Construction and Evaluation of an Underwater Setting Device to Prevent Accidental Capture of Seabirds on Tuna Longlines

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Tasmania

FISHERIES RESEARCH & DEVELOPMENT CORPORATION

Project No. 98/205

Construction and Evaluation of an Underwater Setting Device to Prevent Accidental Capture of Seabirds on Tuna Longlines.

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OBJECTIVES

The objectives of the three year project were:

1. To redesign and construct an improved capsule setting device which is capable of achieving a 5 second cycle setting time at a setting depth of 3m, and is safe for the crew to use in all conditions.
2. To determine the effectiveness of the capsule setting device in preventing seabirds from taking bait during setting.
3. To evaluate the impact of the capsule setting device on catch of target species.
4. To define optimum installation configuration and deployment strategy of capsule setting device in relation to the influence of propeller and hull turbulence.

NON-TECHNICAL SUMMARY

Longline fishing is one of the world's major methods of catching fish (Lokkeborg 1999). Some seabirds, particularly albatrosses and petrels have learnt to take bait from longlines while the lines are being set and when doing so put themselves at risk. If they either swallow the hook or become entangled in it, they are subsequently pulled underwater by the weight of the mainline, and drowned. Longline fishing is currently believed to be the most serious threat to the survival of albatross populations worldwide (Robertson and Gales 1998).

Many longlining countries are now requiring their fishers to take steps to minimise the accidental capture of seabirds on longlines. The Food and Agricultural Organisation (FAO) recently endorsed the preparation of National Plans of Action, to address this issue.

The Australian Threat Abatement Plan (TAP)for the Incidental Catch (or bycatch) of Seabirds aims to significantly reduce the bycatch of seabirds during longline operations by setting a maximum catch rate, and requiring use of various mitigation measures. Fishers that can demonstrate a technique of setting and hauling longlines which does not make the baited hooks available to seabirds can be issued with a permit to operate without any of the restrictions outlined in the TAP, such as night setting or weighting lines. Setting lines underwater, out of sight or reach of seabirds has the potential to be such a technique.

Two prototype underwater setting devices were developed in New Zealand in 1996, and in 1997, a joint New Zealand/Australia project to further develop and evaluate one of these devices was initiated. Funding was provided by the Australian Fisheries Research and Development Corporation (FRDC), the Australian Fisheries Management Authority (AFMA), the New Zealand Department of Conservation, MS Engineering and System

Controls Ltd. As a result of this project, a means of setting baited longline hooks underwater in a retrievable capsule has been developed.

This device is a cigar shaped hollow capsule that is open at one end, has a hinged nose cone at the other and has a slot along the upper edge. The baited hook is placed in the capsule through the open end, and the snood slides along the slot and is secured in a series of overlapping brushes embedded in the slot. The cable holding the capsule in position is released, and the capsule dives into the water until the cable is fully extended. The capsule's decent is accelerated by a heavy weight that hangs below the surface of the water. A computer controlled powering mechanism winches the capsule rapidly back into its retaining cradle.

When the capsule device is used, the baits are released eight metres below the surface of the water. When baited hooks are set in the conventional manner, they land on the surface of the water and take around 35 seconds to reach this same depth (D. O'Toole pers comm 1998). Although some seabirds can dive considerably deeper than eight metres, trials of the capsule device undertaken to date have shown that seabirds are not aware that baited hooks are being set and soon lose interest in the vessel. In addition it appears that use of the capsule may in fact provide an advantage over use of conventional line setting methods, because the bait remains firmly on the hook as the line is set. Further trials are underway to ensure the device is reliable and effective in different sea conditions, and in the presence of different seabird species.

Keywords: seabirds, accidental mortality, underwater setting

BACKGROUND

Demersal and midwater longline fisheries overlap with the foraging zones of a number of seabird species. Seabirds have learnt that longliners provide a predictable food supply in the form of squid or fish used to bait hooks and uneaten bait and offal discarded after hauling. Accidental mortality of seabirds occurs mostly when seabirds either swallow or become entangled on the hook when the longline is being set. When this occurs they are pulled underwater by the weight of the mainline, and drowned.

In 1995 the New Zealand Department of Conservation commenced research into methods to set baited tuna longline hooks below the sea surface, out of reach of seabirds. This work was funded by a levy paid by New Zealand tuna fishers. Two prototype devices were developed; one that sets the bait through a chute attached to the stern of the vessel (Barnes and Walshe 1997), and the other which delivers bait below the sea surface enclosed in a retrievable capsule (Smith and Bentley 1997). The devices were demonstrated to fishing industry representatives who reported that both have considerable potential.

