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A mechanised Bait Throwing Device for Longline Fisheries.

Performance Assessment of a Test Machine.

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SUMMARY

The following unpublished Report (Dept. Parks, Wildlife & Heritage Tasmania 1993) is the only detailed account of BCM function and performance. It has been made available here to assist SBWG Members in consideration of **SBWG8 Doc 19**, Recommendation 1.

One of the main problems with mitigation measures is reliable uptake. BCM is currently used widely for its operations and economic benefits. Any investigation of uncertainties about the consequence of BCM use as proposed by Doc 19, must not undermine the fact that BCM is capable of providing seabird conservation benefits and can reliably do so because of its wide acceptance in the industry. Care is necessary in acting upon the suggestion that BCM is negatively impacting on seabird bycatch. Therefore ACAP might initially seek information from Japan's scientists who analyse their CCSBT fishery observer data and who may also have industry-wide BCM information, including whether all machines incorporate the desirable seabird bycatch mitigation capabilities and whether these are being used appropriately. If and when appropriate, the BCM bycatch mitigation fact-sheet (no.11) could then be updated together with relevant sections in fact-sheets 7a, 8 and the draft sheet (**SBWG8 Doc 08**) for Hook Shielding devices. In addition, it is unknown whether collection of any BCM-related data has been added, as previously proposed, to vessel mitigation measure standard documentation, which should apply across all relevant fisheries.

BACKGROUND TO DEVELOPMENT

In the longline setting operation baited hooks (approx. 3,000 per day) are thrown manually, by crew members from the ship's stern port side. Throwing clear of the ship is the objective, ensuring that each 40 metre branchline to which a baited hook is attached sets uniformly in the water without tangling, not only on itself but on the main longline as well. Throwing clear of the ship is also necessary to reduce bait loss from the hook and line tangles in water turbulence created by the ship's propeller.

Extensive studies from 1988 to 1992 showed clearly that increased loss of bait to birds and death of birds was because of the following factors, all of which relate to the fact that baits are thrown manually.

1. Baits that are thrown less than 5 metres from the ship are far more likely, in fact 5 times more likely, to be taken by birds. More than 20% of baits can be at greater risk of being taken by birds for this reason. Those that are not thrown clear of the ship are more likely to be taken by birds because of water turbulence from the ship's propeller keeping them near the surface of the sea for longer.
2. As all baits are thrown to the same position in the water seabirds concentrate their search in this area so few baits escape detection if they are accessible.
3. It is necessary that baits are thrown clear of the ship and for efficient manual bait throwing crew are restricted to throwing off the port side of the ship. Therefore, on occasions where wind strength above 20 kts and or rough sea conditions onto the ship's port side – the side to which baits are thrown, loss to birds increases significantly (30%) as do branchline tangles. There are two reasons for the increase in bait loss and line tangles in such conditions. Firstly rough sea conditions onto the port side greatly reduces the rate that baits descend from the surface so more baits are accessible to birds for longer. Strong wind onto the port side reduces bait throwing distance such that all baits no longer fall sufficiently clear of the ship to avoid the influence of propeller turbulence – more baits accessible to birds, more line tangles, more bait loss in turbulence.

The potential of a mechanised bait throwing device to overcome the above problems became apparent during the first voyage, on Japanese longline vessel Shoei Maru 52 8LEM in 1988. The concept of such a machine was discussed with the vessels Fishing Master, Koji Ito and with his input initially, and throughout subsequent development it was possible to formulate broad function specification objectives for a bait casting device. These were:

a) a cycle time of less than 5 seconds to match existing bait setting frequency of around 5.7 seconds

b) versatility of throwing to either port or starboard

c) throwing distance of 10 metres or more

d) integration and operation without disruption to existing line setting procedures

Development of the machine proceeded with Australian Engineering Companies, Double Cone Developments and Munro Engineers and a prototype machine was ready for testing in 1991. However, mechanical problems throughout an 86 day voyage delayed successful progress with testing until 1992 by which time considerable advancement in the machines performance and design had been made.

