A Single-armed Manta-board as a New Diver-controlled Planing Board and Its Use for Underwater Surveys

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Introduction

The use of scuba techniques in observation, collection, and recording of marine data is now commonplace to the point of necessity. Towing divers has long since been incorporated in survey observations, and this paper addresses a new technique for this method.

An increase in commercial fishing concepts and the continuous development of prototype fishing gear in the past required better methods of visual evaluation. This led to the introduction of the two-person litter sled of Sand (1956), whose concept was further modified into a side-by-side sled (Hold, 1960). Many modifications have since been added, usually as a direct result of the special needs of particular projects, such as archaeological and geological surveys, search and recovery operations, and evaluation of towed fishing and research equipment. An account of some of these systems is given by Wickham and Watson (1976) and Workman and Watson (1991).

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Abstract—Due to inadequacies of previous underwater towing techniques and the special needs of a recent underwater survey, a modified manta-board technique was developed. With this new technique, the diver holds on to the manta-board with one arm; consequently, the board is referred to as a single-armed manta-board (sam-board). The sam-board proved inexpensive and highly maneuverable, allowing the divers to freely collect samples or record information. Through some experimenting with the board and changing some of the variables, such as rope lengths, towing speeds, etc., a highly efficient towing method can be achieved. Preplanning and strict diving safety procedures must, however, be implemented to assure efficiency. This paper presents the materials, guidelines for board construction, equipment, and preplanning and diving safety procedures necessary for the sam-board towing operation.

For general underwater surveys where detailed information is not required, divers can be towed individually across a preplotted area of great distance with minimal energy (Miller, 1979; Flemming and Max, 1988). A technique suggested to accomplish this is with an aquaplane (Miller, 1979), which is also referred to as a manta-board.

Conventional manta-boarding methods generally require the diver to use both hands on the board to assure the most efficient method of maneuverability and attachment. The inherent problem with this method, however, is the inability to remove one's hand from the board without losing maneuverability.

Underwater fisheries survey work carried out in the winter of 1992 by the authors in the Arabian Gulf required qualitative environmental information such as flora and fauna densities, the recording of the different types of marine organisms, seabed type evaluations, and the rapid collection of specimen and sediment samples. Hence, another technique besides the conventional method of manta-boarding described by Miller (1979) was required; consequently, a new technique for manta-boarding was developed.

Materials and Methods

Figure 1 (top) presents a modified manta-board attached to the diver's arm, allowing the other arm freedom for writing, collecting, and gear manipulation. Hereafter, this device is referred to as a "sam-board" (single-armed manta-board). With this new technique, the hand of the arm attached to the sam-board can also hold a slate to record desired information (Fig. 1, bottom). Both hands can still be used for maneuvering, but with only minimal loss when the free hand is released.

Figure 2 is a diagrammatic representation of the sam-board with an optional attached planing device which increases maneuverability during the tow. The planing attachment can also be seen quite clearly in Figure 1.

Sam-board Construction

The sam-board is small, light, slightly buoyant, simple to construct, and inexpensive. With the attachment of the planing device, it consists of two pieces of 5-ply marine plywood, a 50 × 18 cm ($19^{11}/_{16} \times 7^{1}/_{16}$ inches) main board and a 16 × 18 cm ($6^{5}/_{16} \times 7^{1}/_{16}$ inches) planing board, which are coated with marine varnish. They are joined by two 16 × 2 cm ($6^{5}/_{16} \times {}^{25}/_{32}$ inches) aluminum brackets at a 155° angle (Fig. 2). The main board has two holes, A_1 and A_2, whereby the towing harness is attached. It should be noted that these holes are 2 cm (25/32 inch) off-center toward the bottom of the board, so that the bottom is the leading edge; this helps prevent the diver from ascending during the tow.

