A TEST OF BAITED UNDERWATER VIDEO AS A FISHERIES ASSESSMENT TOOL

A report

submitted to

The Northeast Consortium

by

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August, 2008

Abstract

Baited underwater video (BUV) systems were built and deployed at various sites in the Gulf of Maine to test the potential use of this gear as an assessment tool for fisheries in the New England region. The original device was a copy of the system used successfully by Willis et al. (2000) in a marine reserve in New Zealand. The gear consisted of a frame and a video camera with an umbilical cord to the surface. Bait was placed in the field of the camera and the activity around the bait recorded on a VCR at the surface for a period of 30 minutes. This equipment worked well in shallow water (<30 m depth) but was not effective in deeper waters where currents, lack of light, and fish behavior were issues. A total of 52 BUV drops were completed. Many of these drops did not record any fish. Variations on the original gear type were developed and tested during this and associated projects. These included the addition of a variety of light sources and the development of a self-contained buoy system with a time-lapse camera, which could be left for long periods of time. At the time of expenditure of funds a variety of recommendations could be made based on the efforts in this study, but no single gear type was developed that would be successful in monitoring fish populations in the Gulf of Maine at depths of 100 – 300 meters where most commercial fishing is conducted. More experimentation needs to be done with lighting and alternate designs such as BRUVS (baited remote underwater videos) where self-contained units are left on the sea floor for a specified time period.

Project Objectives

The status of stocks of a variety of commercial species in the northeast has prompted severe restrictions on fishing which have taken the form of catch limits, limits on days at sea and closure (either permanent or temporary) of some areas. There is a great need for better scientific data to support management decisions with respect to these stocks. A key aspect of any management program is assessing fish populations. To date the prime source of information is the spring and fall surveys conducted by the National Marine Fisheries Service. Closure of areas to fishing has highlighted the need for more site-specific information about fish migrations and recovery of stocks. Some of the closed areas, particularly those of high relief, are not amenable to trawling. Alternate methods will be required to assess populations in these areas. BUV is a non-destructive sampling approach which has been used in several localities (Priede and Merrit, 1996; Willis et al., 2000). Willis et al. developed a system to count and measure fish in a marine reserve in New Zealand. Fish were attracted to bait on a frame with a camera and umbilical cord running to the surface to a monitor and video recorder. They found that BUV had the lowest standard error when compared to visual census and angling. The purpose of this study was to test a similar device in the waters of the Western Gulf of Maine to determine whether such gear could be a useful addition for assessing fish populations in these waters.

Participants

Participants in this project were Allan Michael (Principal Investigator) of ADM Associates located in Magnolia, Massachusetts and Captain Bill Lee of Rockport, Massachusetts. Captain Lee built the underwater gear used in this and other related projects. The 43 ft fishing vessel, the Ocean Reporter was used as the platform for field trials of the BUV equipment. In the early stages of the project the Principal Investigator visited the Leigh Marine Laboratory in New Zealand where Dr Trevor Willis conducted the original work using a system similar to that built for this project.

Methods

A baited underwater video system was built by Captain Lee. This was a copy of the design used by Willis et al (2000) in studies of fish populations in a marine reserve in New Zealand (Figure 1). The unit was made of round stock (legs) and 1-1/4 inch pipe (upright). The arm consisted of 1-1/4 flat bar steel. Total weight was approximately 50 lbs with camera and lights. Lighter units of 34 and 25 lbs were built with smaller materials for use in shoal water with little or no tide, and from small boats. The legs of the units could be removed for storage. The camera was set on the frame at a standard height (115 cm) above the bag and thus the same relative area was in view on all occasions. An umbilical cord led from the camera on the frame to a monitor and video recorder on the vessel.

The unit, with a bait bag attached to the bottom of the frame, was lowered to the sea floor at selected sites. Once the gear was observed through the video monitor to be on the sea floor, the video recorder was started and recording continued for 30 minutes. The numbers and types of fish attracted to the bait were recorded continuously for a 30-minute period. Bait was changed on each deployment. A variety of baits were tried in the early stages and a subjective evaluation was that a combination of herring and clams was the most suitable. After a series of tests of the original equipment at inshore sites a total of 52 drops were performed at a variety of sites throughout the southern Gulf of Maine (Figure 2). In the laboratory, videotapes were reviewed and the number of fish at the bait enumerated at 30-second intervals. Footage was continuously monitored to establish the maximum number of fish (MAXf) present at the bait during the 30 minutes. Because many of the drops recorded very few fish or none at all, we have listed all the types of fish seen in the 30-minute videos.