TESTING

Logistics and Operational Summary

It was agreed, again through the co-operation of Japan Tuna, Kiichiro Yorozuya Shoei Maru 52 (JRXG) owner and the Fishing Master of the vessel Koji Ito that the machine for testing would be installed on Shoei 52 in Auckland New Zealand and the author would be permitted to remain aboard the vessel for the duration of the SE Indian Ocean fishing campaign. The 90 day voyage commenced on 4 August 1992 from Auckland and finished on 2 November 1992 in Freemantle.

Fishing operations occurred on 69 days and the machine operated on 59 of these. Operation of the machine was prevented for setting 532 hooks on 11 October due to abrasion of a hydraulic oil hose and on 19 October machine operation ceased following damage by a hook to a hydraulic oil hose for which there was not a replacement.

Apart from these exceptions the machine was used for all of each days line setting, totalling approximately 325 operating hours (5.5 hours/day) during which time it threw 173,484 baited hooks.

Fishing operations occurred in two fishing grounds, the Indian Ocean Southern Bluefin Tuna (SBT) fishing ground and the Freemantle Big Eye Tuna fishing ground (30 degrees South 101 degrees East). In the Indian Ocean fishing ground the machine was used to set all of the 149, 840 baits. Because operating conditions, target species and bird abundance and species diversity are very different between the two fishing grounds, information on machine use in the Indian Ocean only was selected for detailed examination of the machines performance.

Catch Rate of Southern Bluefin Tuna

The following is a summary of SBT caught by Shoei 52 whilst the machine was in operation. Catch rates of other vessels, for comparison were not available at the time this report was compiled. Regardless of how the test vessels SBT catch rate compares to other vessels the author cautions strongly against any conclusions being drawn owing to the notoriously variable inter-vessel catch rates for which a number of factors and combination of factors are responsible.

Total weight of SBT catch	11,399kg
Total number of SBT caught	258
Total number of SBT less than 40kg	135
Total number of SBT greater than 40kg	123
Average weight of all SBT	51kg
Average daily catch	228kg
Hook number	149,840
Days fishing	50

Machine installation for testing aboard Shoei 52 was affected by the following design feature that, as far as the author is aware, is unique to this vessel. The branchline conveyor used in line setting had been constructed to place the bait throwing position as far to the port side of the vessel as possible in order to reduce problems caused by baits entering the water too close to the vessel. All other vessels have a conveyor centrally located so their problems of bait loss and line tangles in propeller turbulence are aggravated. However because of the layout of line setting apparatus on Shoei 52 it was necessary to mount the throwing machine on the vessels stern port side which meant that it was not ideally situated in terms of operator access of for throwing equally well to port and to starboard. (This problem of machine positioning was improved with installation of a new machine after the test voyage).

Performance Assessment

The capacity of the machine to meet all of the function specifications that had been identified as necessary was clearly demonstrated throughout the test voyage.

a. <u>Cycle time</u>

The time interval between each baited hook thrown manually from the vessel is 5.7 second, which was easily matched by machine throwing. With machine operation it would be possible to increase hook timer interval to between 3.5 and 4 seconds. This ability has obvious advantages for potentially increasing fishing effort or maintaining present fishing effort but reducing actual work time – which ever of these two operations are taken advantage of the result is increased profitability.

b. <u>Starboard side bait throwing</u>

On two separate occasions limited starboard throwing trials were undertaken. Because starboard throwing necessitates that the branchline with hook attached passes over and across the longline there were initial concerns that line-tangling would occur.

The first starboard-throwing test was in conditions of rough seas and wind onto the ships port side. Prior to commencing the starboard test bait loss to birds was assessed at 90 per thousand hooks.