Development of the underwater setting chute has continued in New Zealand with funds sourced from the fishing levy.

In 1997 funding was obtained from the Australian Fisheries Management Authority (AFMA) and the Australian Fisheries Research and Development Corporation (FRDC) for three years to develop and test the underwater setting capsule.

This report describes the results of the development and testing of the capsule during this period.

NEED

Population declines have been identified for a number of seabird species and fisheries related mortality has been implicated in these declines. The Australian Threat Abatement Plan (TAP) aims to significantly reduce the bycatch of seabirds during longline operations by setting a maximum catch rate goal, and requiring use of mitigation measures. Fishers that can demonstrate a technique of setting and hauling longlines which does not make the baited hooks available to seabirds can be issued with a permit to operate without any of the restrictions outlined in the TAP, such as night setting or weighting lines. The underwater setting capsule device is considered to be such a technique.

OBJECTIVES

The objectives of the three year project were:

1. To redesign and construct an improved capsule setting device which is capable of achieving a 5 second cycle setting time at a setting depth of 3m, and is safe for the crew to use in all conditions.

2. To determine the effectiveness of the capsule setting device in preventing seabirds from taking bait during setting.

3. To evaluate the impact of the capsule setting device on catch of target species.

4. To define optimum installation configuration and deployment strategy of capsule setting device in relation to the influence of propeller and hull turbulence.

METHOD

Design and development of the capsule device was undertaken in Warkworth, New Zealand. MS Engineering was responsible for the mechanical aspects of the device and Systems Control Ltd for the electronic components.

In year one of the project (funded by Australian Fisheries Management Authority), a test tank was constructed and the components of the device were rigorously tested for durability, and strength. Several prototype devices were subsequently built and tested at sea. As part of the current FRDC funded phase of the development, a device was built for testing on a commercial vessel by August 1999.

Prior to final construction, a series of at sea trials of various prototypes were undertaken on a chartered vessel in New Zealand. The Principal Investigator, Nigel Brothers, made several visits to assess progress and provide technical advice. David Chaffey who was selected as a suitably qualified fisher to represent the Australian industry, made two visits to New Zealand to provide technical input to the project.

Upon completion of sea trials the device was re-engineered to a high standard, incorporating all features of safety, reliability and function in readiness for shipment to Australia and commencement of performance assessments on a commercial vessel.

During his visits to New Zealand, David Chaffey realized the potential this device offered his vessel *Thylacine* (based in Hobart), and subsequently made his vessel available for assessment trials. Trials commenced in mid-September 1999 and were attended by project staff including the New Zealand developers.

Initially, dedicated trials were undertaken to obtain bait sink rate measurements using the device, to determine the best place for the device on the stern of the vessel to minimise the impact of propeller turbulence, and to familiarise crew with its operation.

Following these trials, the device was used as part of normal fishing operations targeting Southern Bluefin Tuna *Thunnus maccoyii* off South East Tasmania. Predictably, as with any such new device, problems were encountered with its design and performance. So far, it has been possible to overcome these problems with ongoing fault reckoning and modifications. The speed with which performance assessments will be completed on the *Thylacine* is dependent upon the availability of fish quota, which, at the time this report was compiled remained uncertain.

RESULTS AND DISCUSSION

Redesign, Construction And Mechanical Performance Of The Capsule.

The underwater setting device developed during this project is made up of the following components:

1. A cigar shaped capsule that the bait is placed in for delivery to the required depth. The capsule is open at one end (the inboard end), and has a hinged nose cone at the other (seaward) end. A slot runs along the top of the capsule, with overlapping brushes to hold the snood in position during deployment. The capsule is designed so that it always remains in the correct orientation. A cable is attached to the inboard end of the capsule to enable the capsule to be retrieved once the bait is delivered to the required depth.

2. A winch drum which the cable is wound on and off during capsule deployment and retrieval.

3. A weight attached to a cable that in turn is attached to the seaward end of the capsule to pull the capsule to the required depth. This weight is always below the water when the device is in use.

4. A computer controlled powering mechanism to winch the capsule in. The computer also enables the operator to set the depth the bait is delivered to.

5. A landing cradle that holds the capsule in position ready for deployment.

The device is fabricated in stainless steel with all components assembled within a compact cabinet.