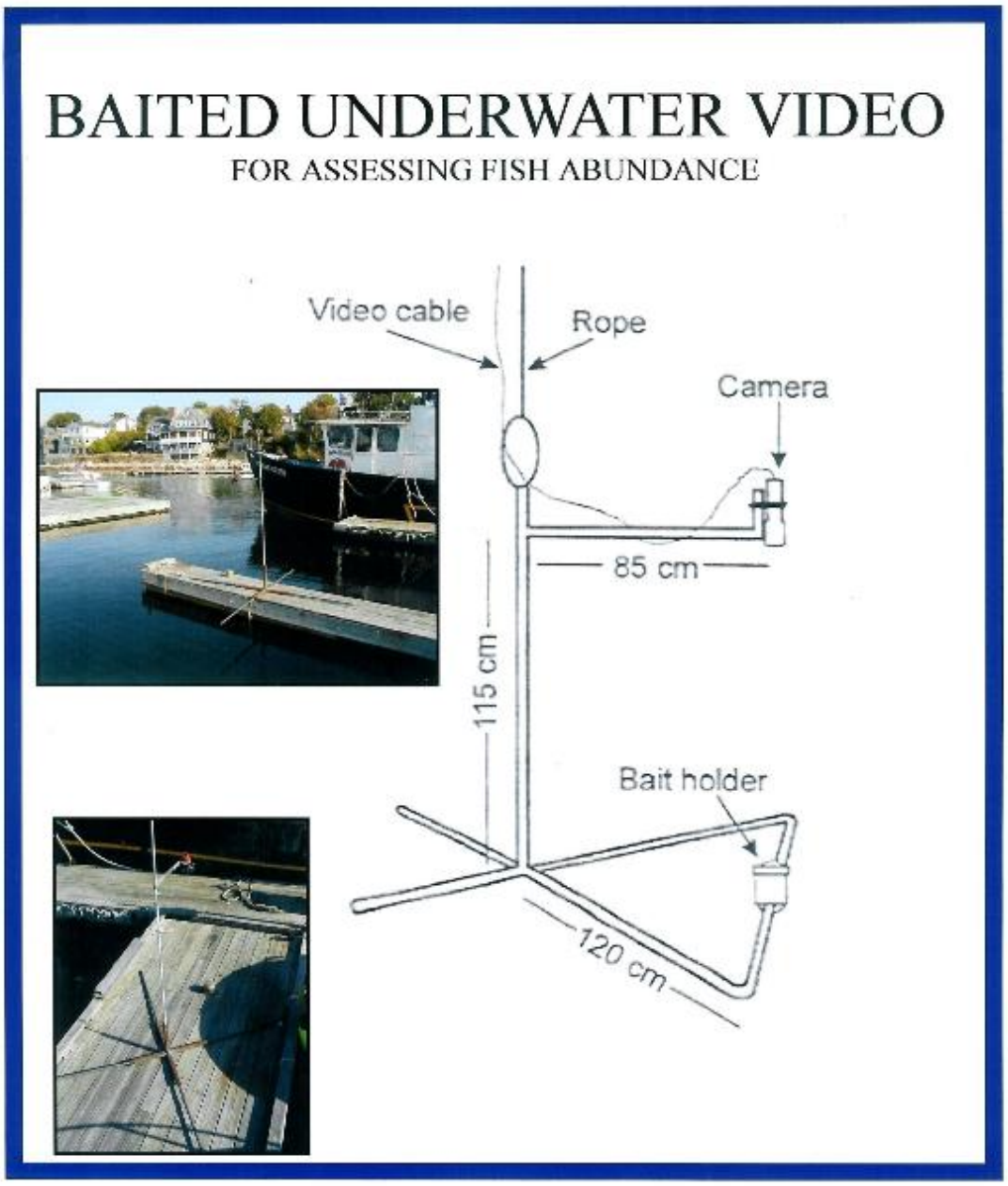
BAITED UNDERWATER VIDEO
FOR ASSESSING FISH ABUNDANCE
Video cable
Rope
Camera
85 cm
115 cm
Bait holder
120 cm

Figure 1.

Results

52 sites in the southern Gulf of Maine were visited during the course of the study (Figure 2). Nine near shore sites were used for testing the gear before recorded video drops were initiated. In 20 drops no fish were observed but crabs, shrimp or other invertebrates appeared in some videos. The videos that showed large numbers of fish such as cod and pollock were taken near underwater outcrops such as Pigeon Hill (renamed Sanctuary Hill by USGS), Halfway Hump and Tillies Bank.

In the initial tests in inshore waters shallower than 30 meters depth, the gear worked well with numerous fish, mostly cunners, attracted to the bait. It was common to see 20 – 30 fish on the video screen at one point in time. As depth increased beyond 30 meters, light became a factor and it was not always possible to identify the fish at the periphery of the video screen. An incandescent light source was added to the frame. Some fish appeared to be attracted to the light and others showed an avoidance reaction. Redfish appeared to "bask" in the light (see Plate 10) and often stayed motionless whereas cod and haddock moved away from the light. In some of the early videos it was apparent that fish were circling around the outside of the frame. Currents were a significant problem in many areas at the time of maximum ebb and flow.

