

Type 1. 2 two hundred litre galvanised steel drums joined end to end with an external counterweight (Fig 1).

Type 2. 3 two hundred litre galvanised steel drums joined side by side, to form a raft, with an external counterweight (Fig 2).

Type 3. A spar buoy constructed from P.V.C. pipe with an internal counterweight (Fig 3). Type 3a used a separate chain from which to hang the attractor, rather than the mooring chain. (Fig 4).

In each of the designs a radar reflector was incorporated to allow easy location of the F.A.D. and to alert shipping to the presence of the structure.

Type 1 buoys were used in the early stages of the programme but were found to be difficult to locate by sight and were modified by the addition of P.V.C. buoyancy tubes around the upper drum. This increased the stability of the buoy and caused it to ride higher in the water, although the thin walled P.V.C. was easily damaged by shipping or by smaller vessels mooring to the buoy.

Type 2 buoys replaced type 1 because of losses, developments overseas and the relatively fragile nature of the extra buoyancy tubes. The type 2 buoy utilised a raft construction of 3 two hundred litre drums bolted together in a hardwood frame. A steel counterweight was attached under this frame and a rolled steel cone was placed on top of the raft to house the battery, light and radar reflector.

A single type 3 buoy design had been used succesfully in the mid 1970's to mark an artificial reef off Narrabeen. The Coastal Engineering Section of the Public Works Department was contacted and recommended a change from the raft style type 2 buoy to a spar buoy. They considered that the raft placed excessive strain, in the form of shock loading, into the mooring line. Raft buoys had been used successfully in Hawaii, but currents off the New South Wales coast were found to be too great for similar designs. A spar buoy tends to negate this problem.

The spar buoy was constructed from a 6m length of 315mm diam. heavy duty P.V.C. sewer pipe. The end caps were fabricated from rings of the pipe glued to discs cut from 18mm thick sheet P.V.C.. An 18mm diam. steel rod passed through the centre of the end caps and the pipe with a loop on one end and a nut on the other. Ballast was placed in the lower end, a radar reflector in the top and the pipe filled with closed cell foam.

In all cases, the buoys were well marked with Departmental insignia, address and phone number.

(B) Mooring Design : The early mooring lines (F.A.D. No's 1 to 8) were plastic coated galvanised steel wire that were swaged to the upper and lower chains (Table 1). To eliminate the problems of electrolysis this was changed on F.A.D. No's 9 to 18 to 28mm soft laid polyethylene rope, which was spliced around a hard eye at each end. Ten metres of galvanised chain was used at each end with a swivel at the top. All the connectors used were hammerlocks. The scope of the mooring (that is the ratio of rope length to depth of water) was originally 1.5:1. This required small weights along the rope's length to ensure that under 'no wind-no current' conditions there was no rope floating on the surface (i.e. a reverse catenary). The scope was later reduced to 1.15:1 (F.A.D. No's 14 to 18) which, allowing for the chain, eliminated the need for weights along the mooring line.

The anchor used was originally a concrete block which weighed 500 kg and measured 1m x 0.5m x 0.5m (F.A.D. No's 1 to 10). This was changed to a railway wagon wheel weighing 450 kg and 1m in diam.,(F.A.D. No's 11 to 18) which was denser and easier to handle.

(C) Structural Integrity : During the diving surveys around the structures, particular attention was paid to the condition of the mooring line and hardware associated with the top end of the structure (the lower end being well out of the range of a SCUBA diver). No sign of wear or damage to this top section of the mooring was ever observed. It seems likely that the breakdown in the mooring system (if that was the cause of losses) occurred in the hardware associated with the ground tackle.

An attempt was therefore made to observe the mooring block and hardware from a small two-man submersible. Preliminary dives were carried out on a shallow artificial reef (30 metres) but the submersible's navigation equipment was unsuitable and the craft was not granted a certification for deeper water.

A further attempt was made to observe the ground tackle using a small remote controlled vehicle (R.O.V. Dart). This submersible was controlled from the surface by a cable and carried video cameras and lights. The current prevailing in the area attempted was too strong and stopped the submersible at a depth of 150 metres.

After the loss of eight structures, it was decided to deploy them in pairs (No. 11 was deployed by itself as a replacement for 2 buoys suspected of being vandalised) and it was proposed to lift one of these after approximately 5 months to inspect the ground tackle. Inclement weather prevented this on the two suitable pairs, and they were unfortunately lost before such inspections could be made. It is advised that any future buoys constructed and deployed in similar fashion should be lifted at the most after a 5 month period.

(D) Attractor Design : The attractors used were 21 ply 40mm polyethylene netting hung from the top mooring chain (F.A.D. No's 1 to 14). The netting was replaced by 45mm welded cross-strip plastic webbing (used by the Department of Main Roads as safety fencing) and hung on a separate chain for F.A.D No's 14 to 18 (Fig 4).

(E) Launching : The F.A.D.'s were launched from the 28m F.R.V. Kapala (F.A.D. No's 1 to 11), the 14m F.R.V. Kamala (F.A.D. No's 12 to 17) and F.A.D. No 18 from the New South Wales police boat Nemesis (16m).

The buoy and top chain were placed in the water, the attractor seized around its chain and lowered. The mooring line was then payed out and the weight dropped. If radar was available, fixes were taken and recorded. Compass bearings and visual fixes were also noted at this time.

(F) <u>History of Durability of Structures</u> : A total of 18 structures was deployed in various depths of water along the New South Wales coastline. One of these structures is still in position off Coffs Harbour in 84 metres of water. Table 1 summarises details of each F.A.D. The main points of interest are as follows:

<u>F.A.D. No. 1</u> Type 1. Observed by fishermen 2 weeks before confirmed missing. No sign of wear. Not recovered. Fish observed: Large schools of baitfish (*Decapterus sp.*).