With the use of Time Depth Recorders (TDR) it was determined that baits were being delivered to a depth of 8 metres in around 2 seconds. In conventional setting, it takes a baited hook about 35 seconds to reach eight metres (D.O'Toole pers comm 1998). For the capsule to complete a full cycle and release the bait at 8 metres, 6 seconds is required. Cycle time is depth dependent, and as stated above the setting depth and cycle time can be programmed to suit crew or vessel requirements, or in response to the abundance and feeding activity of seabirds around the vessel. For safety reasons, the device has an instant response shut down switch and when reset, will automatically re-program itself to the pre-shut down performance schedule (i.e. cycle time and depth). The machine will shut down if the capsule begins returning at a greater speed than the target speed. All pinch points around the machine have been removed by providing clearance around the moving parts.

A video of the capsule in use, for the first time on a commercially operating vessel has been included as part of this report).

Effectiveness Of Device In Relation To Bait Take By Seabirds.
So far, during performance testing there has been no evidence to suggest that seabirds are capable of interacting with baits set by the capsule. Observation of bird behaviour during capsule use suggests that they are not aware that baits are being set and their interest in following the vessel seems to be lost. These observations so far are confined to commercial operations during which approximately 5000 hooks were set, half in daytime, half at night without the additional protection afforded by a bird scaring line. The seabird species and abundance present during these observations was consistent with expectations in this region, and under normal setting operations would have resulted in bait taking activity. The capsule has yet to be tested in waters where these is an abundance of proficient deep-diving species, such as the smaller petrels or shearwaters. Bird species encountered during daylight setting have included those most at risk of capture by longline hooks (Table 1).

Impact Of Capsule Use On Target Species Catch.
Two aspects of capsule use could potentially have a positive or negative affect upon target species catch rate:

i) The bait setting cycle time (using 11.6 metres of cable) was 1.5 seconds slower than was normally achieved on the *Thylacine*. This was due in part to crew being unfamiliar with its use, and a need to further integrate use of the capsule with other time-related operational aspects of line setting. The position of the capsule device on the stern in relation to the snood box and line shooter are important factors to ensure maintenance of normal hook setting intervals. Even if a slightly longer hook setting interval is inevitable (this has not been proven), use of the capsule device provides fishers with the flexibility of setting their lines at any time of day or night.

ii) The affect of capsule use on bait retention on hooks and entanglement of the snood around the mainline was assessed, by setting two hundred hooks and immediately retrieving them. No instances of snood tangling or fouling on the main line were recorded, evidence that capsule setting does not pose any threat and may actually assist to obtain better line setting performance. All baits set in this instance (with the exception of one that caught a fish) were returned which demonstrated that capsule set hooks will provide optimum fishing effort.

Capsule Installation And Use In Relation To Propeller And Hull Turbulence
In conventional line setting operations any negative influence of propeller and hull turbulence is limited by baited hooks generally entering the water beyond the port or starboard corner of the stern. When the capsule is used it is not possible to avoid this turbulent region and so it was thought necessary to understand any influence of turbulence on bait sink rate, line tangling and bait retention on the hook. Again, using TDR'S baited hook sink rates were repeatedly measured at three positions; starboard, centre and port, across the stern of the vessel. Because vessel motion (pitching) actually alters the extent of turbulence, bait sink rate was compared from two depths of deployment from the capsule, one of 8.5 meter cable run (equivalent to a setting depth of around 6 metres) another of 11.6 meter cable run (setting depth about 8 metres). Irrespective of setting position bait retention and line tangle problems were not encountered.

Interestingly a central (to the propeller) setting position tended to result in the best sink rate performance although differences were only small between the three positions assessed, particularly if the capsule is being deployed to a greater depth.

In conditions of crosswind, problems have been encountered with the capsule fouling the main line when the mainline is deflected across the stern towards the point the capsule enters the water. A solution to this has been identified and is being pursued currently.

Considering all operational aspects of line setting with the capsule, a central mounting position is likely to achieve the best performance. Because the machine is relatively small, it can be readily moved to operate in any position along the stern.

BENEFITS

The potential for this device to assist in overcoming seabird interactions, has been demonstrated. Aside from the obvious benefits of achieving this, including more bait on hooks to catch fish, no serious detrimental consequences of capsule use have been identified. Although further performance assessment is required along with several minor mechanical improvements to meet industry needs, the capsule is likely to be a considerably more economical alternative than present options for longline operators to meet their obligations to the Threat Abatement Plan (TAP). Furthermore, uptake of the capsule device by industry would accelerate progress considerably toward meeting the TAP objectives.