Poor lighting made identification difficult or impossible in many of the deep BUV drops and this problem will need to be solved in future applications of BUV. The need for artificial light increased with cloud cover, at night and in deeper water. Some fish react to light but the best quality video and pictures are obtained with good light. Preliminary tests were conducted using a variety of light sources including 35 and 50-watt incandescent, 100-watt halogens, and an assortment of LED lights. The disadvantages of incandescent light include the high amperage needed to keep the lights at full brightness and possible avoidance or attraction by various species of fish. LED lights consume about 25% of incandescent light amperage. They are also cold and the reaction from fish is minimal. A bank of LED lights is probably the best source for uniform light that also has minimal impact on fish behavior.

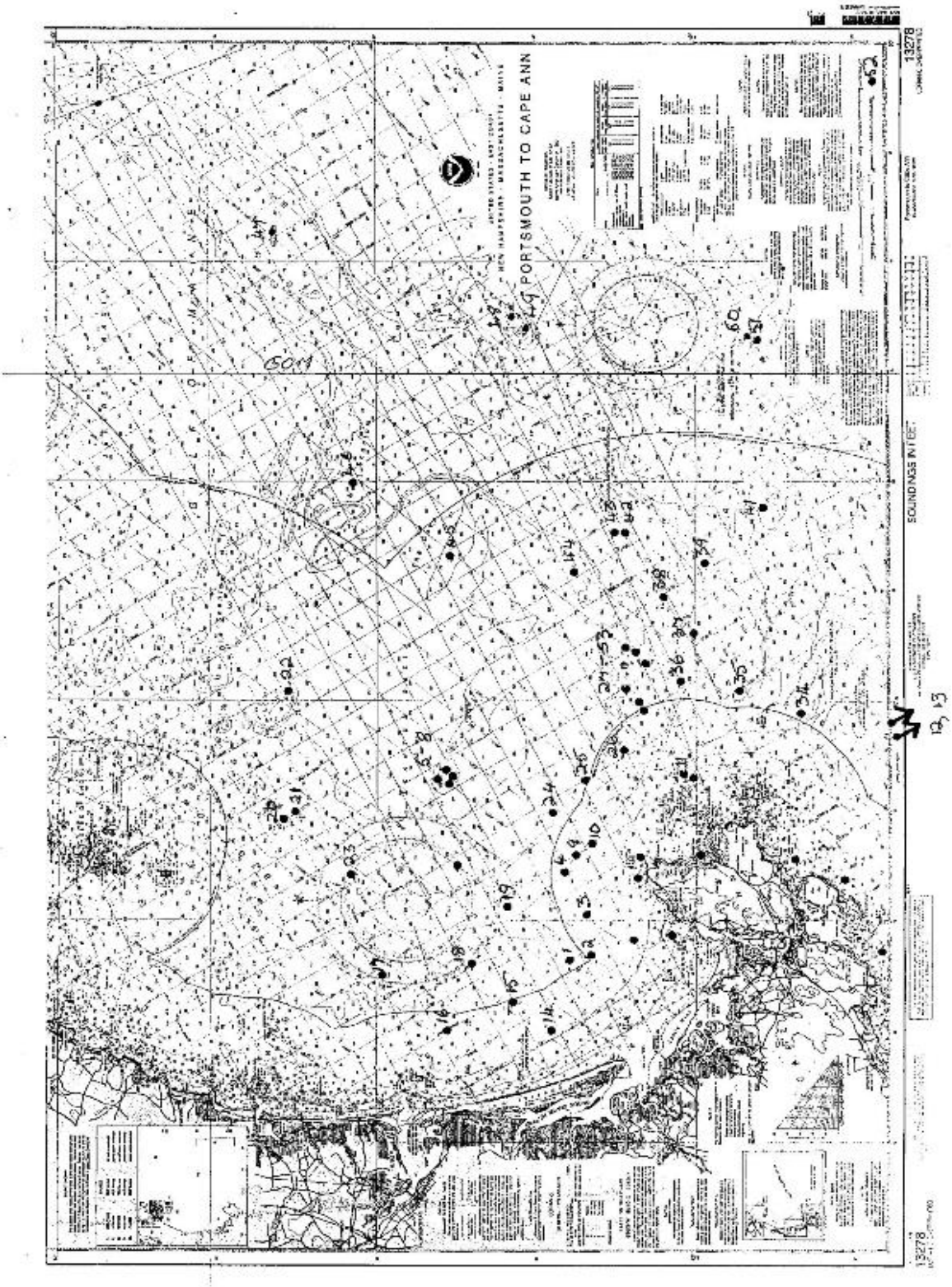

Figure 2. BUV deployment sites

Table 1: Underwater Video Sightings

Results list all the types of fish seen during the 30-minute video.

