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ANCHORED RAFT EXPERIMENT TO AGGREGATE TUNAS IN THE EASTERN PACIFIC OCEAN

by

Rafael Guillén and David A. Bratten

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INTRODUCTION

During the past decade, work by fishermen and fishing gear specialists has resulted in the development of purse seining gear and improved rescue techniques that are effective in reducing dolphin mortality in the purse-seine fishery for yellowfin tuna (Thunnus albacares) in the eastern Pacific Ocean. Dolphin mortality rates in the fishery decreased dramatically through the mid-to-late seventies following the introduction of improved gear and techniques. Although the mortality has continued to decline, significant reductions have leveled off in the past two or three years. Because of factors beyond the control of fishermen such as gear malfunctions and dolphin behavior, further significant reductions may not be attainable without a reduction in fishing for tunas associated with dolphin schools. Such a reduction would require that there be an economically attractive alternative to fishing for tunas associated with dolphins*.

It is well known that tunas associate with floating objects at sea. Fishermen in the Philippines have demonstrated that tunas can also be attracted to anchored rafts in numbers large enough to successfully support commercial purse seining operations (Murdy 1980). The U.S. National Marine Fisheries Service has successfully experimented with anchored devices to aggregate fish in Hawaii to the benefit of that state's pole-and-line fishery for skipjack tuna, Katsuwonus pelamis (Anonymous,1979). If similar devices can attract tunas in sufficient numbers for commercial purse seining operations in the eastern Pacific, then some fishing pressure may be taken off the dolphin stocks, possibly resulting in lower mortality levels, especially if tuna aggregating devices are placed in areas where tuna are frequently caught in association with dolphins.

*The reduction in "porpoise fishing" could even become mandatory for a national fleet such as the U.S. fleet which must keep mortality levels below yearly government imposed quotas. In 1976 the U.S. fleet was restricted from "porpoise fishing" by the U.S. government with several months left in the year because the fleet surpassed that year's dolphin kill quota.

In 1980 the IATTC staff constructed and anchored five rafts in the eastern Pacific Ocean to determine if they are effective in attracting tunas in that area, and to determine their longevity in deep, open seas with little or no maintenance. The main objectives of the project were as follows:

1) construct five rafts that could be transported to the fishing grounds aboard a purse seiner,
2) charter a purse seiner to transport and deploy all five rafts in areas frequently fished by purse seiners of the international fleet for tunas associated with dolphin schools,
3) check each device twice during the cruise to determine structural condition, presence of fish, etc,
4) notify all purse seiners of the international fleet operating in the eastern Pacific Ocean of the rafts' positions, and
5) determine the rafts' effectiveness through vessel provided information.

Secondary objectives during the cruise portion of the project were to collect the IATTC's standard data on cetacean sightings, daily vessel activities, and expendable bathythermograph observations.

Methods

Buoy design and materials

The design chosen for the rafts and anchoring system was very similar to one of the several designs used in the Philippine "payao" fishery. This design is shown in Figure 1, the major components being a foam filled, wooden raft, 12 x 4 x 1 feet, the anchor line consisting of steel cable and synthetic line, and the anchors, three 55-gallon drums filled with concrete.

The raft frame was constructed of 2 x 12 inch lumber, with cross pieces dividing the frame into four sections. All corners were reinforced with 2 x 2 x 1/8 inch aluminum angle, and the frame assembled with bolts and wood screws. A steel anchor bracket with an anchor eye was bolted to the center frame crosspiece. The bow of the frame was cut at a 45^{o} angle. The anchor eye was placed forward of center on the bottom plane, allowing the bow of the raft to always point upwind or up-current. This also allowed easier movement of the raft through the water during the anchoring procedure. The top and bottom of the frame were covered with 1/2 inch plywood and the raft frame sections were filled with polyurethane foam.