FURTHER DEVELOPMENTS

Before a proven product can be assured for industry, further performance assessments must occur. A focus of these assessments will be proving reliability and effectiveness of the capsule over time, in varying sea conditions, and in the presence of different seabird species. If faults or deficiencies are identified during these assessments these will need to be rapidly rectified.

Funds to undertake these assessments have been obtained from Environment Australia. It would be beneficial to have several devices in commercial use in Australia to accelerate this final assessment phase and thus ensure a final product is available to industry as quickly as possible. Such installations could also be used for practical demonstrations to industry.

A direct benefit of this project was also the advancement of the other underwater setting device (chute system) developed in New Zealand. The chute system has been performance tested in New Zealand, and further assessments will commence shortly in Australia. If both devices prove effective and reliable, fishers will have a choice of ways to set their longlines underwater.

CONCLUSION

The potential of a capsule device to be developed to set longline hooks underwater in a mamer that is operationally effective and avoids seabird interactions has been realised. Certain minor modifications to improve performance have been identified and when completed, ongoing assessment should result in a device that can be offered to industry.

This project has demonstrated the ability and value of a number of organisations (Fisheries Research and Development Corporation, Australian Fisheries Management Authority, Tasmanian Parks & Wildlife, Department of Conservation, Environment Australia, Fishing Industry, along with developers MS Engineering, Systems Control), involving two countries (Australia and New Zealand), with a common problem (seabird bycatch in longline fishing) to collaborate and achieve mutually beneficial outcomes. These outcomes stand not only to benefit seabird conservation, but industry worldwide.

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APPENDIX 1: INTELLECTUAL PROPERTY

The Intellectual property relating to this project was discovered during an earlier contract let to the engineering company by the New Zealand Department of Conservation. The intellectual property can be best described as a method of setting baited pelagic longline hooks underwater using a retrievable capsule. Intellectual property may be considered to reside with all organisations that have been involved in development so far: the New Zealand Department of Conservation, the Fisheries Development Corporation, Environment Australia, the Australian Fisheries Management Authority, the Tasmanian Department of Primary Industries, Water, and Environment, and MS Engineering.

Currently, the engineering firm involved (MS Engineering) consider the risks too great to enter into a commercial situation, as the device has only been used on one vessel. A New Zealand fishing company has indicated interest in trialling the vessel on one of their vessels (which is in a different size class to the vessel used so far). Trials with this vessel are likely to occur in May 2001. MS Engineering considers that there is a need to trial the device on a range of vessels before industry will gain confidence so that any engineering company is likely to enter into a commercial situation.

APPENDIX 2: STAFF

Mike Smith, MS Engineering, Warkworth
Kim Subritzky, MS Engineering, Warkworth
Noel Bentley, MS Engineering, Warkworth
Chris Chandler, System Controls Ltd, Auckland
Duncan Thompson System Controls Ltd, Auckland
Dave Chaffey, owner, F.V. Thylacine, Hobart
Paul Barnes, Paul's Fishing Kites, Auckland
Harry Verney, charter vessel owner, Warkworth
Tim Reid, Department of Environment and Land Management, Hobart
Nigel Brothers, Department of Environment and Land Management, Hobart
Janice Molloy Department of Conservation, Wellington

Date	Species	Counts during line setting with the capsule (15 minute interval 500mX500m astern)					
14-Jun	Shy albatross	2	2	3	6	5	
	Black-browed albatross	1	2	2			
	Buller's albatross				1	3	
	Yellow-nosed albatross		1			1	
	Giant-petrel sp.		1	2		1	
	Cape petrel		1	1	1	1	
	Fairy prion		1				
	Grey petrel				1		
15-Jun	Royal albatross	2					
	Shy albatross	1	9				
	Black-browed albatross	1	1				
	Cape petrel	4	8				
	Great-winged petrel	2	1				
	White-headed petrel	1					
	Grey petrel	2					
16-Jun	Royal albatross				2		
	Shy albatross	4	3	19	50		
	Black-browed albatross				1		
	Buller's albatross			5	5		
	Yellow-nosed albatross			2	2		
	Giant-petrel sp.				1		
	Cape petrel		1	1			
	Fairy prion				5		
	Grey petrel				1		
	Sooty shearwater	1					
16-Jun	Shy albatross	10					
	Buller's albatross	1					
	Cape petrel	4					
	Crested tern	4					
18-Jun	Wandering albatross				1		
	Royal albatross				1		
	Shy albatross	9	11	16	7		
	Black-browed albatross	2	2	2	3		
	Yellow-nosed albatross		1	1			
	Giant-petrel sp.				1		
	Cape petrel	2	3	3	5		
	Great-winged petrel	1			1		
	Fairy prion				1		
19-Jun	Royal albatross			1	1	1	
	Shy albatross	8	12	5		3	1
	Black-browed albatross		1				1
	Buller's albatross	1	3		1		
	Yellow-nosed albatross			2			
	Giant-petrel sp.			1	1		
	Cape petrel		2			2	3
	Sooty shearwater				1		
	Australasian gannet				2		
20-Jun	Shy albatross	1	3	1			
	Black-browed albatross	1	1				
	Buller's albatross	4	1				