Test	1.	5 crabs, 2 unidentified fish
	2	No fish
	3	2 crabs, 1 shrimp, 4 sculpin
	4	1 crab, 1 unidentified fish
	5	15 redfish, 4 pollock, 10 cunner, 1 crab
	6	2 sculpin
	7	cunner*, redfish*, 1 cod, 1 silver hake, 2 pollock
	8	1 silver hake, 2 haddock, 1 cod, 1 monkfish, 1 silver hake
	9	no fish
	10	3 crabs
	11	20 cunner, pollock**, 4 small cod, several scallops
	12	no fish
	13	shrimp**
	14	no fish
	15	shrimp*
	16	1 crab
	17	no fish
	18	1 blowfish, 1 skate
	19	1 scallop, 6 crabs
	20	cunner*, 1 catfish, 1 cod, 1 pollock, 1 scallop

21	10 redfish, 6 pollock, 10 cunner
22	pollock*, 25 cunner, 10 redfish
23	no fish
24	15 redfish, 6 pollock, 10 cunner
25	no fish
26	2 windowpane flounder, 1 crab, 4 skate
27	1 pollock, 2 cod
28	25 cunner, 8 cod, 2 pollock, 10 redfish
29	2 cod, 1 silver hake
30	no fish
31	6 cod, 1 windowpane flounder, 1 cunner, 1 redfish, 1 lobster
32	1 cunner, 1 cod, 1 dogfish, 2 lobsters
33	18 cunner, 1 cod, 2 crabs, 1 lobster
34	no fish
35	no fish
36	no fish
37	5 crabs
38	scallops*
39	no fish
40	2 sculpin
41	shrimp*
42	crabs*
43	1 dogfish, 2 crabs

44	1 slime eel
45	2 cod
46	no fish
47	1 wolffish, 1 cusk, 2 redfish
48	3 cusk, 1 redfish, 1 cunner, 1 unidentified fish
49	2 haddock, 2 cusk, 1 sculpin, shrimp**
50	cod**, 1 cunner
51	pollock**, 20 cunner,1 cod
52	1 cusk

* more than 20 individuals

** 30 + individuals

Plates 1 through 10 are representative images recorded during successful deployments at depths of from 60 to 100 meters. Fish species seen include cunners, cod, haddock, pollock, dogfish, hake, redfish and wolffish. Images highlight the difficulty of counting and identifying species around the periphery of the frame due to the concentration of light from the incandescent source.

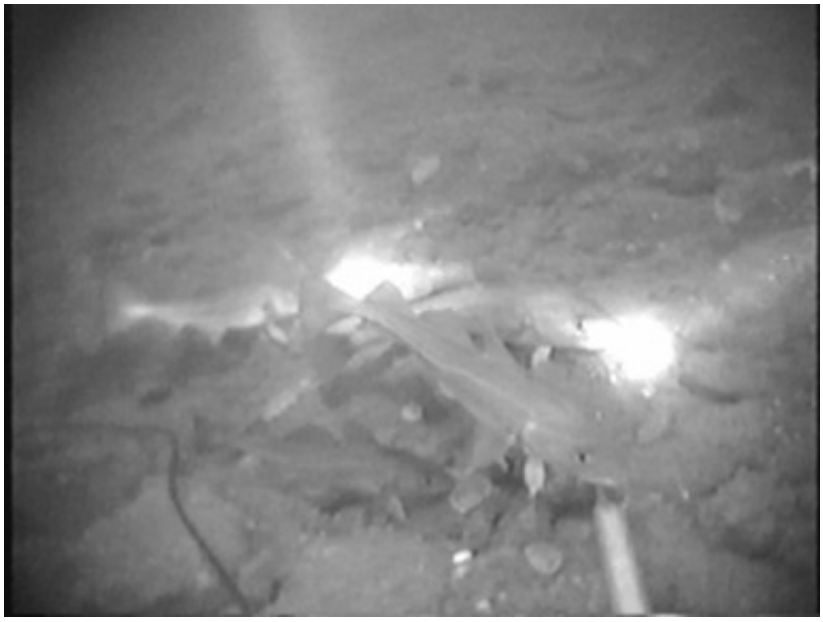

Plate 1.