A seven foot tripod made of 2 x 4 inch lumber was constructed on the stern deck of the raft. A quick-flashing light, battery box, and flag were mounted atop the tripod. The light was powered by a six volt dry cell battery housed in the battery box. A light sensor was included to automatically turn on the light at night. The battery was charged by a windmill generator mounted on a three foot pipe stand just forward of the tripod. One of the five rafts had no windmill generator or battery box, the light being a self-contained flasher unit.

The raft frame and tripod were coated with several coats of bright orange tinted fiberglass resin to increase strength, retard wood rotting, and to increase the visibility of the raft. Each raft was then numbered one through five on the top deck with white paint. Rectangular signs were mounted to the tripod legs with the following notice in English and Spanish.

"IATTC EXPERIMENTAL ANCHORED FISH AGGREGATOR"

The Philippine rafts employ a weighted length of line, approximately 10 to 15 fathoms long to which palm leaves are attached at intervals to act as an additional fish attractant. Since the Commission rafts are not expected to receive much maintenance after the deployment cruise, it was decided to use 6 x 6 foot pieces of purse seine webbing instead of leaves. A 1/2 inch eye screw was mounted to the stern of each raft and a concrete weighted section of 5/8 inch polypropylene line, approximately 15 fathoms long with the webbing pieces attached at three foot intervals, was tied to the eye screw with a double half hitch and bowline knot. The idea was to make this line detachable from the raft in the event fish could not be set on due to their close proximity to the raft. Thus, the line could be towed clear, possibly drawing the fish away from the raft so they could be set on easier.

Because drifting pieces of rope are known to attract tunas, seven-3 foot pieces of 5/8 inch polypropylene were attached at two foot intervals to each side of the raft. Longer pieces were not used because of the risk of entangling propellers of speedboats that may approach the raft.

The anchor line consisted of 150 fathoms of 1/2 inch galvanized steel cable connected to a one inch jaw and eye galvanized swivel at the bottom of the raft, followed by either 5/8 inch or 3/4 inch polypropylene line extending down to an anchor junction of four tire sidewalls (one tire yields two sidewalls) near the anchors. The steel cable served two functions, to prevent the raft from being cut loose, and to avoid the problem of fish biting through the

anchor line in the area where algal growth is most likely to occur. One inch eye and eye galvanized swivels were inserted in the synthetic line at 600 fathom intervals. The synthetic portion of the anchor line was constructed with 200 fathom segments with all ends tied together with scaffold knots (Ashley, 1944). Scaffold knots were also used to tie the synthetic line to the steel cable, swivels, and to the tire sidewall anchor junction.

The anchor weights used were three 55-gallon drums filled with concrete for each raft, a total of approximately 3800 lbs. per raft. Two tire sidewalls were embedded in the concrete of each drum. Six fathom pieces of 1 1/2 inch polypropylene line connected the drums to the anchor junction. Again, scaffold knots were used to tie the line to the tire sidewalls at the anchor junction and to the concrete embedded tire sidewalls in each drum.

Vessel and equipment

The vessel chartered to deploy the rafts was the M/V Tifaimoana, a 65-meter U.S. flag purse seiner built in 1979, with a fish carrying capacity of about 1,600 tons. The five rafts, 15 anchor weights, 78,000 feet of synthetic anchor line, and 4,500 feet of steel cable were stored on the vessel's bow deck and on top of the pilot house. Vessel equipment used during loading and deployment included two hydraulic cargo cranes permanently mounted on the vessel's bow deck and a hydraulic speedboat crane permanently mounted on the speedboat deck.

Anchoring procedure

Prior to the cruise, bottom topography charts for the proposed anchoring area were studied to determine the amount of anchor line that would be needed for each raft. Since depths in the area rarely exceed 2200 fathoms, it was decided that 2600 fathoms of line be allowed for each raft, some rafts possibly requiring more and others less.