Four other holes in the main board, B_1–B_4, are for the arm-holder attachments, one for the upper forearm and one for a handgrip (Fig. 1, 2). The holders can be adjusted according to individual preference and the ropes inserted into sections of plastic hose (i.e., garden hose) for added comfort (Fig. 1). Figure 3 illustrates the towing bridle arrangement and positioning of the divers, sam-board, boat, and handler. A 7 m (23-foot) 5-ply rope towing harness is attached to the sam-board at holes A_1 and A_2, and has a 3 cm ($1\frac{3}{16}$ inch) stainless-steel swivel-shackle fastened to it to prevent the ropes from twisting during the towing operation. The main towing rope, 6 mm (1/4 inch) Kevlar,[1] is 50–70 m (55–77 yards) long and attached to a 7 cm ($2\frac{3}{4}$ inches) diameter stainless-steel ring. The stainless-steel ring is attached to the boat harness, which consists of a 15 m (50-foot) 6-ply rope cleated to both sides of the boat's stern. Color-coded ropes may be used to facilitate their identification during storage, handling, and deployment.

[1] Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

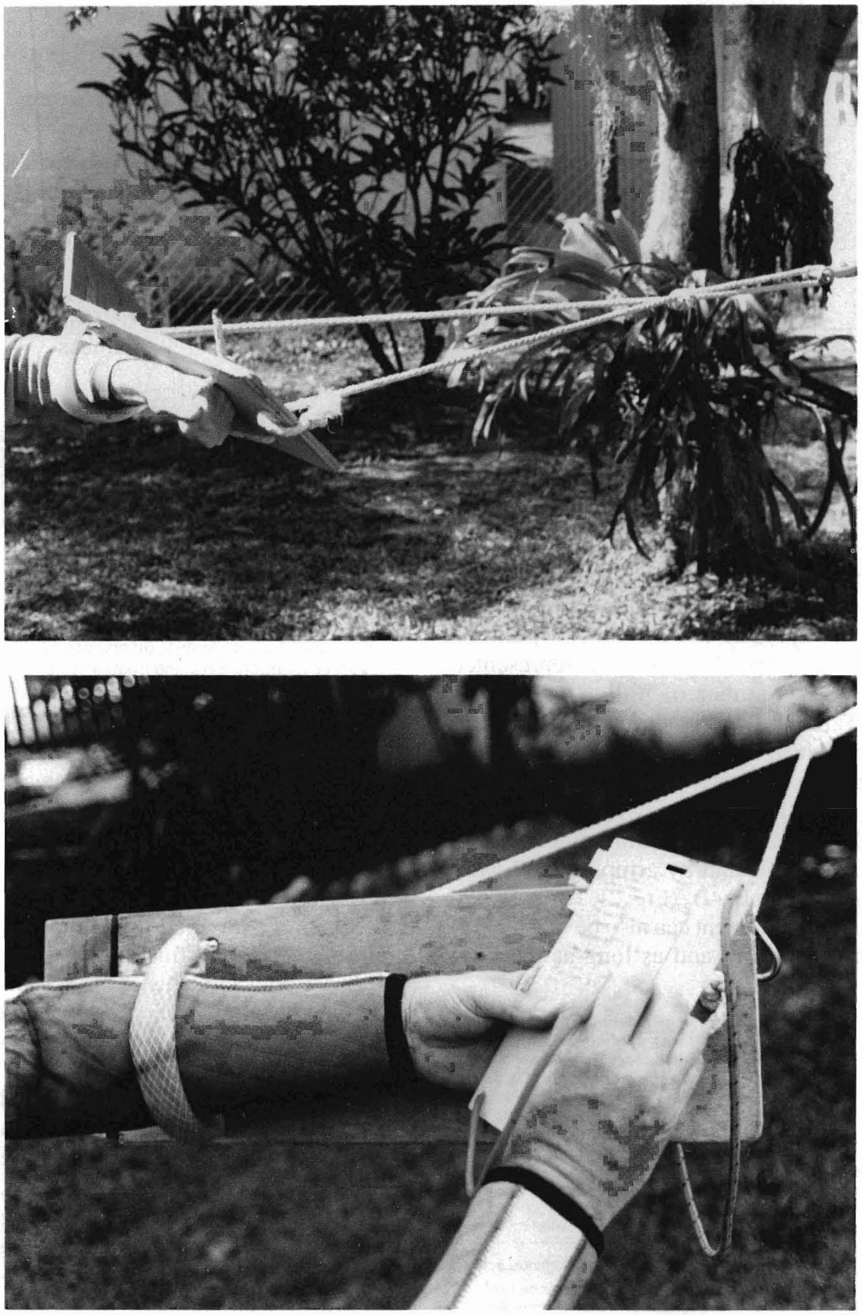

Figure 1.—Photographs of the sam-board (single-armed manta-board). Note in the top photo, the angle of the board relative to the current flow which counters the natural tendency to ascend, and the position of the diver's arm with the upper forearm and hand in the correct holders. At bottom, the diver is holding an underwater slate to record the desired information with the free hand. A plastic hose covers the rope for comfort.