During the starboard throwing no bait loss occurred but on resuming port side throwing bait loss increased again to 60 per thousand hooks. To assess the suitability of starboard side throwing in terms of line tangling rate, 100 hooks prior to and 100 hooks after the starboard test period were monitored during line hauling. In the periods before and after starboard throwing an average of 2.5 lines per hundred tangles and 6.5 minor line twists occurred. During starboard throwing 2 lines tangled and 3 minor twists were recorded. The second starboard throwing test occurred in quiet weather conditions. On this occasion there were 2 line tangles in 100 hooks to starboard and 9 in 100 hooks to port. Whilst the results of these tests must be viewed with caution owing to the short duration of testing it is likely that only further improvement on the reduction in line tangles and bait loss will be achieved under conditions when starboard throwing is desired. Easily learned but new skills are necessary for crew to develop when throwing to starboard and these can only be learned through prolonged starboard side operation of the machine.

A true test of the advantages of the machines starboard side throwing capability would involve changing from port side manual throwing to starboard side machine throwing. Such testing on a commercially operating longline vessel is impractical. However, during past voyages when manual throwing only was employed bait loss in unfavourable conditions for port side throwing can be as high as 100% with a similarly dramatic increase in line tangles.

c. <u>Throwing distance</u>

To develop a machine capable of throwing baits a distance of 10 metres to the side of the ship was the target as previously it was found that bait loss was 5 times higher with short distance throwing. Unimpaired by wind onto the ships port side, the machine threw consistently 20-23 metres. In the strongest wind conditions onto the ships port side, 10 metres throwing distance was still achieved (conditions when throwing to starboard should have been instigated). In terms of fishing efficiency the greater the distance the better, however there is a compromise here that must be understood. Regardless of how far from the vessel baits are thrown it is still necessary to protect the bait from loss to birds in the first 10 seconds by:

1) Using a streamer line and

2) By having the bait enter the water right at the outer edge of water disturbed by the passage of the ship. This distance can be achieved with greater accuracy in all weather conditions by using the machines instantaneous response distance gauge adjustor. There was a tendency for the machine to throw further than the protection of the bird pole and streamer line on the test voyage, a problem readily overcome with correct installation of the equipment along with a greater understanding of optimum throwing distance (which is not necessarily as far as possible). In addition, there is a relationship between distance thrown and branchline tangles. At maximum machine throwing capability the frequency of line tangles (usually minor at swivels) was greatest, at 3.2 per thousand hooks.

   It is difficult to assess with accuracy this aspect of machine use as the greatest influence on frequency of line tangles is the competence of all crew-members at line coiling during hauling operations. Inexperienced, lazy or incompetent crew-members increase line tangle rates significantly and would have contributed to a proportion of the tangle rate observed. The compromise in throwing distance referred to earlier applies also to line tangles. At the optimum distance for bait protection the line tangle rate was less than that indicated in the above figures but even the above rate at maximum throwing distance was considered irrelevant by the vessels crew in terms of the overall improvement in this area with machine use, especially in rough weather.

e) <u>Integration</u>

In terms of integration without disruption to the line setting operation the machines ability to equal and, in fact better the usual hook setting interval was first priority (see cycle time section).

The physical dimensions of the machine are such that, should a breakdown occur or for any other reason it is found necessary to revert to manual throwing this ability is not lost with machine installation. During the test voyage 31,957 of the 205,441 hooks set were manually thrown with the machine still mounted in the operating position.

The attitude of crew members to the machine as well as their ability to operate the machine is a very important part to be considered in the process of integration. Generally the most experienced and competent crew members recognise the potential benefits of the machine however, understandably all were initially sceptical of its capabilities. Despite the added difficulties of having to become familiar with machine use in rough weather conditions of the Indian Ocean fishing ground crew members became competent in operating the machine very rapidly.