When the deployment site for each raft was chosen and the depth determined, the anchor line was constructed using several hundred fathoms of line more than the depth. Prior to deployment, the steel cable was attached to the bottom swivel, coiled on the raft's deck and secured. The bait attractant line was attached to the stern eye, coiled and secured inside the tripod base. A six foot sling of 5/8 inch line was also attached to the bottom swivel for towing, and the top end of the synthetic line was temporarily tied to the sling. To prevent the raft from turning sideways while moving through the water, bridle lines were tied to eye screws located on either side of the bow deck of the raft and tied to the towing sling directly beneath the bow.

Deployment began with the raft being lowered into the water using one of the hydraulic cranes. Once clear, the vessel moved slowly ahead in a long arc, allowing the line to pay out over the bow rail. If any tangles or kinks were encountered, the vessel would stop until it was cleared and then proceed. Once all the line was payed out, the vessel stopped and the anchors were lowered over the rail and released simultaneously. As the weights dropped, the raft moved over the water's surface towards the drop site. After the raft stopped, indicating the anchor weights had reached the bottom, the end of the anchor line was untied from the sling and the stern towline from a speedboat was tied to the sling. A man in the open bow cockpit of the speedboat retrieved excess floating line and coiled it in the bow. The line was cut just before the point where it submerged. The speedboat towline was untied from the sling and the sling and sling bridles were cut and removed. The surface end of the synthetic anchor line was then tied to the end of the cable on the raft's deck and the cable was then lowered into the water. The bait attractant line was lowered over the stern ending the deployment procedure.

Two of the rafts, #1 and #2 were deployed in close proximity to natural logs found by the vessel. Both of these logs had associated forage fish, but no tunas. After the rafts were deployed, the natural logs were towed close to the rafts, the forage fish remaining close. Then, the natural logs were removed from the water by the main vessel. The forage fish appeared to re-associate with the rafts. Later checks of these rafts showed them to have good amount of forage fish (see Results) which quite possibly could have been the same fish originally associated with the natural logs.

Raft locations

An objective of the project was to anchor the rafts in an area where there is consistent fishing for tunas associated with dolphins. Also to ensure that as many seiners as possible have ready access to the rafts, all of them were deployed outside of 200 miles from the coast (Figure 2). Three of the five rafts were anchored within the area chosen for the experiment, but due to rough weather two had to be anchored elsewhere. These latter two were anchored in areas where tunas were being found in association with floating objects. Raft locations are shown in Figure 2 and anchoring information is provided in Table 1.

Notices of the rafts' positions were distributed to vessels of the international fleet by IATTC employees in San Pedro and San Diego, California, and in Mexico, Panama, Puerto Rico, Ecuador, and Peru. The notices also explained

that vessels should not tie up to the rafts, and that purse seine nets should not be set directly around them because they are anchored to the bottom. Vessels were asked to provide the IATTC certain information if they checked out or fished around the rafts.

Results

One of the original objectives was to check each raft twice after deployment during the cruise. However, only one of the rafts was checked twice, two were checked once, and two were not checked at all because the vessel fished in other areas and ran short of fuel at the end of the trip.

No tunas were caught near the rafts by the chartered vessel, however one purse seiner did catch approximately five tons of mixed yellowfin and skipjack that may have been associated with raft #2 (see following summary). No measurements were obtained from these fish, but the vessel navigator reported that the fish were "small". No other reports of tuna being caught near the rafts have been received.

There have been no confirmed reports of any of the rafts being lost. There have been reports of vessels not being able to find some of the rafts, although other vessels have found these same rafts. This problem is probably due to the fact that the IATTC published incorrect positions for the first three rafts for several weeks after their deployment.

An encouraging note on the rafts' longevity is that raft #2 was struck by Hurricane Kay two weeks after it was moored, withstanding winds in excess of 100 mph. The raft remained securely anchored although some of the gear was lost. Raft #1, located approximately 200 miles from the storm's path, remained securely anchored but capsized in swells that probably reached heights of 15 feet.