Materials

For two sam-boards, the following are required:

1) Two wooden planks, 50×18 cm ($19\frac{11}{16} \times 31\frac{1}{2}$ inches) of 5-ply marine plywood

2) Two wooden planks, 16×18 cm ($6\frac{5}{16} \times 7\frac{1}{16}$ inches) of 5-ply marine plywood.

3) Four 16 × 2 cm ($6\frac{5}{16} \times \frac{25}{32}$ inches) aluminum brackets and screws.

4) Two 6 mm ($\frac{1}{4}$ inch) diameter Kevlar tow ropes, 70 m (77 yards) long.

5) Two 3 cm ($1\frac{13}{16}$ inches) swivel-shackle.

6) One 7 cm ($2\frac{3}{4}$ inches) diameter stainless-steel ring.

7) Two 30 × 2 cm ($11\frac{13}{16} \times \frac{25}{32}$ inches) diameter reinforced garden hoses.

8) One 6-ply rope, 15 m (50 feet) long.

9) Two 5-ply harness ropes, 10 m (33 feet) long.

Towing Operations

The selection of a proper boat and motor for the procedure is important. A 12-foot inflatable boat with a 25-50 hp motor is sufficient, but in windy conditions a keeled aluminum or fiberglass boat of similar dimensions is necessary to minimize wind drift effects. Larger boats can be used but only with smaller motors because higher powered motors have difficulty maintaining the lower speeds required for the towing procedure. A maximum towing speed of 2.5 feet (0.75 m) per second is recommended, as faster speeds will reduce the observation and recording accuracy of the divers and increase their tendency to ascend during the tow. Also, under these conditions, diver fatigue becomes a problem.

To reduce unnecessary delays and maximize dive time, a regimented div-

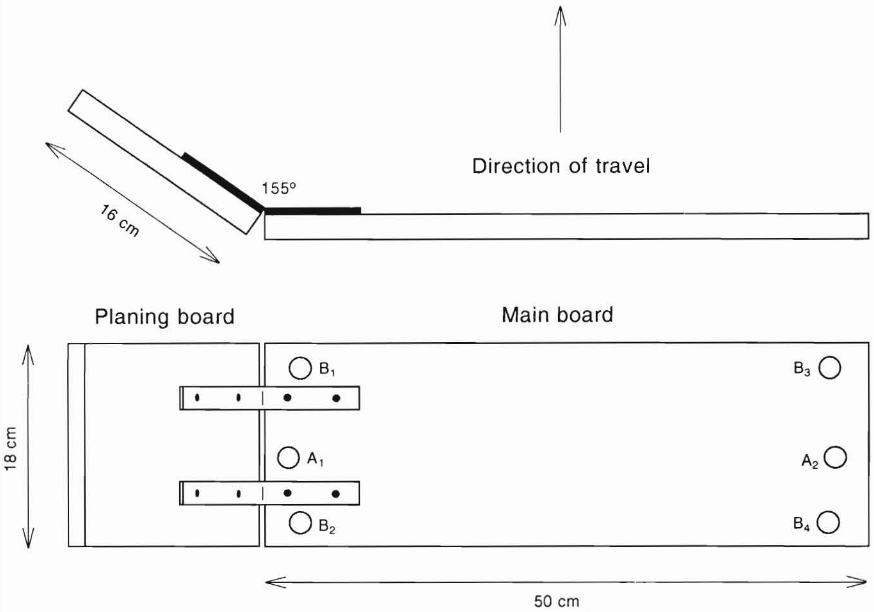

Figure 2.—Diagrammatic representation of the sam-board showing the main board and optional planing board. The boards are joined by two aluminum brackets at a 155° angle. The A_1 and A_2 holes are for the attachment of the towing harness, the holes B_1 through B_4 are for the two arm-holder ropes, one for the upper forearm and one for a handgrip.