<u>F.A.D. No.2</u> Type 1. Surveyed by divers 2.5 weeks before confirmed loss. No wear observed. Heavy seas. Not recovered. Fish observed: 100+ small yellowtail kingfish and small schools of baitfish.

<u>F.A.D. No. 3</u> Type 2. Surveyed by divers 1 month before confirmed missing. Attractor tangled badly with chain and counter weight. Two periods of heavy weather. Not recovered. Fish observed: Large schools of baitfish and 150+ small kingfish.

<u>F.A.D. No. 4</u> Type 2. Observed 5 days before confirmed missing and reported low in the water although the current was strong and could have pulled it down. Heavy seas just before confirmed missing. Not recovered. Fish observed: Small schools of baitfish and 10+ small kingfish.

F.A.D. No.5 Type 2. Surveyed by divers 5 days before confirmed missing. No sign of wear. The buoy was recovered from the rock platform at Long Reef 2 weeks later. All fittings had been removed from the buoy and the cause of the break could not be determined. Fish observed: Large school of striped tuna, small school of baitfish, 10+ small dolphin fish. A number of small yellowfin tuna were captured.

F.A.D. No.6 Type 2. Located so that the Montagu Island lighthouse keeper could observe the buoy. The buoy was found off Bermagui 17 days after it was confirmed missing, apparently anchored. It was observed again 22 days later 5km south of Eden, and was again reported to be anchored. It is thought that the concrete mooring block may have cracked leaving a small part of it attached to the mooring line which was catching on reef periodically. Fish observed: Large schools of baitfish, 50+ small kingfish and both albacore and striped tuna were captured while near Montagu Island. The F.A.D. was fished while it was drifting and reports indicate that recreational anglers caught approximately 300 small kingfish associated with the structure.

F.A.D. No.7 Type 2. Surveyed by divers 2 weeks before confirmed missing. Bracket found loose on first survey and repaired. No futher wear observed. Not recovered. Fish observed: Small schools of baitfish, 100+ small kingfish and 150+ small dolphin fish. Striped tuna were caught and marlin sighted on the surface near the buoy.

E.A.D. No.8 Type 2. Surveyed by divers 3 weeks before confirmed missing. Not recovered. Fish observed: Small schools of baitfish, 100+ small kingfish, 100+ small dolphin fish. Striped tuna were also captured near the structure.

E.A.D. No.9 and 10 Type 3. Placed in tandem 100m apart. Calm seas. Suspected vandalism to obtain mooring rope. Not recovered.

E.A.D. No. 11 Type 3. Seen 2 weeks before confirmed missing. No sign of wear. Not recovered. Fish observed: 15+ baitfish and 5 to 7 small kingfish. Two of the kingfish had scars which allowed them to be identified while diving and they were present on each survey.

E.A.D. No.12 and 13 Type 3. Placed in tandem 100m apart, one with the attractor attached, one without. The drag of the netting attractor could easily be observed in a current and was higher than expected. No wear was observed and the buoys were not recovered. Fish observed: Large schools of baitfish, 50+ small kingfish, 100+ dolphin fish. Small yellowfin tuna were captured.

E.A.D. No. 14 and 15 Type 3a. Placed in tandem 100m apart in an area that could be observed from a staff member's home (providing that the weather was clear). Lost during heavy seas. One buoy was recovered from an Island to the north of Lizard Island in northern Queensland, 10 months after it was confirmed missing from the Sydney site. The buoy was damaged, presumably when crossing a coral reef, and was of no use in determining the failure point. Fish observed: Large schools of baitfish and 10+ small kingfish.

F.A.D. No. 16 and 17 Type 3a. Placed in tandem 100m apart. Confirmed missing 2 weeks after a diver survey. No sign of wear observed. Not recovered. Fish observed: Large schools of baitfish, 100+ small kingfish, 200+ small dolphin fish, 50+ rainbow runners. Recreational anglers reported taking striped tuna, marlin and tiger sharks.

F.A.D. No. 18 Type 3a. At the time of writing, this F.A.D. was still in place. It had been struck by a vessel and suffered minor damage to the top of the buoy.

(G) Effectiveness: It was hoped that the F.A.D.'s placed to the south of Sydney (Jervis Bay, Montagu Island and Eden) would attract commercial quanties of southern bluefin tuna (*Thunnus maccoyii*). This was not the case and no southern bluefin were observed by Department staff or commercial fishermen in association with the F.A.D.'s. (This may have been due to the species' absence from the area. See conclusions). Commercial quantities of yellowtail kingfish (*Seriola lalandi*), however, were very often observed on each of the southern F.A.D.'s along with large schools of baitfsh (*Decapterus sp.*). Fishermen reported sporadic captures of albacore tuna from the Montagu Island F.A.D.

Commercial quantities of dolphin fish (*Coryphaena hippurus*) were present around F.A.D.'s off Sydney and Port Stephens during summer and autumn each year. A quantity of dolphin fish was marketed from the Sydney F.A.D. No. 7 (600 kg in 1 week) but prices were low (less than $1/kg) due to poor handling and possible consumer unfamiliarity. A smaller quantity was put through the markets from Port Stephens. Yellowtail kingfish from the Sydney F.A.D. No. 7 were sold in small quantities and in larger quantities from Port Stephens where two trap boats fished that buoy when returning from their normal trapping activities. The prices paid for the kingfish were average for that time of year.

Other species of fish taken from near the structures, although not caught by commercial fishermen, included yellowfin tuna, striped tuna, marlin, wahoo, whaler and tiger sharks. All of these were captured by recreational fishermen in the near vicinity of the F.A.D.'s.