A limited amount of information has been received from vessels concerning the rafts. Since personal interviews with individual captains after each trip may be difficult, if not impossible, it is hoped that information will be obtained from vessels' logbooks. Following is a summary of information collected by the chartered vessel and other vessels:

Raft #1 - anchored 8/26/80

First check, 9/9/80 (14 days): Raft in good condition - forage fish (bait), dolphin fish, sharks, and birds present - no tunas sighted - raft in position.

Second check, 10/7/80 (42 days): Raft found capsized, then righted - lost flag, generator, light, and radar

reflector, only flag replaced - forage fish, dolphin fish, and sharks present - no tuna sighted - in position.

Other: Checked by purse seiner 28 days after deployment - found capsized - birds and dolphin fish present - no tunas present - in position. Checked by purse seiner 85 days after deployment - reported algae covering fifty percent of raft - no associated forage fish - no flag or bait attractant - raft in good condition. Checked by purse seiner 90 days after deployment - reported "few trigger fish" - in position. Checked by purse seiner 137 days after deployment - in good condition - small amount of forage fish present. One other check by purse seiner, date unknown, no information.

Raft #2 - anchored 9/3/80

First check, 9/28/80 (25 days): Light, radar reflector, and flag missing (probably from storm), all replaced - birds, forage fish, sharks, dolphin fish, small yellowfin, skipjack and bullets present (Auxis sp.) - in position.

Second check: None

Other: One purse seiner captured 5 tons of mixed yellowfin and skipjack on 10/18/80, that was reportedly attracted away from raft. School seen associated with raft on previous day, but would not move away to allow set. Vessel put over own raft and drifted overnight. Set made next morning approximately 7 miles from raft position. Captain believes fish caught was part of school seen near raft.

Checked by two other purse seiners, one 42 days after deployment, other date unknown. Reports indicate birds, forage fish, dolphin fish, and several tons of yellowfin, skipjack, and bullets present - bait attractant, flag and light missing - visible at approximately 5 miles - in position.

Sighted by longline vessel, 62 days after deployment - raft reported in good condition - "small fish" present.

Raft #3 - anchored 9/22/80

First check, 11/4/80 (43 days): Raft in good condition - bait attractant missing and replaced - only birds and some forage fish present- no tunas present - in position.

Second check: None

Other: Checked by seiner 54 days after deployment - reported raft in good condition with good bait, dolphin fish and sharks present. Checked by seiner approximately 77 days after deployment - reported not much bait - bait attractant missing - raft in good condition - in position.

Raft #4 - anchored 11/3/80
No charter vessel checks.
Other: Checked by purse seiner approximately 22 days after deployment - reported some bait and withstanding rough weather. Checked by seiner 80 days after deployment - Reported "no fish" - in position. Checked by purse seiner 84 days after deployment - not much associated forage fish, some sharks, no tuna - natural logs nearby had more associated forage fish as well as tuna.

Raft #5, anchored 11/4/80
No charter vessel checks.
Other: Checked by seiner 26 days after deployment - raft in good condition - bait attractant reported missing - only dolphin fish found in association with raft - in position. Checked by purse seiner 123 days after deployment - not much associated forage fish, some sharks, no tuna - more associated forage fish and tuna with logs nearby.

During the cruise, the Commission's standard data on cetacean sightings and daily activities were collected and 16 expendable bathythermograph recordings were taken.

Discussion

A proper evaluation of the raft's effectiveness in aggregating tuna, especially yellowfin of the size normally found associated with dolphins, can not be done until more information is collected from vessels which have checked the rafts. Rafts #1 and #2 have attracted some yellowfin and skipjack. Five tons of mixed yellowfin and skipjack have been caught near raft #2. Additional catches and, if possible, length measurements will be necessary to determine if the rafts can aggregate larger yellowfin tuna.