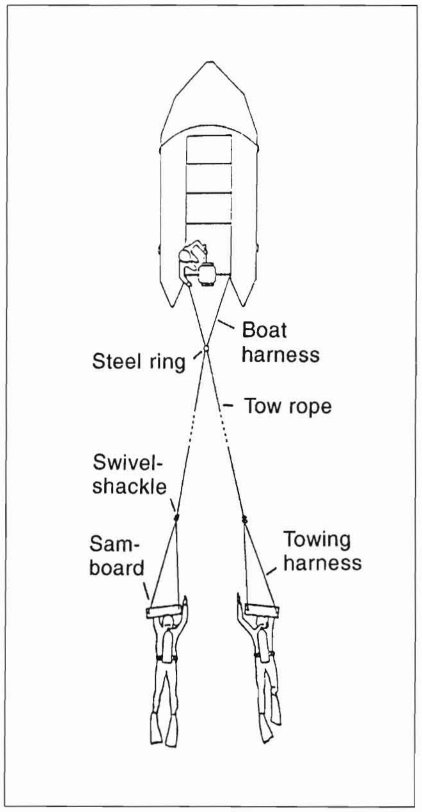

Figure 3.—Diagrammatic representation of the towing operation showing the positioning of the sam-board, divers, various ropes, etc., and the boat and boat operator.

ing procedure is recommended. This involves careful planning, close interaction between the boat operator and the divers, and a thorough understanding of the duties of each. Local safety guidelines may vary and must be considered during planning. Markers are set to indicate the towing path, one at the beginning and several others at intervals (the periphery of visibility). Large marker buoys are suggested to make it easier for the boat operator to maintain the proper course, especially in rough seas or during low visibility periods. Actual marker location can be easily determined through triangulation methods if close to known landmarks; otherwise, other techniques of navigation will have to be employed.

Divers are responsible for their own gearing-up and their own and their dive buddy's safety check (Miller, 1979; Flemming and Max, 1988). With the assistance of the boat operator, the divers next deploy and position their sam-boards in the water before initiation of the tow.

At the survey starting point, the divers descend, conduct their pre-tow checks, and signal each other and the boat operator to begin the tow. Communication between the divers and the boat operator is by means of pulls on the tow rope. A simple code represented by the number of pulls on the rope (Table 1) should be prearranged and practiced by all parties before towing begins.

The sam-board is attached to the diver with the rope arm-holder at position B_3–B_4 and by gripping the holder at position B_1–B_2 (Fig. 2). This arm and hand attachment can also be seen in Figures 1 and 3, and as long as the arm-holder is not tight an emergency release of the board can easily be accomplished. Depth modifications are achieved during the tow by altering the angle of the face of the board relative to the water flow. This, in combination with the attitude of the diver's fins, allow depth and directional controls. Some additional weight for the divers is suggested to prevent the tendency to ascend during the towing operation.

Table 1.—An example of a communication system between the divers and boat operator using a certain number of pulls on the tow rope. The number of pulls on the rope is related to the word "OARS" which, in turn, refers to a particular message. As an example, 1 pull (the letter "O") refers to "OK", two pulls (the letter "A") refers to "Advance" and so on. The asterisk (*) is signalled by multiple pulls, has no letter assigned to it, and it indicates dive termination.

Code letter or symbol	Signal	Meaning	Remarks
O	1 Pull	OK	OK/Continue activity
A	2 Pulls	Advance	Commence tow/ Increase speed
R	3 Pulls	Reduce	Reduce tow speed
S	4 Pulls	Stop	Stop tow/Await next signal
*	Multiple pulls	Termination of dive	

Competency with the sam-board technique can be achieved after only a few practice sessions. However, some experimenting with tow-rope length, board size, plane angle, and towing speeds may have to be carried out to obtain the most comfortable and efficient towing technique.