(H) Conclusions : During the period of the study the buoy design necessarily underwent changes in structure, materials and complexity. These changes were made in an attempt to produce a structure capable of withstanding the rough weather and currents experienced off the New South Wales coast, which would be difficult to vandalise and which would be easy to locate and relatively cheap to build.

The type 1 F.A.D. sat too low in the water, which made locating the buoy in moderate seas difficult. The type 2 buoy solved the problem of visibility but introduced increased shock loading into the mooring system. This buoy also was more complex in design, resulting in more parts which could fail. Similar structures had been used in other states of Australia and overseas. Failures in both of these buoys were attributed to the mooring systems, which were also changed as a result. Concrete blocks were replaced by more dense railway wheels (it is thought that one of the blocks broke on the bottom and allowed its F.A.D. to drift). Because of the possibility of electrolysis, the wire mooring line was replaced by rope. The scope of the mooring was shortened to eliminate rope tangle when using a reverse catenary mooring.

The final structure used (type 3 and 3a) was designed to ease the shock loading in the mooring system, and to provide an easily visible mark for fishermen. It is also a very simple structure with few parts to fail.

Losses of the type 3 and 3a systems (type 3a used a separate attractor chain) were attributed to failures in the bottom chain, since no corrosion or wear was ever observed in the top chain. It is therefore recommended that the mooring be lifted within 5 months of placement to check for wear and replace gear as necessary. If this is done, then it is predicted that this final design should remain in place for much longer periods than were observed during this study.

Although it would appear that the F.A.D.'s that were located to the south of Sydney with the aim of attracting southern bluefin tuna were ineffective for this purpose, catch records show that only very small quantities of this species were landed in New South Wales during the period of the study. It is therefore yet to be determined if such structures would indeed concentrate southern bluefin tuna in areas in which they are more abundant.

All of the structures did attract large quantities of small kingfish, (with the exception of the F.A.D. off Coffs Harbour to date). Dolphin fish have been attracted in large numbers to the F.A.D.'s off Sydney, Port Stephens and, more recently, Coffs Harbour. Quantities of dolphin fish have been potentially commercial, and with improved handling and marketing of this species, represent the most likely commercial application of F.A.D.'s off the Australian east coast.

__Table 1__ :Summary of deployment, survival and survey details of F.A.D.'s

FAD No.	Location	Type	Anchor	Scope	Date In	No. of Surveys	Date Lost	No. of Months
1	Eden	1	Block	1.5:1	9.81	5	11.81	2.2
2	Jervis Bay	1	"	"	9.81	5	2.82	4.8
3	Eden	1	"	"	12.81	4	2.82	2.6
4	Sydney	2	"	"	3.82	3	4.82	1.0
5	Sydney	2	"	"	4.82	3	5.82	1.0
6	Montagu Is.	2	"	"	11.82	5	1.83	2.5
7	Sydney	2	"	1.3:1	12.82	8	2.83	2.2
8	Pt Stephens	2	"	"	12.82	4	3.83	3.0
9	Sydney	3	"	"	2.83	-	3.83	0.5
10	Sydney	3	"	"	2.83	-	3.83	0.5
11	Sydney	3	Wheel	1.25:1	7.83	3	11.84	3.8
12	Sydney	3	"	"	12.83	6	2.84	2.8
13	Sydney	3	"	"	12.83	6	2.84	2.8
14	Sydney	3a	"	1.15:1	4.84	10	10.84	5.5
15	Sydney	3a	"	"	4.84	10	10.84	5.5
16	Sydney	3a	"	"	11.84	10	5.85	6.0
17	Sydney	3a	"	"	11.84	10	5.85	6.0
18	Coffs Hbr	3a	"	"	2.86	3	?	?

FIG. 1 DESIGN FOR TYPE 1 BUOY.