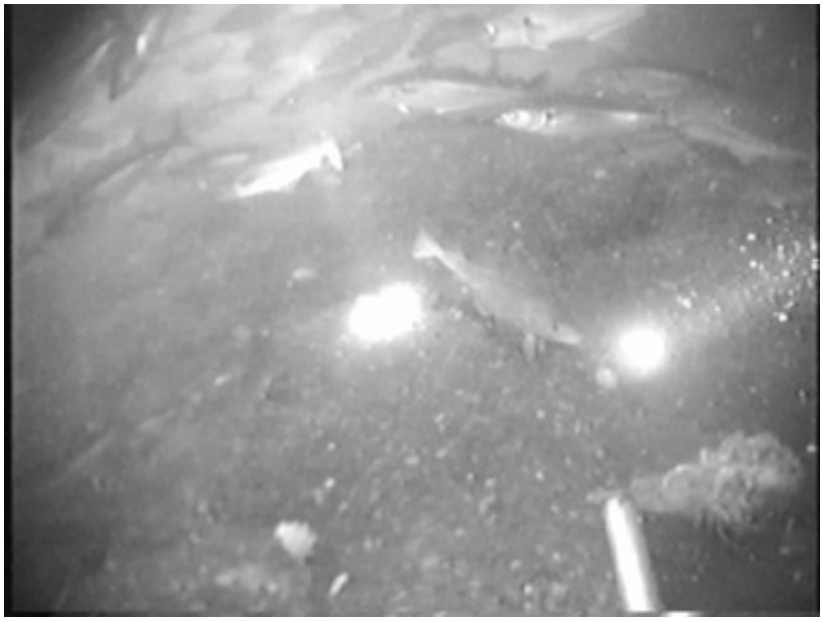

Plate 2.