Also, the rafts' longevity can not be evaluated at this point. Raft #1 and #2's ability to withstand a powerful storm is a good indication that the anchor system may be adequate to handle heavy stress. The capsizing of raft #1 indicates that some type of a counter balance or a different raft design may be necessary to prevent overturning in heavy seas. The lights, radar reflectors, generators, and flags are not likely to remain intact or in operation for very long periods due to weather factors and perhaps vandalism. Periodic maintenance is necessary for this hardware to remain in good repair. If reports continue to indicate that the rafts are remaining in position, vessel captains may be asked to replace or service these items if they plan on being in the vicinity of the rafts.

Several of the rafts reportedly have attracted what has been described as good amounts of bait, or forage fish, but later reports indicate only small amounts of bait fishes. There could be several reasons for this. First, fishermen may have different ideas of what constitutes a good amount of bait. Second, vessels may be setting near the rafts and cleaning out portions of the associated bait fishes, although even if a vessel set right next to a raft, it is unlikely that all of the bait species would be captured. Third, the bait fishes attracted to the raft may have difficulty remaining there due to the force of the currents.

Three of the rafts' bait attractant lines have been reported missing. It is possible that the lines were untied in order to set on the bait attractant, and the fishermen failed to re-tie them to the raft, or re-tied them incorrectly. An alternative would have been to attach the bait attractant in a more permanent way, requiring vessels to use other means to coax fish away from the raft. In any case floating logs successfully aggregate tunas without having a vertical attractant, so it is not known whether the bait attractant enhances the rafts' tuna aggregating properties.

If these rafts prove effective in aggregating tuna in quantities large enough to benefit commercial purse seining operations, they may hold some promise in providing an alternative, if only partial, to fishing for tunas associated with dolphins, especially if larger non-associated yellowfin are attracted to them. Successes in the Philippines in attracting tunas to anchored rafts for seining operations certainly should encourage similar attempts in the eastern Pacific.

Acknowledgements

We are grateful to Captain Joe Ramalho and the crew of the M/V Tifaimoana who provided tremendous assistance during the deployment of the rafts.

Literature Cited

Anonymous, 1978. A statewide fish aggregating system. State of Hawaii. Department of Land and Natural Resources.

Ashley, Clifford W. 1944. The Ashley book of knots. Doubleday & Company Inc., Garden City, New York. pg. 204.

Murdy, Edward O., 1980. The commercial harvesting of tuna-attracting Payaos: A possible boon for small-scale fishermen. ICLARM Newsletter. Vol.3, No.1. Pages 11-13.