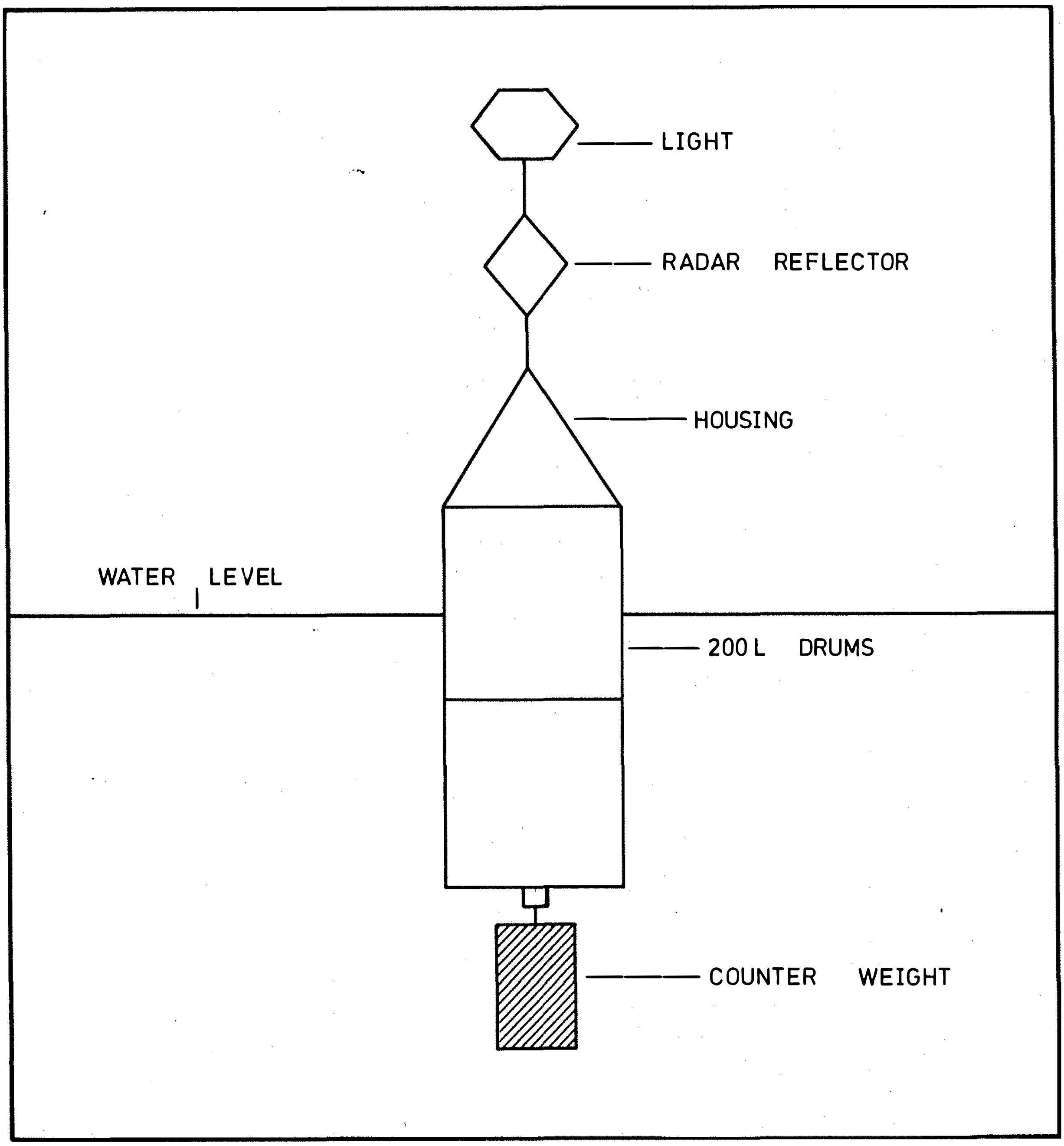


FIG.2 DESIGN FOR TYPE 2 BUOY.

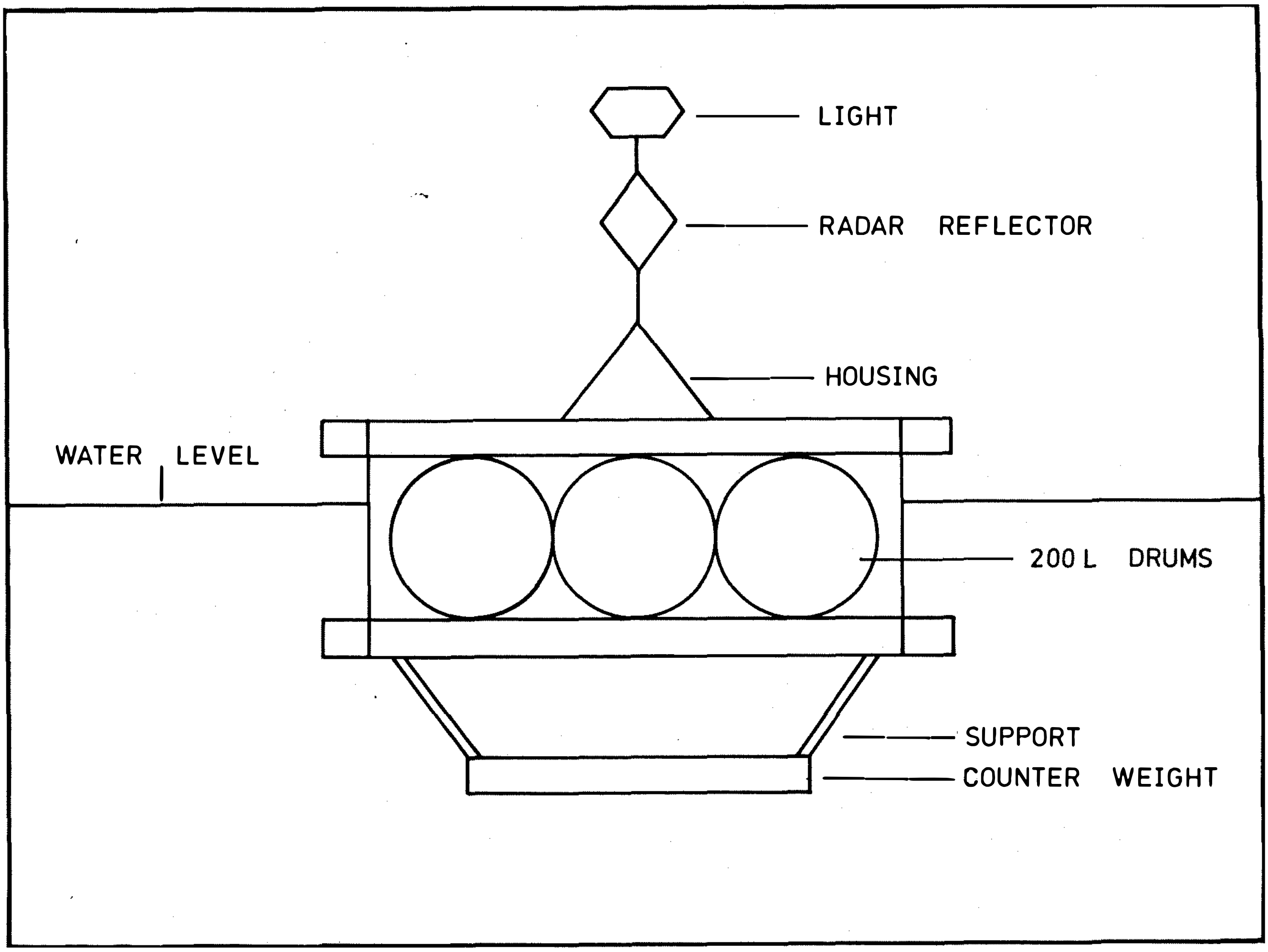


FIG. 3 DESIGN FOR TYPE 3 BUOY.