Plate 3

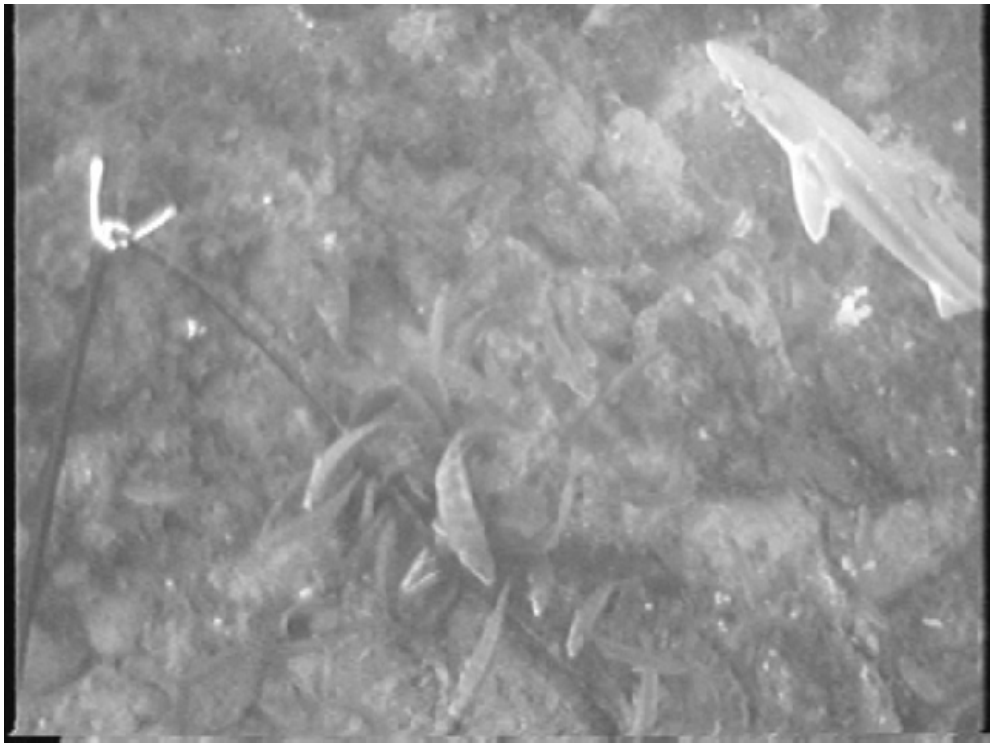

Plate 4

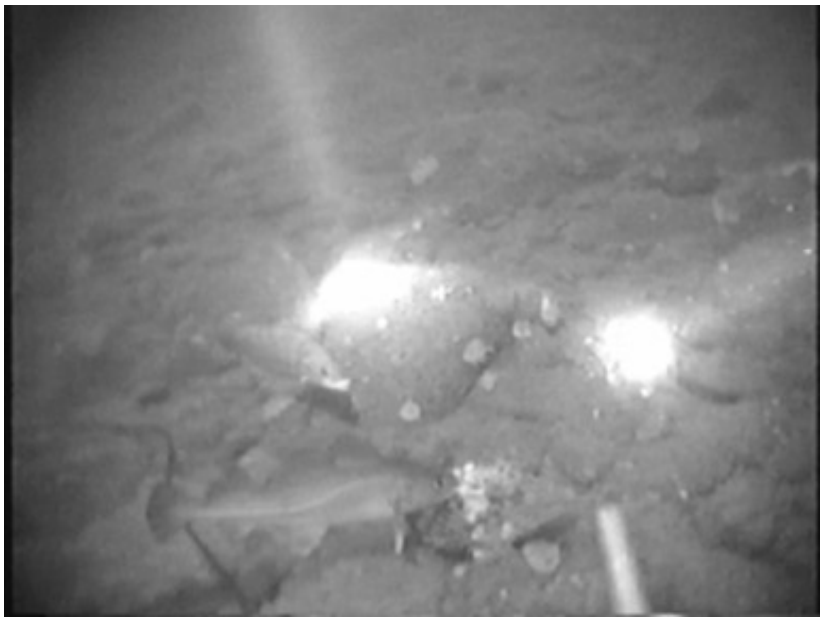

Plate 5

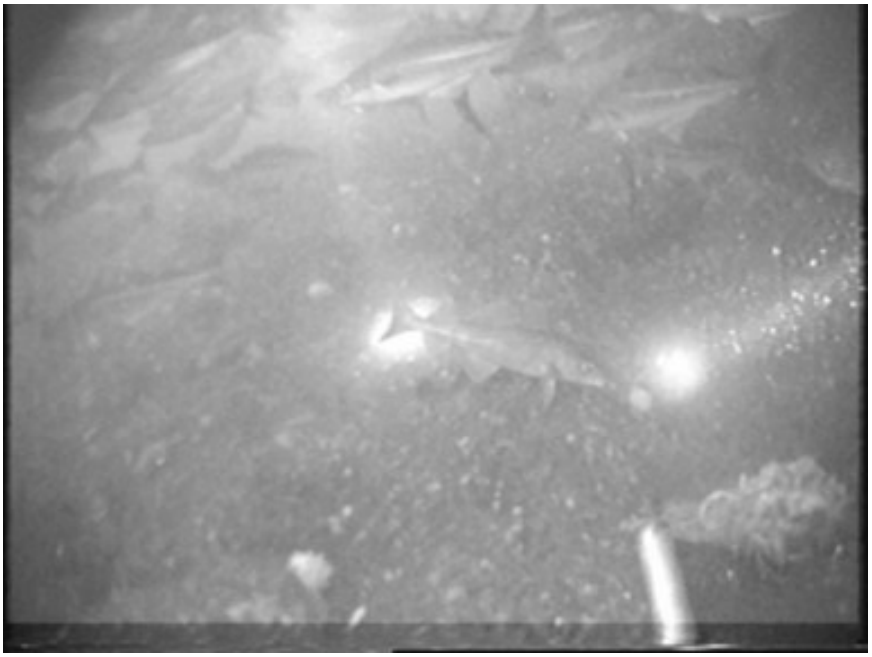

Plate 6

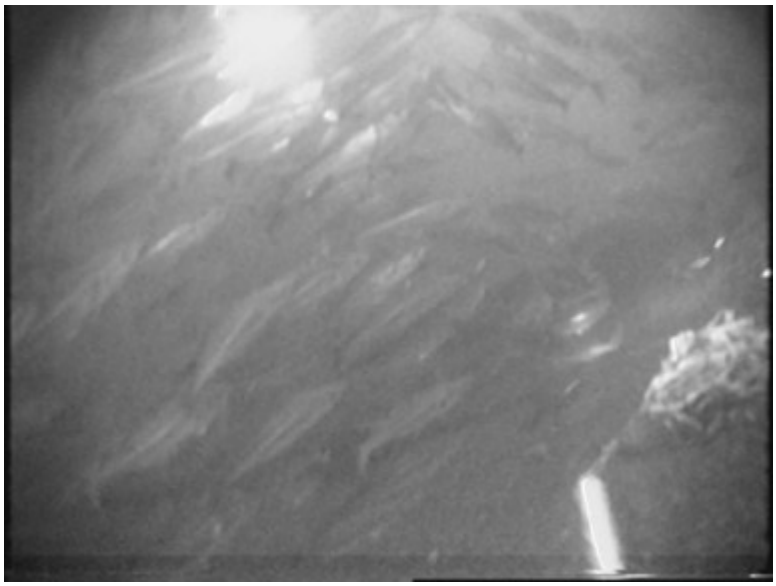

Plate 7

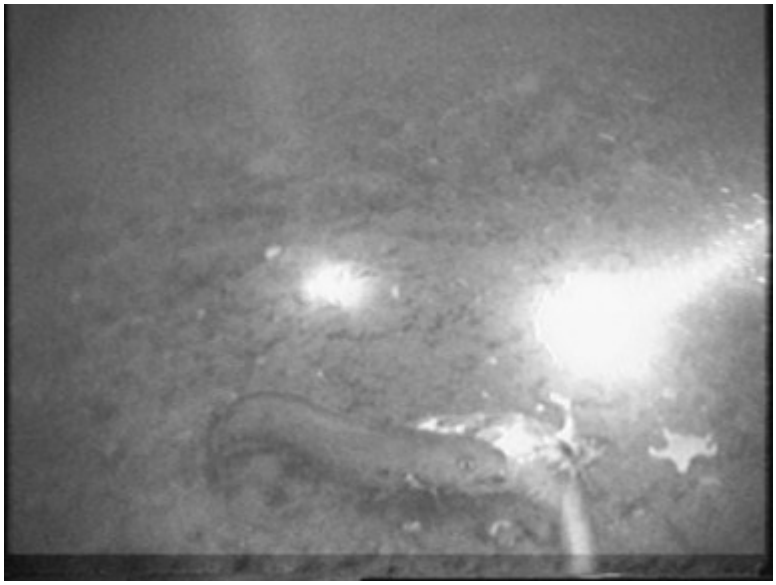

Plate 8

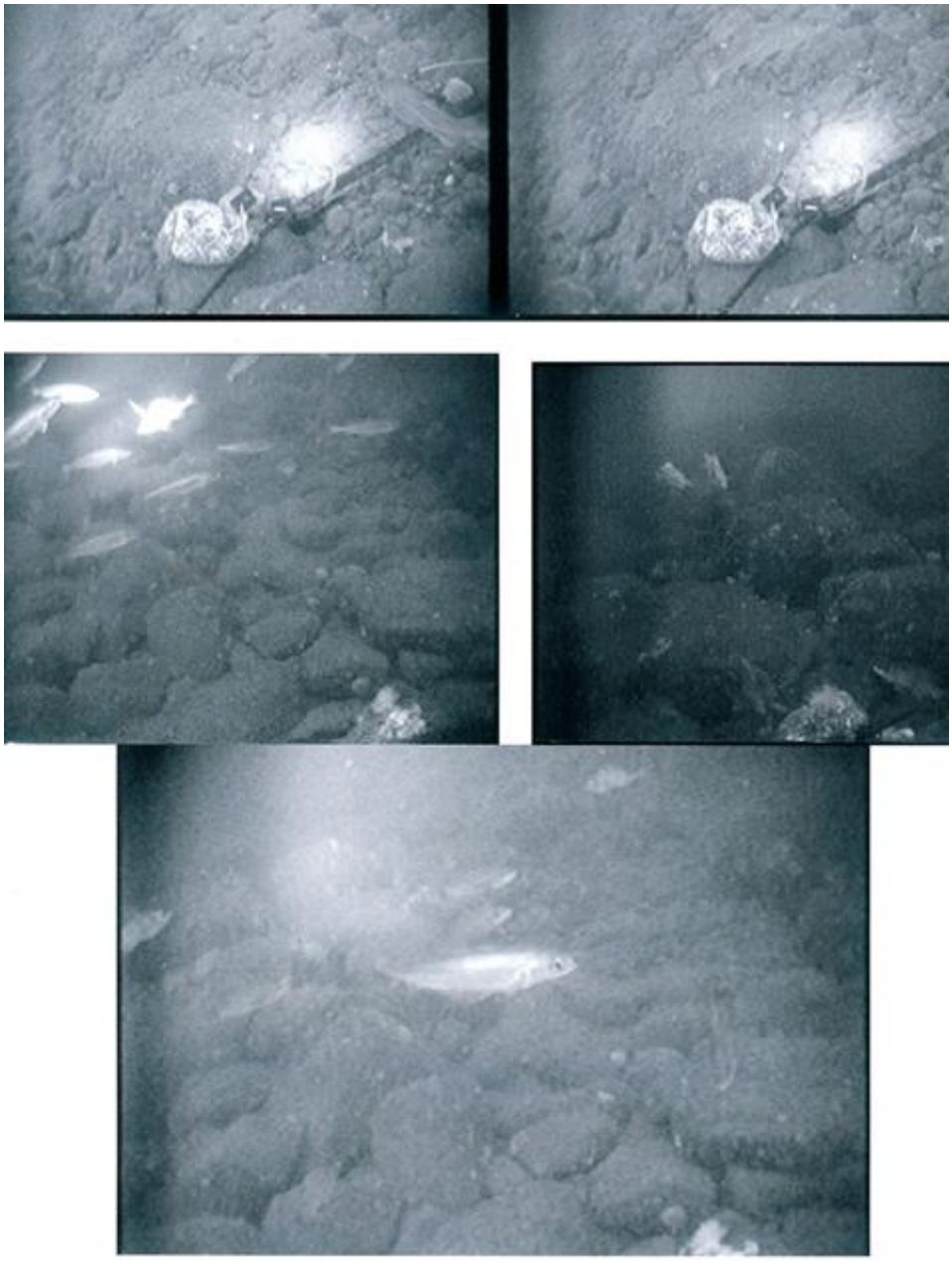

Plate 9

Plate 10

While experimenting with various light sources, a Wavetech LM631 digital light meter was used to assess the candlepower output from a variety of devices . The meter was held one foot from the light source and the maximum readings were obtained in foot-candles