Thirteen crew members used the machine routinely (another 5, including the Fishing Master operated the machine less frequently) and their performance was monitored almost continuously amounting to approximately 10,000 bait throwing operations each (about 650 operations every third day for each individual). It was observed that all crew members, after their third day of machine use had become fully competent although there remained some difference in competence between crew members. The most inexperienced crew members who had, previous to machine installation been excluded from manual throwing because of incompetence, were permitted limited time on machine throwing and had little difficulty with the operation. Crew members were reluctant to experiment with the machines versatility – port/starboard throwing and throwing distance variability which meant that the full advantage of machine use was not attained.

Bait loss to birds and bird mortality

As discussed previously mechanised bait throwing can overcome problems present in manual throwing that contribute significantly to increased bait loss and death of birds.

Although the capability of the test machine to overcome these problems was well demonstrated its functions were by no means fully utilised during testing. This is one of several reasons why the results of machine performance in terms of bait loss and bird mortality should at this stage be regarded as inconclusive.

This situation is also aggravated by the fact that the author was prohibited up to the time of preparing this report from using relevant data, for comparative purposes, that were obtained by observers on vessels operating in the same region during the test voyage.

A total of 19 seabirds, 7 Black-browed albatrosses, 7 Grey-headed albatrosses, 3 Royal albatrosses, 1 Giant petrel and 1 Flesh-footed shearwater were caught from 149,840 hooks set, an average of 0.12 birds per thousand hooks.

Comparing the catch rate and bait loss rate of one vessel to another or one season to another can produce dangerous misleading, inaccurate, results because of the variables and combinations of these variables that influence catch rates. Having said this, a 71 day voyage in the same fishing ground last year caught 26 birds from 213,140 hooks (0.12 birds per thousand hooks). The catch rate of bird from these two voyages if alone taken as evidence of the effectiveness of machine use, indicate that it was of no benefit in reducing interference by birds. (On both voyages streamer lines were used, a device that reduces bird interference by 70% and manual bait throwing in 1991 was with a crew who had been educated to throw correctly – a factor that aided greatly in reducing bird interference). Previously documented seabird mortality was about 0.42 birds per thousand hooks. However, if the frequency of attempted bait taking by birds during the two voyages are compared the difference is significant. Birds attempted to take an average of 8.5 baits per thousand and of these 2.5 per thousand were successfully taken (174,873 hooks observed) in the 1991 voyage. With machine use birds attempted to take an average of 2.7 baits per thousand and of these 1.4 per thousand were successfully taken (136,980 hooks observed). With the exception of 3 birds caught during machine use that were not observed, the cause of death of all other birds (also bait loss) was observed and none was as a consequence of the problems associated with manual bait throwing that contribute significantly to bird deaths.

Bait condition is also a major consideration. With manual throwing there is a tendency for a high percentage of bait to be frozen or part frozen, a deliberate strategy by vessels to reduce bait loss from hooks that occurs if baits are soft when thrown. The result of setting frozen or part-frozen bait is greatly increased loss to birds as bait in this condition floats. Because of the throwing action by machine operation (no line tension on the bait and gentle trajectory) baits are not lost from hooks during throwing even with soft or thawed bait. This advantage of machine use led to the establishment of a bait thawing routine by crew-members. However, the great advantage of adopting this strategy was reduced by the frequency of bait, particularly muro aji (mackerel) on the test voyage that had swim bladders full of air. Regardless of bait throwing, fish with inflated swim bladders float or do not sink sufficiently fast to avoid being taken by birds. Twelve of the fifteen birds for which a reason for being caught was determined took floating muro aji baits. Obviously, regardless of mechanised bait throwing and all its advantages the condition of swim bladders in the bait will continue to contribute to significant economic loss and high bird mortality unless a method of expelling air contained in the bladder is found. Samples of bait used during the test voyage were dissected and it was found that 90% of muro aji swim bladders contained sufficient air to cause them to float or reduce their sink rate whereas a very small percentage of saba and uwashi (sardines) were in the same condition. About 20% of Ika (squid) bait was more buoyant because of trapped air within the mantle.