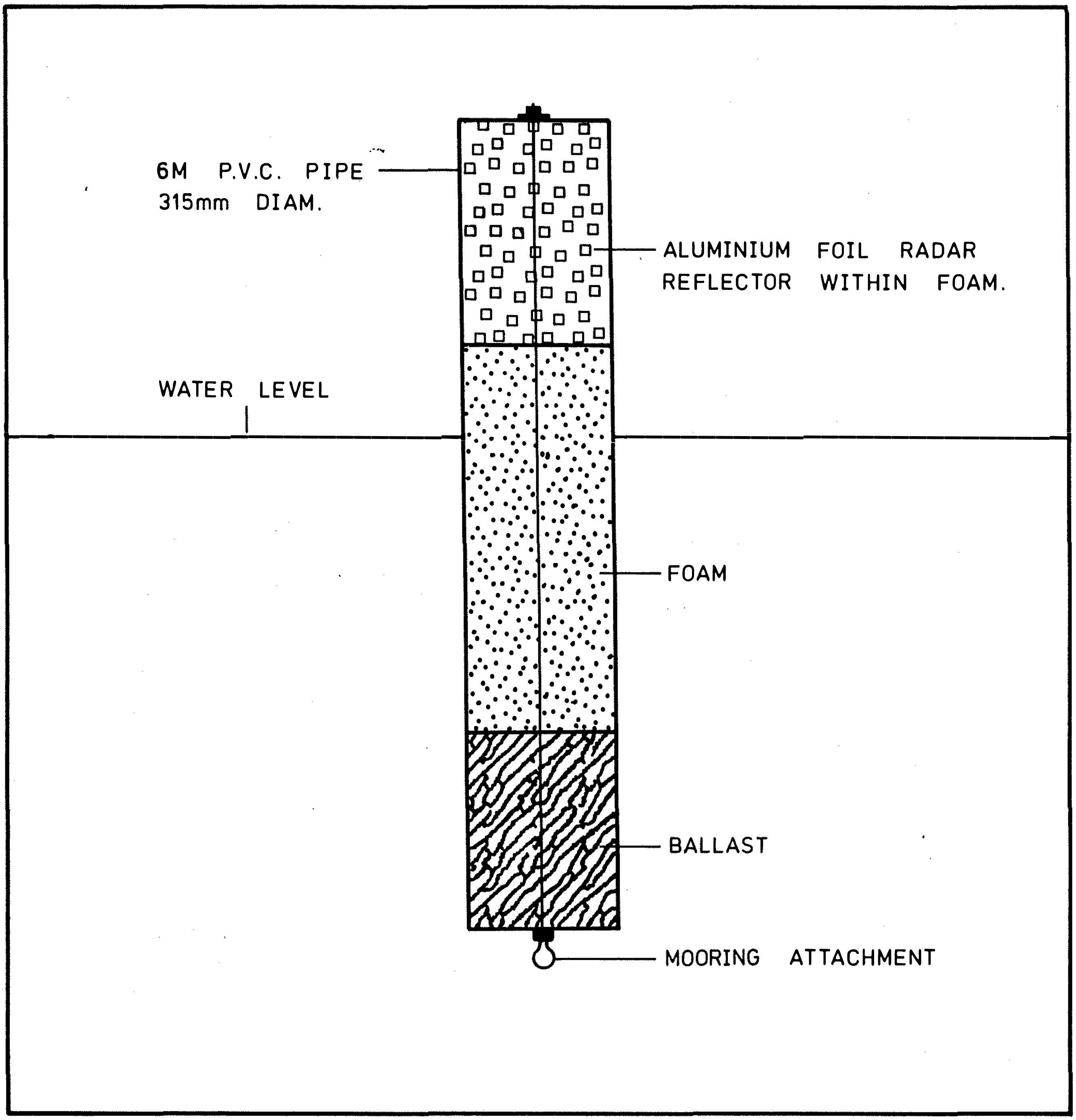
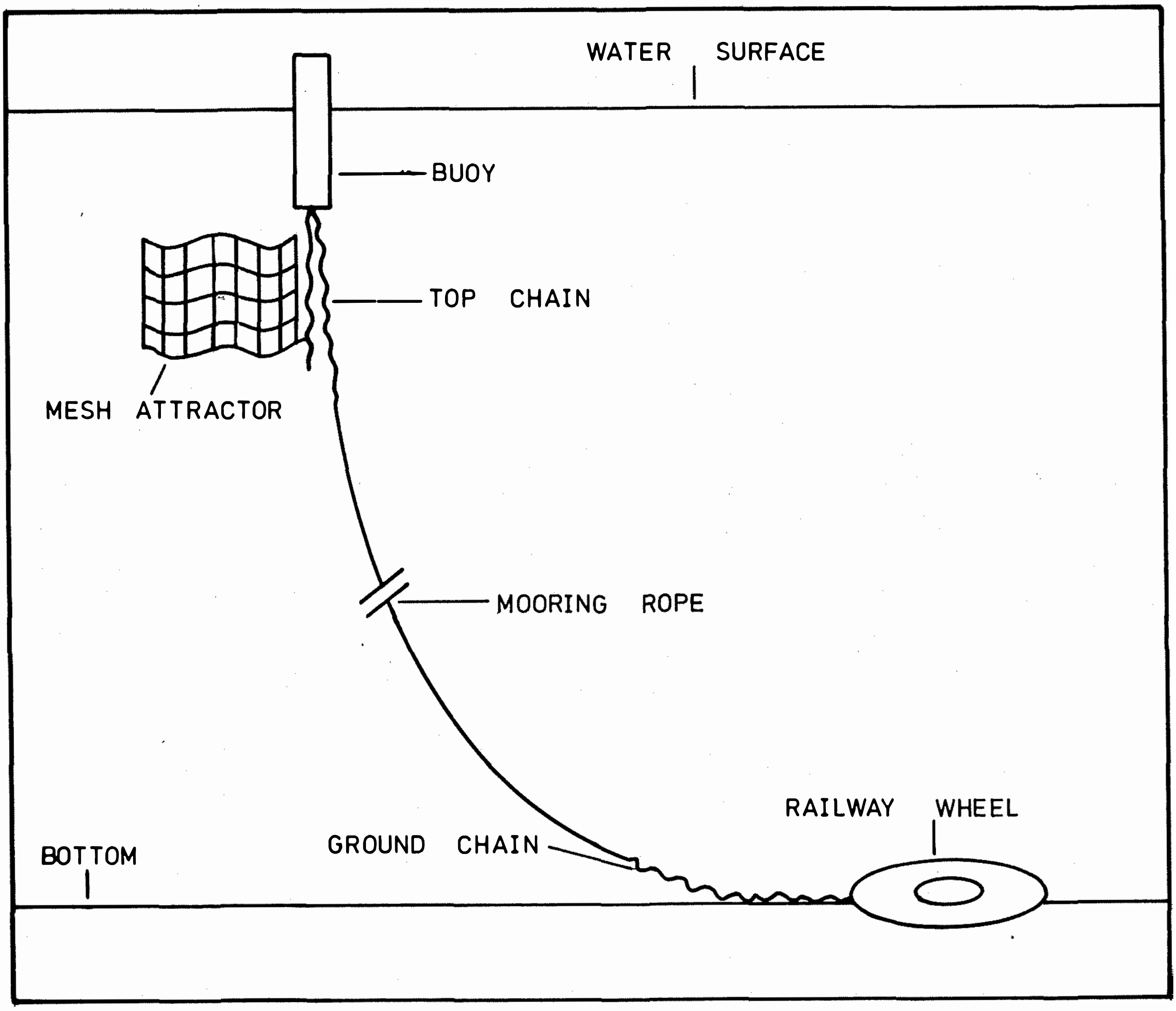