Data and Sample Collection

Preliminary dive sessions in the survey area will show the type of environ-

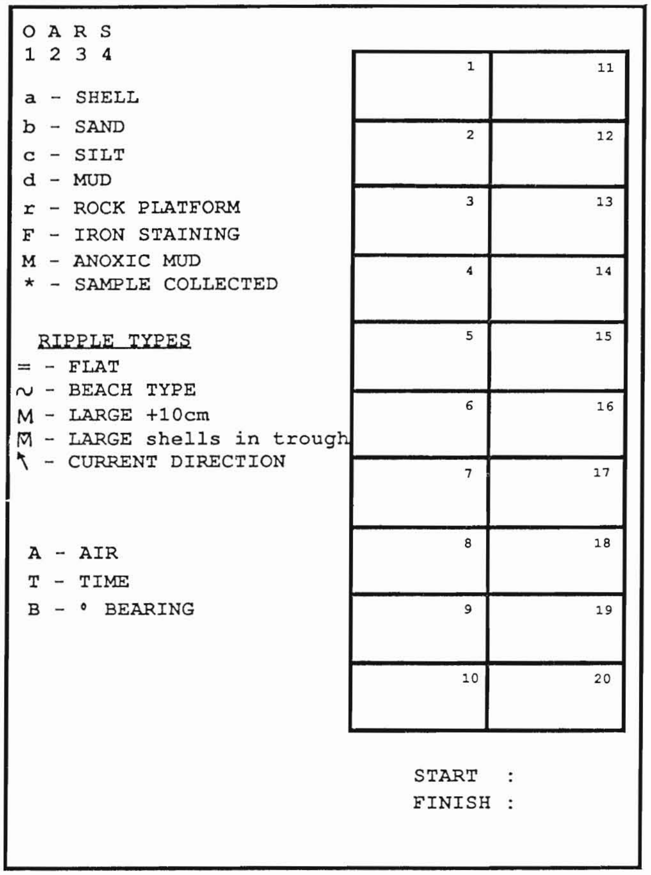

Figure 4.—Data recording slate for geological information. Example of underwater slate showing the symbols and abbreviated notes for the quick data entry into the respective time period for both geological and biological information. The numbered blocks (21-50) are continued on the back of the slate.

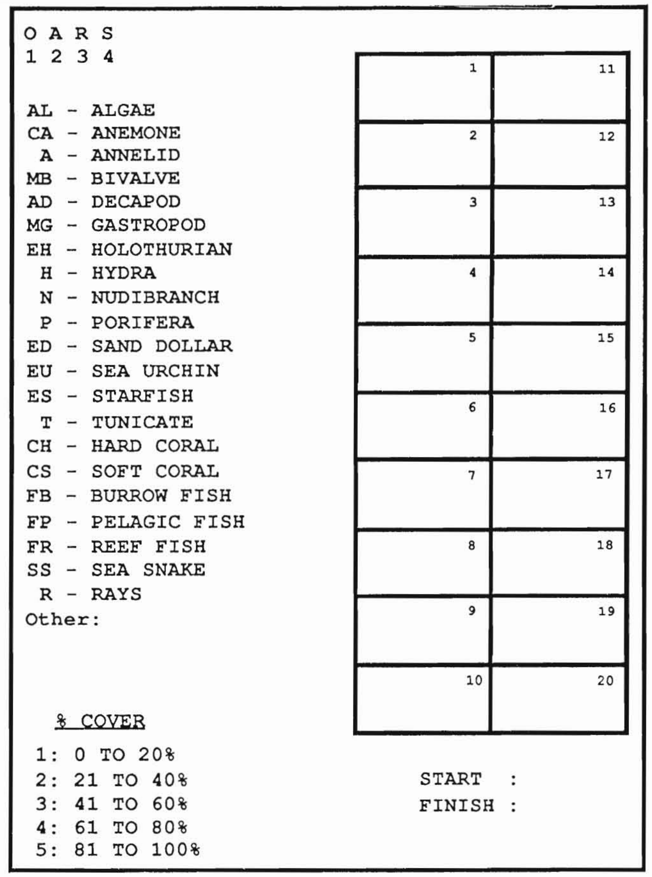

Figure 5.—Data recording slate for biological information.

ment to be encountered. This helps determine the type of sampling that will take place, the required equipment and its set-up, as well as such safety factors as currents, changes in depth, obstacles, etc., that need to be considered.