The greatest economic impact, in terms of bird interference is the longline fishing occurring when species such as White-chinned petrels, Flesh-footed shearwaters, Short-tailed shearwaters and Grey petrels are present in large numbers. These species are proficient deep divers and retrieve large numbers of bait to the surface, thereby increase the vulnerability of albatrosses to being caught. They are also capable of avoiding to some extent the protection afforded to baits by streamer line use which again aggravates albatross bycatch. The machine test voyage finished prior to the arrival of large numbers of White-chinned petrels, which seems to occur in the last week or two of October in the Indian Ocean so the machine's capability to assist in reducing bait loss under such conditions was not assessed.

However, it is worth noting here the potential in the machines ability of starboard-side as well as port-side throwing to reduce interference by such species. With manual throwing, to port only petrel species learn to concentrate their bait search in only one area so few baits escape detection whereas with the versatility of machine throwing direction, bait detection by the birds can be greatly reduced. (A combination of high petrel abundance and port-side wind and sea conditions has been observed to result in almost total bait loss during manual throwing). Also, with a trend toward night-setting of longlines by vessels in recent years to avoid bait loss, machine throwing will be a great asset. Night-setting stops interference by albatrosses almost completely however certain petrel species are active night-feeders. Versatile direction of bait throwing by machine is the only way to reduce petrel interference. Other species of seabird, the Brown skua although only occurring in small numbers associated with longline vessels can be responsible for significant bait loss owing to its bold, aggressive nature (avoids streamer line protection to take baits right alongside the vessel). Crew members during machine testing very quickly realised that bait loss from hooks to this species can be avoided simply by using the machine to throw several baits (no hook attached) directly to the bird. The result of this is to satisfy the bird's appetite deliberately thus preventing the loss of many baits from hooks, most of which are immediately 'stolen' from the skua by albatrosses – skuas' appetite is not satisfied so it persists in taking more baits.

Performance Summary

Performance assessment of a bait throwing machine developed to assist in reducing seabird bycatch on longline fishing hooks and by so doing improving fishing efficiency revealed that it has the capability to largely overcome all the bird problems caused by traditional, manual bait throwing. The most obvious economic advantage is catching more fish because birds take less bait. Other economic advantages forecast are subtle but nevertheless just as significant to the longline industry. Assessing the advantage of machine use in Yen is very difficult and complicated at this stage but is likely to be considerable – this is so particularly if, for example, vessels utilise the machines efficiency to increase line setting speed and by so doing increase fishing effort or decrease actual working time.

Work effort by crew is less with machine throwing and reduced frequency and severity of line tangles also makes life easier for crew members. These factors are particularly important at present owing to competition between vessels for experienced crew members of which there are few. Vessels that are equipped with throwing machines are likely to become more attractive to crew members. These are additional important economic considerations as is the increasing number of inexperienced Indonesian and Korean crew members being employed who, because of their inexperience affect the efficient, economic operation of vessels. Mechanical bait throwing will contribute greatly in this area to the fact that even the most inexperienced crew member can rapidly become proficient with machine throwing. Full integration of the machine may reveal the potential to reduce the present number engaged in line setting from five to four crew members.

More extensive machine use is necessary before its role in reducing seabird bycatch will be clearly evident. As an aid to longline fishing and fishing efficiency the machines capabilities were well demonstrated during the test voyage. Further evidence of this is the fact that the crew who participated in the test were enthusiastic about a new, further improved machine that was installed for use during the remainder of the vessels fishing campaign prior to returning to Japan in January 1993. Also, by January 1993 two other Japanese longline vessels had placed orders for machines.

Operational Summary

The machines effectiveness is reliant on correct use which will only be achieved with persistent operation and education of crew members to the advantages (those advantages that are not immediately obvious). Adjusting the distance and direction of bait throwing in relation to sea and weather conditions is essential as is a strict regime of frozen bait thawing and deployment of properly constructed streamer lines and poles, one for port side throwing, one for starboard side throwing. The problem of bait fish swim bladders being full of air is a high priority matter for the industry to overcome.