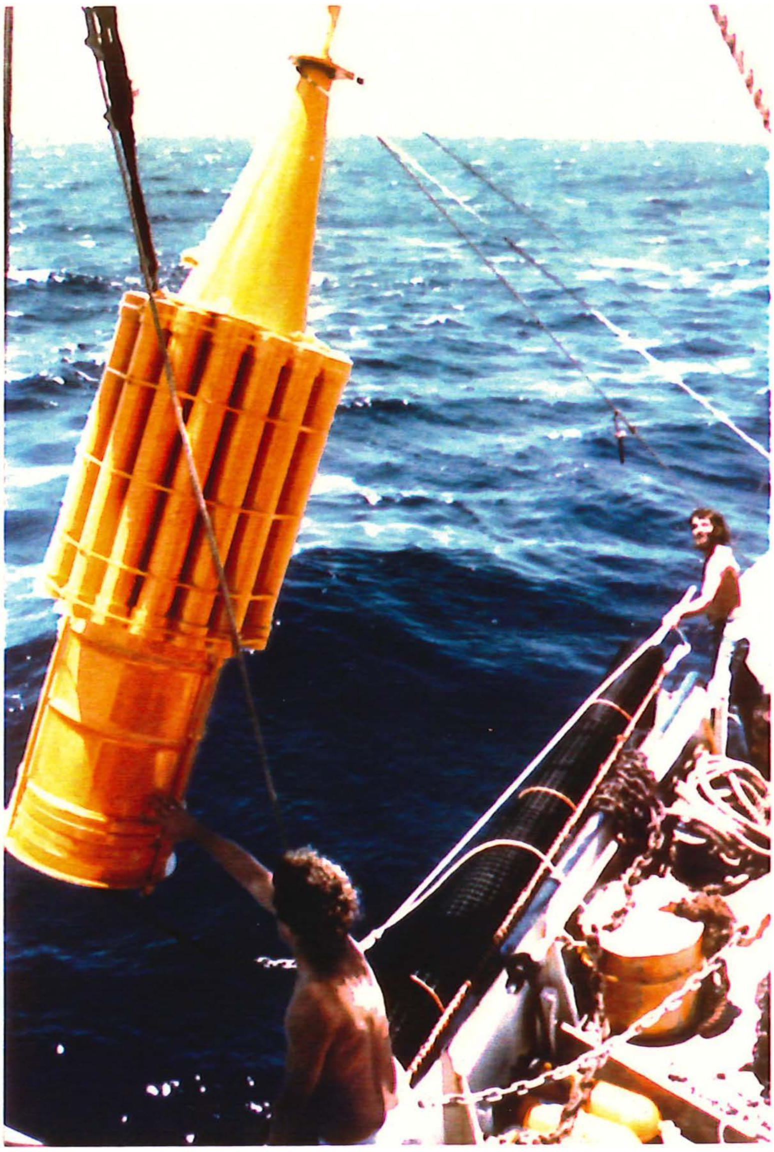
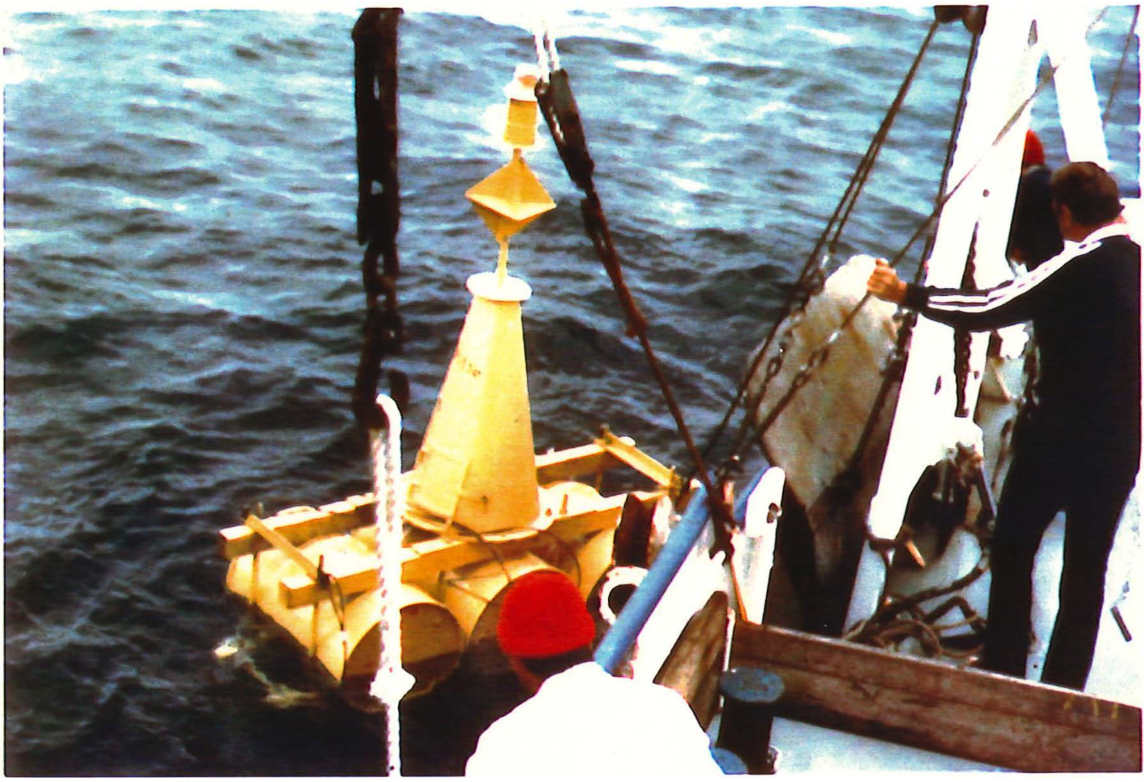