	Yellow-nosed albatross			1			
	Giant-petrel sp.			1			
	Cape petrel		1				
	Fairy prion		1				
28-Jun	Wandering albatross						1
	Royal albatross			1	2	1	2
	Shy albatross	1	4	15	2	3	2
	Black-browed albatross			1	2	1	1
	Yellow-nosed albatross				1	1	
	Giant-petrel sp.			2	3		1
	Cape petrel	1	2	2	7	4	7
	Great-winged petrel				1		
	Antarctic prion						1
	Grey petrel					1	1
29-Jun	Royal albatross	2	4	4	1	3	3
	Shy albatross	4	15	23	17	10	20
	Black-browed albatross			1		1	1
	Buller's albatross		1	2	2	2	1
	Yellow-nosed albatross					1	1
	Giant-petrel sp.			1	2	1	2
	Cape petrel			1	4	10	6
	Grey petrel	3					
	Fairy prion		1				

Table 1. Species and number of seabirds observed every 15 minutes in a 500mX500m area astern of the vessel during line setting using the capsule.

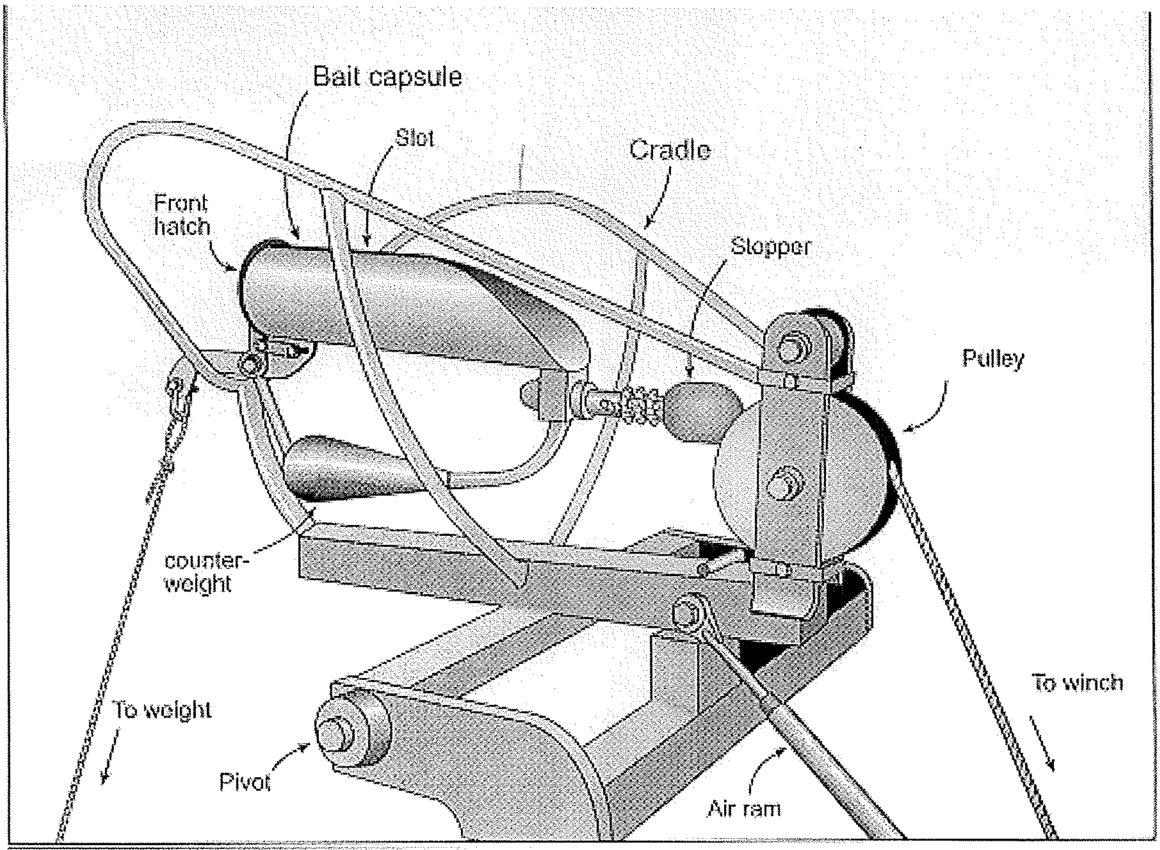

Figure 1. Bait capsule in cradle.