The present trend toward night-setting by longliners is the direction for the future and a combination of this strategy along with mechanised bait throwing will be the most valuable contribution that the longline fishery can make in terms of improving fishing efficiency and achieving a conservation objective of minimising the severe impact of the fishery on seabird populations world-wide.

ANNEX 1

Economic Potential

The following calculation should be used only as an indication of the machines potential economic benefits. The figures presented are related to fishing efficiency only and do not include other aspects of potential economic advantage discussed in the report.

These calculations are based upon the following figures:

1.	Daily operating cost of longline vessel	$10,000
2.	Operating days per year	200
3.	SBT hooking rate average	0.33 %
4.	SBT average weight	62.8kg
5.	SBT average price per kg	$50

Present timer speed of 5.7 sec per hook = 4.75 hours to set 3,000 hooks
Machine use may permit 4 sec per hook = 3.3 hours to set 3,000 hooks
<u>OR</u> at 4 sec per hook for 4.75 hours set 4275 hooks

1. <u>Maintain fishing effort with reduced operating time</u> – potential saving

   Time saved per set = 1.45 hrs/day.
   200 (work days/year) x 1.45 (hrs/day saved) = 290 hrs (12.08 days).
   12.08 x 10,000 (daily operating costs) = $120,800 PROFIT
   (Assumes that actual saving is the whole amount of a days operating costs, which is not strictly correct but, in theory it will take 12.08 days less to catch the same number of fish).

2. <u>Increase fishing effort with same operating time</u> – Potential saving
   4 sec hook interval increases hooks set by 1,275 in 4.75 hours
   1,275 x 200 (work days/year) = 255,000 (annual increase in hooks set)
   0.33% of 255,000 =841 (number of SBT at average hooking rate of 0.33%)
   841 x 62.8 (SBT average wt) x 50 (SBT average $/kg) = $2,640,740 PROFIT

3. <u>Bait loss reduction</u> –Potential saving
   (based upon conservative figures and assume Indian Ocean operation only)
   Bait loss without machine 2.5 per 1,000
   Bait loss with machine 1.4 per 1,000

   a) Maintaining present fishing effort
      3,000 (hooks set/day x 200 (days fishing/year) = 600,000
   b) Increase fishing effort
      4,275 (hooks set/day) x 200 (days fishing/year) = 855,000

1) Bait loss without machine
   2.5 x 600 = 1,500 baits lost per year

0.33% of 1500 = 4.95 fish lost x 62.8kg x \$50 = \$15,543 loss

2) Bait loss rate with machine
   1.4 x 600 = 840 baits lost per year
   0.33% of 840 = 2.77 fish lost x 62.8kg x \$50 = \$8704 loss

3) Bait loss rate with increase in fishing effort from machine use.
   1.4 x 855 = 1,197 baits lost per year
   0.33% of 1,197 fish lost x 62.8kg x \$50 = \$12,403 loss

Therefore there is a potential saving of \$6,839 with maintained fishing effort and machine use or with machine use and increased fishing effort potential profit is \$2,640,740 - \$12,403 =\$2,628,337.

Remember that on certain days (and these may coincide with a peak in SBT hooks rate so economic impact will be considerable) bait loss can be around 75 per 1,000 without machine use and in the same conditions with machine use this can be reduced to near 0.

So, on such days savings can be conservatively calculated at:
75 per 1,000 baits lost = 255 per 3,000 hooks
0.33% of 225 = 0.74 fish lost x 62.8kg x \$50 = \$2,331 loss/day
or \$466,200 per year

A considerable improvement in these figures will result from correct installation and operation of the machine, particularly if this is simultaneous with the use of other strategies to reduce bait loss to seabirds mentioned in this report.

Postscript August 2017

This particular BCM was manufactured and distributed for less than two years during which time a copy was produced in Japan. It is not known how many of the approximately 200 machines supplied to ships in that initial four-year period remain in operation today and after 1998 when up to half distant water longline vessels were BCM equipped, it is not known how much more prevalent they were to become. Of three different type manufacturers at that time the one producing appropriate capacity devices ceased manufacture.