FIG. 4 DESIGN FOR TYPE 3a SYSTEM.

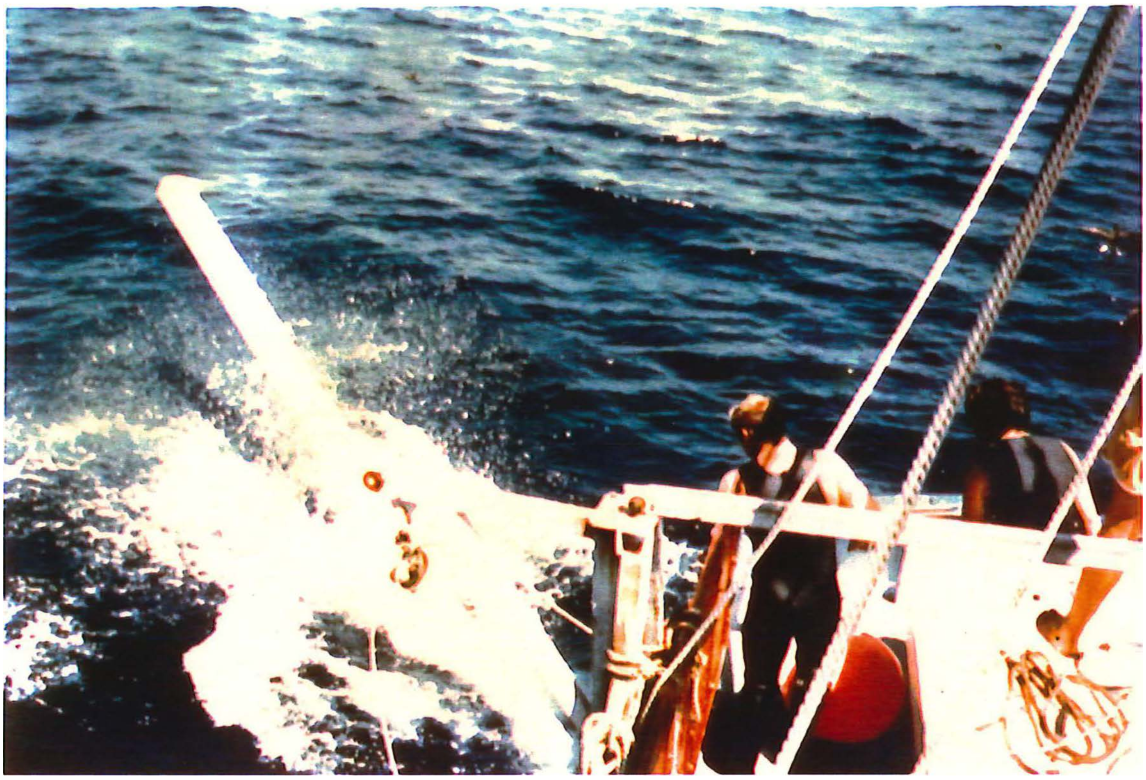




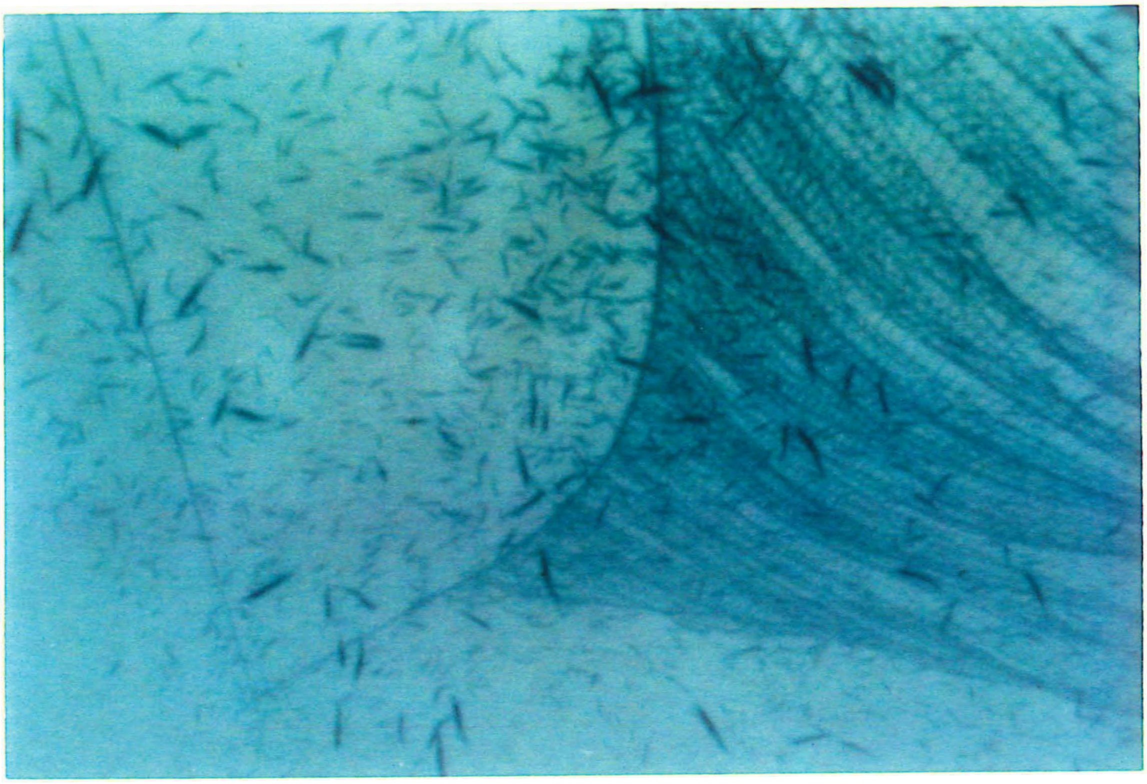
TYPE 1 F.A.D



TYPE 2 F.A.D

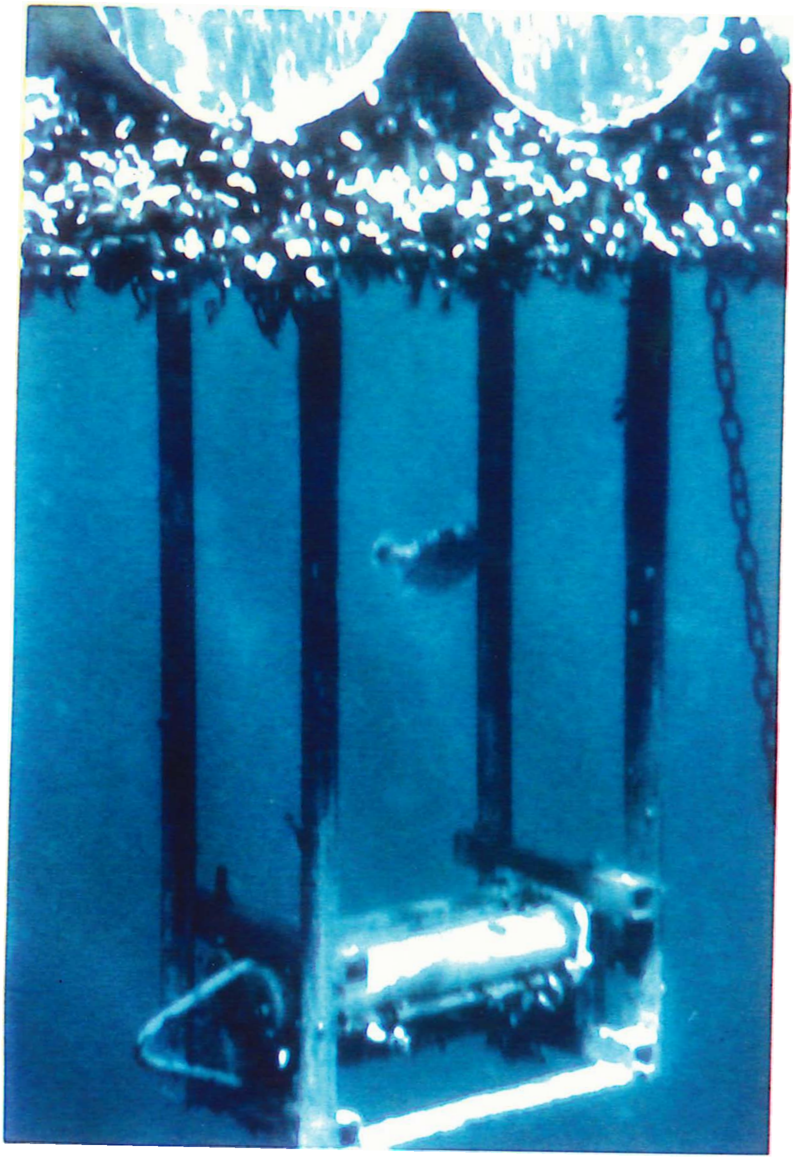


TYPE 3 F.A.D.



SCHOOL OF BAITFISH AROUND ATTRACTOR

TYPE 1 F.A.D. IN A 3 KNOT CURRENT



TYPE 2 F.A.D. SHOWING GROWTH

A SCHOOL OF DOLPHIN FISH IN THE VICINITY
OF A F.A.D. OFF SYDNEY.

A SCHOOL OF KINGFISH AROUND A TYPE 2 F.A.D.