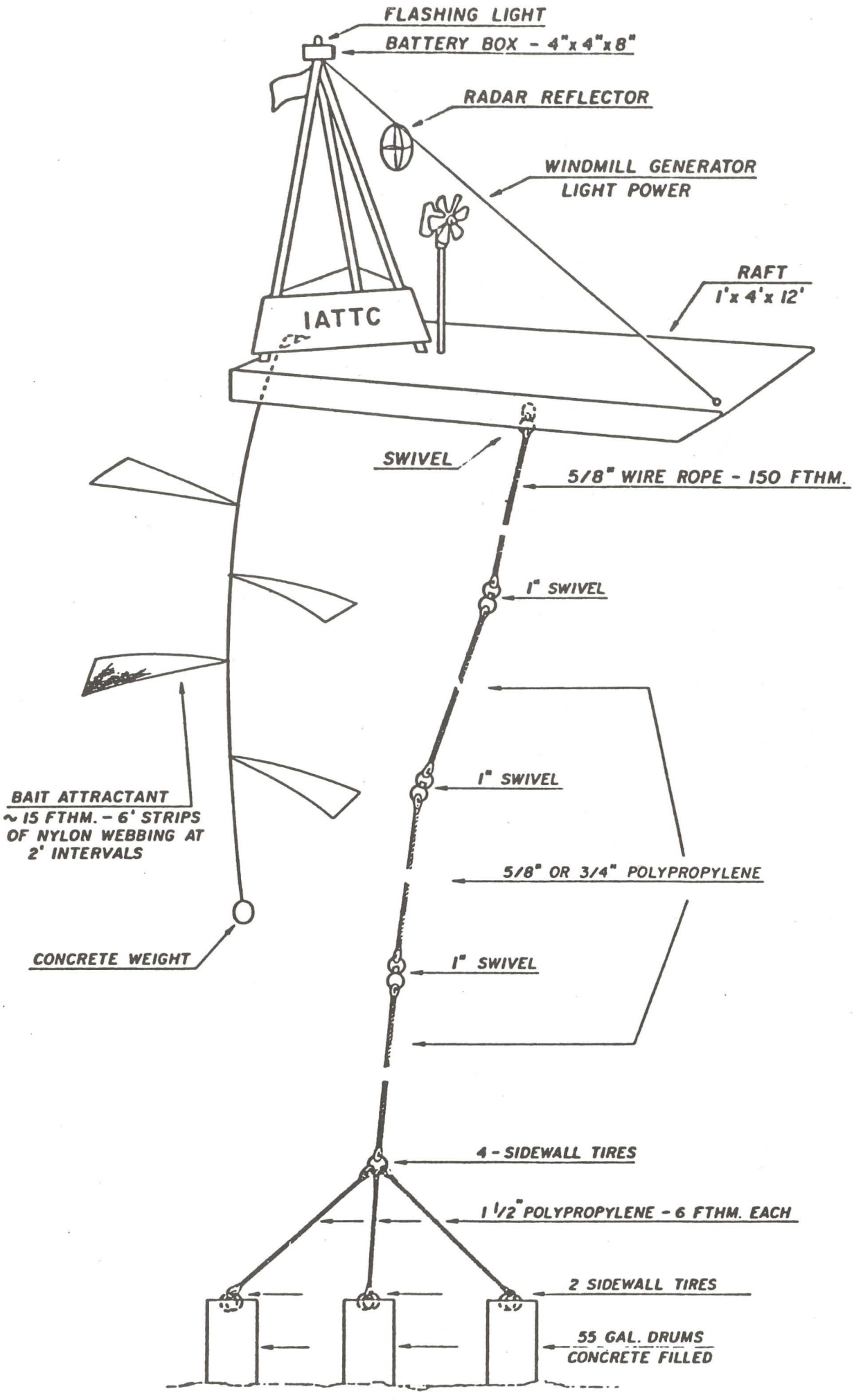

FIGURE 1. IATTC Raft and Anchoring System.