Data is recorded underwater on slates which can be designed according to one's special needs. They can be made from white-plastic board or purchased commercially. Figures 4 and 5 present examples of slate data-boards designed by the authors for collection of information during the Arabian Gulf survey. Each numbered block represents 1 minute during the 50-minute survey tow for which pertinent information was compiled. Figure 4 is an example of a slate used for the geological information, with the symbols and abbreviated notes for the quick entry of the factors relating to a particular time period. Figure 5 is similar to Figure 4 but designed for biological information. A reminder of the diver/boat operator communication system (Table 1) can be seen in the top left of the slates.

The actual time and time divisions for each survey depend on a variety of factors such as the required information, density of organisms, depth of the water, and desired length of the survey. The survey is timed with a diver's stopwatch by the diver designated as the project leader. This individual determines the starting and finishing times of the survey, in addition to any temporary stops during the survey. A separate watch worn by the second diver is used to time the divers' total bottom time.

The slate and markers should be secured to prevent their loss during the tow. A wrist lanyard is the most convenient method, but they can also be attached to the sam-board.

Other suggested items for the tow are 1) a mesh collecting bag, which is attached to the diver with a carbine clip, for specimen bottles, etc., 2) a compass, 3) surface marker buoy, 4) extra markers within easy reach, 5) specimen and sediment collecting containers prefilled with salt water to prevent them from floating, and 6) any specialized gear needed for sampling during the pre/post survey periods.

Results and Discussion

The sam-board construction and procedures for its use were developed as a result of the inadequacies identified with previous towing systems and the special needs during our Arabian Gulf surveys. The technique proved successful in that data collection was possible without losing control of or having to alter the tow. The sam-board also allowed for a wider coverage area during the tow as compared to the two-person sled, since the divers did not have to be right next to each other.

The sam-board is inexpensive, mobile, easily transportable, and highly recommended when budgets are limited. Though it can only be used for obtaining qualitative information, quantitative investigations are facilitated through a better understanding of the areas of interest.

This paper is a basic guide to construction and use of the sam-board, but we cannot emphasize enough that planning, practice, and experimentation is required before an efficient and safe technique is achieved. Diver safety should be thoroughly considered and carefully reviewed prior to each survey operation. If the towing technique is employed while on scuba, constant depth monitoring is important to prevent barotrauma injuries or tissue damage occurring from gas volume changes (Edmonds et al., 1984). This is especially important with pulmonary barotrauma.

Edmonds et al. (1984) point out that not all ascent pulmonary barotraumas are the result of breath holding. Lung stiffness or lack of elasticity which may also play a role, may be prevented through aquatic fitness, and the likeliness of occurrence may be determined through physical examinations, chest x-rays, and simple respiratory function tests. It should be stressed that at no time should one attempt to ascend during a tow while breathing compressed gas, and only normal ascents (60 feet/min or keeping pace with smaller exhaust bubbles) should be executed.

Underwater towing procedures, including advanced diving techniques, hold a higher potential of barotrauma injuries, and thus should only be practiced by divers competent in gear manipulation, buoyancy control, and in proper physical condition. According to Edmonds et al. (1984), proper aquatic fitness can only be achieved through regular swimming and breath holding exercises.

Regarding decompression sickness, the "no decompression limits" should be strictly adhered to. However, a safety stop at 3 m (10 feet) for 5 minutes at the end of the survey is recommended, especially if repetitive dives are made or if excess bottom time is accrued.

If snorkeling, ear and sinus barotrauma are of concern as rapid ascents and descents can occur during underwater tows. Also, one must not try to achieve excess depth during tows since, if the boat stops for some reason, resurfacing can only be achieved by ones own power. Avoid being towed into underwater obstacles, which are particularly of concern in areas of low visibility or during the recording of information for both snorkeling and scuba procedures.

In summary, to obtain an efficient and safe towing technique one must 1) check out the area of interest thoroughly prior to the actual procedure, 2) determine what is required for recording and collecting during the tow, and the exact procedures for doing it, 3) practice with the sam-board to become familiar with its use, 4) experiment with the different factors such as rope length, board size, etc., 5) thoroughly review all operational and safety aspects, 6) undergo physical examinations, chest x-rays, and simple respiratory function tests, and 7) maintain excellent aquatic fitness.

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