It is likely, since 1998 that engineering refinements have been made in response to operational objectives fishermen have specified of BCM that may have included further bird interaction avoidance capabilities.

Below is an outline of specific attributes of the original machine that provide the bird bycatch mitigation benefits. When these particular features were not incorporated into other later/copy BCM models, the mitigation benefits were greatly compromised. Note that BCM's throwing **distance** is not the only capability related to bird mitigation performance.

1. The gimbal motion in the original machine enables a flat throwing trajectory causing the throwing arm to travel in a near horizontal arc. The unit must be gimbaled to

compensate for ship roll. If the machine is not gimbaled or it has a high throwing arc, branchlines will go over, not under BSL and tangle.

2. A throwing **distance** controller is essential in order to:
   a) adjust for wind direction and strength.
   b) to ensure exact bait placement under the BSL.
   c) to ensure bait placement at the edge of the wake to conceal bait.
   d) to ensure bait placement at the edge of the wake to ensure optimum and immediate sinking.
   e) enable BCM installation to be adjustable. Installation position relative to ship centerline alters the machines distance capability, so the throwing distance control mechanism accommodates this variation.
3. Throwing **direction** option of both port and starboard during a set, is critical for bird mitigation because alternating sides:
   a) helps to avoid birds becoming habituated to one single point of water entry. It can be especially helpful during times of peak bird interactions involving white chinned petrels/shearwaters together with albatrosses.
   b) because changing the direction of the throw can be used to maximise the machines performance in different weather conditions such as wind direction and strength relative to setting course.

It is believed that some of the above features necessary for effective bird bycatch mitigation were excluded from the earliest Japan made copies of BCM’s in order to reduce manufacturing costs. The full significance of benefits from BCM had not been evaluated and realized in the industry before the cheaper (less effective) copies came on the market (within 2 years). Because of this, the industry only ever had the benefit of one aspect of this device – that of labour saving from not manually casting baits. The most important capability of the machine - that of bird bycatch mitigation was never fully realized by the industry. Fishermen have missed out, and the birds have also suffered as a consequence.

BCM performance assessment occurred at a time of great resistance to the idea of weighting lines in order to improve sink rate. Weighted lines become a major consideration if incorporating a mechanical bait throwing device. Incorrect positioning of weight is likely to affect the throwing distance of BCM, and entanglement rates might rise – discouraging uptake of either weighting and BCM, or both. The best BCM performance is likely to be gained from placement of weight closer to the hook, which is also preferable for bird mitigation.

A BCM with the right features can be used effectively with side setting. This is an important fact that will become more relevant in the future when the economic and practical advantages of side setting are fully realized through incorporation in new ship design.

Mechanised bait casting by any such device could actually be alleviating the manual casting deficiencies that aggravate bird interactions the most, particularly the consequence to birds of shorter manual cast distance. And, if lines were to be appropriately weighted and set at night or weighted and day set under vessel-specific BSL deployment, the most important component of which is placement and design of the tori pole itself, BCM does have the potential to deliver further conservation, economic and operational advantages.

There have been five publications in which a description is provided of necessary BCM features and appropriate operating information:

ACAP Bycatch Mitigation Fact-Sheet 11, ACAP 2014.

The Incidental Catch of Seabirds by Longline Fisheries: Worldwide Review and Technical Guidelines for mitigation, (Brothers, N. ,Cooper, J. , Lokkeborg, S. 1998 FAO) - p70-73.

Longline Fishing Dollars and Sense, (Brothers, N. 1997) - p52/53. Spanish/English. Cantonese/English

Catch Fish not Birds, (Brothers, N. 1994) - p15/16. English only, for Aust industry.

Catch Fish not Birds, (Brothers, N. 1990) - p14/15. Japanese with English and Indonesian summaries.