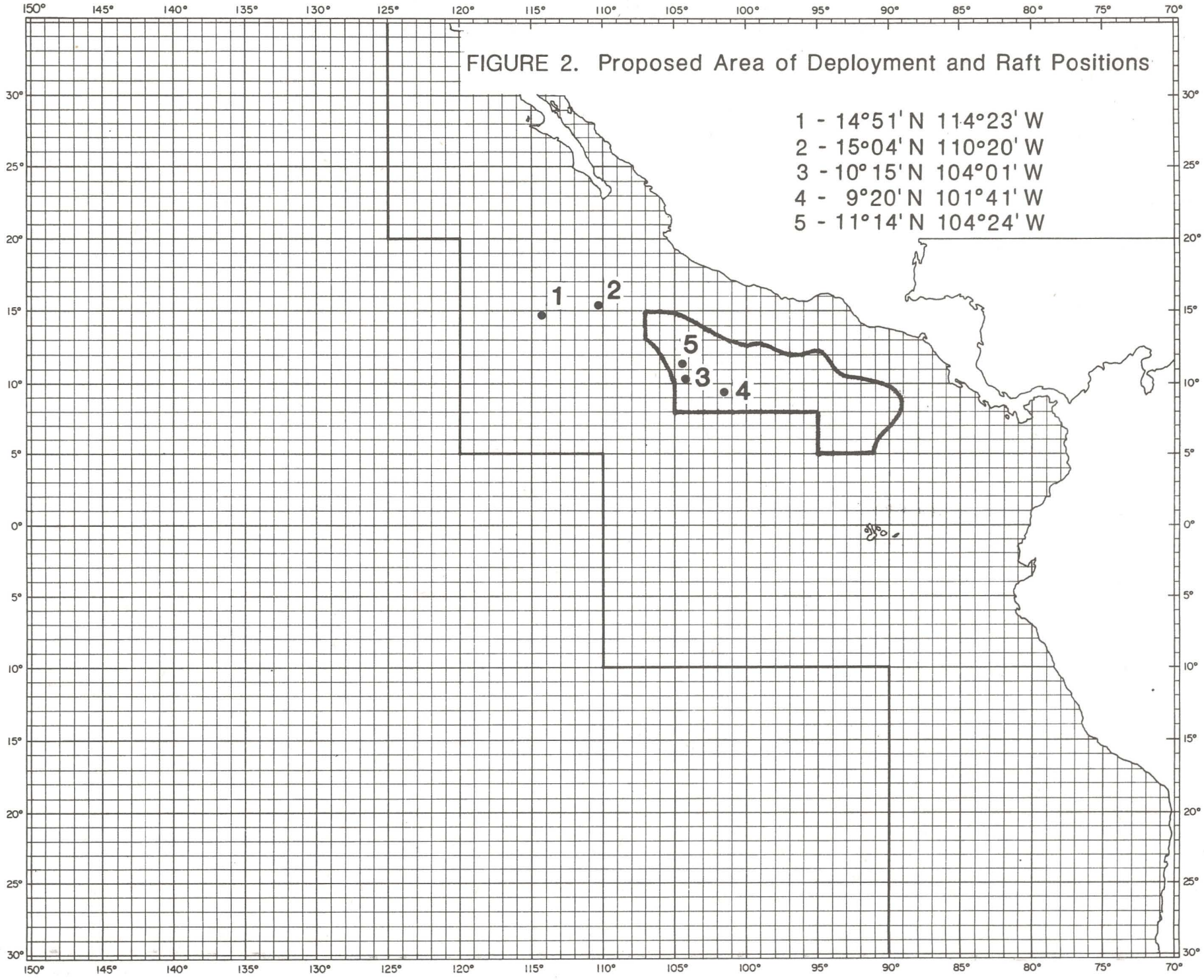
FIGURE 2. Proposed Area of Deployment and Raft Positions
1 - 14°51' N 114°23' W
2 - 15°04' N 110°20' W
3 - 10°15' N 104°01' W
4 - 9°20' N 101°41' W
5 - 11°14' N 104°24' W
1
2
3
4
5
150°
145°
140°
135°
130°
125°
120°
115°
110°
105°
100°
95°
90°
85°
80°
75°
70°
30°
25°
20°
15°
10°
5°
0°

TABLE 1. Raft anchoring information

	RAFT #1	RAFT #2	RAFT #3	RAFT #4	RAFT #5
Date anchored	8/26/80	9/3/80	9/22/80	11/3/80	11/4/80
Position	14°51'N 114°23'W	15°04'N 110°20'W	10°15'N 104°01'W	9°20'N 101°41'W	11°16'N 104°24'W
Depth	∿ 2100 fathoms	∿ 1800 fathoms	∿ 1730 fathoms	∿ 2100 fathoms	∿ 1800 fathoms
Type of mooring line	5/8" polypropylene	5/8" & 3/4" polypropylene*	5/8" & 3/4" polypropylene*	5/8" & 3/4" polypropylene*	5/8" & 3/4" polypropylene*
Scope	∿ 1.4:1	∿ 1.2:1	∿ 1.3:1	∿ 1.4:1	∿ 1.2:1

Notes:

* 3/4" polypropylene used at lower depths