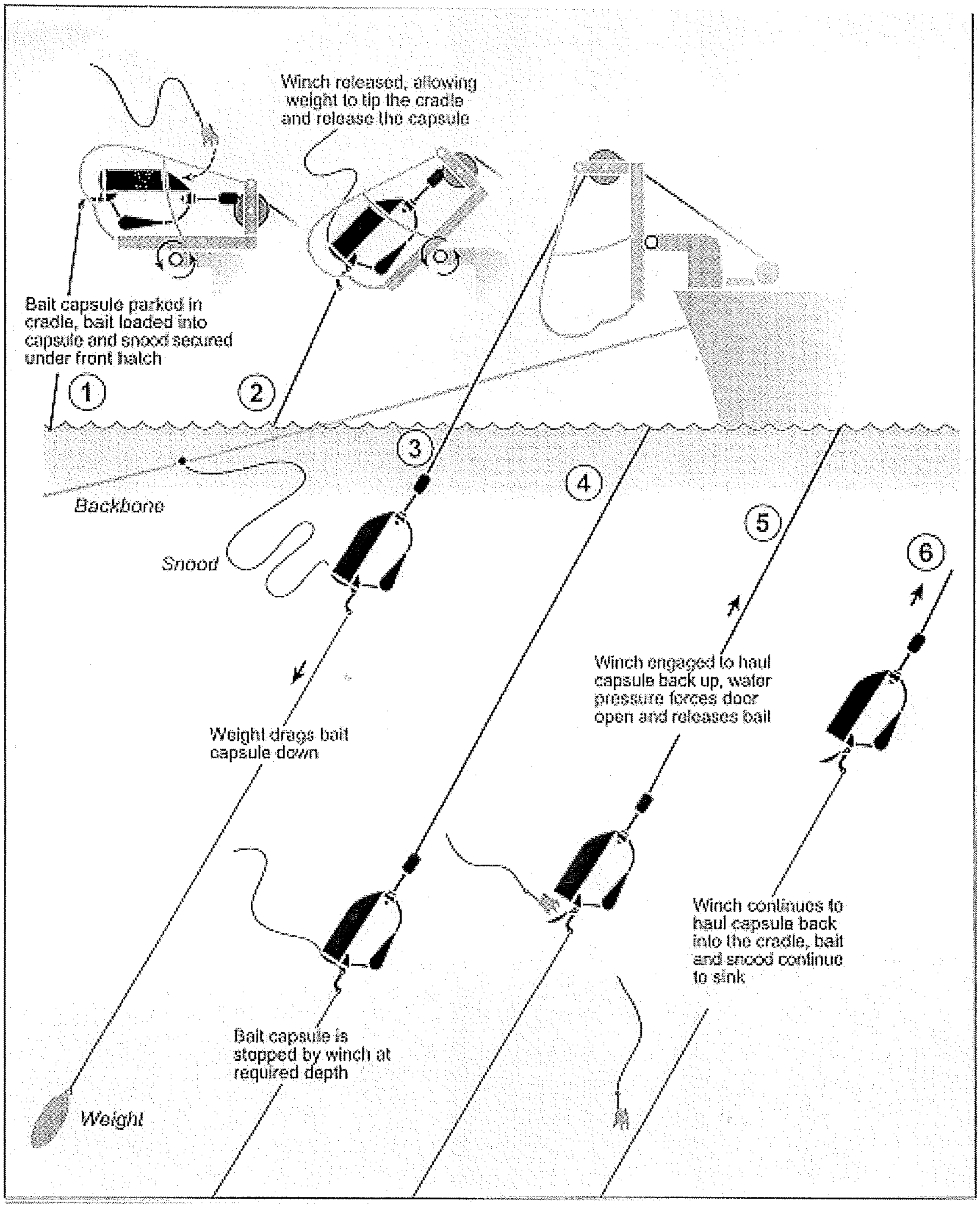

Figure 2. Operation of bait capsule.