Table 2. Light Output from Various Sources

Source	Foot-candles
Single LED red	0.03
Single LED yellow	0.03
Single LED green	0.07
10 white 12 volt LED bayonet-based bulbs	13.06
12-volt bright red 22-bulb LED	47.5
12 volt single red 6-bulb LED	13.55
12 volt four amber with 4-bulb LED	20.1
Princeton dive light single LED	11.8
Princeton dive TEC-40 white incandescent	0.97
12-volt 50 watt halogen	67.0
Regular flashlight, 2 D-dell	0.15
Tektite Expedition Star	331
Cluster of 4 LEDs, 10 lights each	60.4

A bank of diode lights that emit red light in the spectra invisible to fish might be the most effective source of illumination. They are also very conservation in battery use. Another, more expensive, option includes low-light cameras.

Related Projects

In a separate cooperative research project, Captain Lee built video buoys that could be deployed for long periods of time (Plate 11.). They consisted of 12-inch PVC pipe and a 12-inch bottom cap which was glued on. A low voltage VCR inside the buoy was powered by a deep cycle battery. The VCR could be programmed in a time-lapse mode to take pictures for a specified length of time at planned intervals. A live cable ran to the camera portion of the gear deployed on the sea floor which was of a similar design to that used in this study. The video buoys were successfully deployed for up to a week in shallow water and worked well on projects for monitoring cod traps and the use of artificial bait for lobsters. This gear design was also tried in an offshore habitat study funded by National Marine Fisheries Service (Michael et al, 2006) but with little success due problems with currents and lighting.

Plate 11. Video buoys

Discussion

The original design as used by Willis et al., which we copied, worked well in depths of less than 30 meters with a good supply of natural light. Results in offshore deeper areas were not good enough with the gear we used to recommend this approach for assessment purposes in that environment. The major problems were visibility at depth and currents. Researchers at the Australian Institute of Marine Science (Cappo et al, 2004) used a modified approach to underwater video assessment at the Great Barrier Reef. Cheap Hi8 "Handicams" were installed in underwater housings made of PVC sewer pipe. These systems were baited with 1 kg of pilchards and set in strings of six – each with a rope for hauling and a string of surface buoys. The cameras recorded for 1.5 to 3 hours and the timing and abundance of fish visits were documented using the time code stamped on the tape. The gear setup was called baited remote underwater videos or BRUVS and offers an alternative to the system we used. One main advantage of that system is the lack of an electrical umbilical cord to the surface, which was a problem at

times of high current speeds with our gear. These BRUVS were tested at depths up to 100 meters in Australia but in an area that has much better visibility than we encountered in the Gulf of Maine.

Trawls were made close and parallel to a long-shore set of five BRUVS set at regular intervals along one nautical mile. For each species, the sum of the maximum number of fish sighted on BRUVS at any one time was compared with the number of fish caught. The two techniques recorded different components of the fauna on fish grounds although there was a considerable overlap of species common to both techniques. Both techniques indicated very similar patterns of grouping of fish species assemblages, despite sampling different components of the fauna. The trawls caught mainly small sedentary demersal species such as flatfishes while the BRUVS recorded a greater number of larger mobile species from a much wider size range of families including sharks and rays, trevallies and mackerel. The BRUVS technique more precisely and accurately described and predicted the fish assemblages in the field comparison.

Since the publication of that study, Cappo et al have provided a summary of the published research on fish assessment using baited video systems (Cappo et al, 2006). They identify three different approaches as HBRUVS (horizontal baited remote video stations), VBUV (vertical baited video underwater television, as used here) and SBRUVS (stereo-horizontal baited remote video stations). Langois et al (2006) made a direct comparison between diver surveys (UVS), vertical camera systems (VBUVS) as used in this study, and horizontally deployed HBRUVS. Resulting data indicates that various approaches have differing success rates depending on the types of fish and the habitats. Large species such as sharks and rays are too big to enter the field of view below a vertical camera system but can be seen in horizontal deployments.

The issue of bait plumes is a major factor in the use of baited video systems. Current speed will have a significant effect on the area sampled by the bait plume. Some initial evaluation of this aspect was done by Ellis and DiMartini (1995) who suggested that, based on swim speeds and current speed, distances of greater than 100 m were independent in their 10-minute deployments. Cappo et al 2004 calculated separation distances of 450 m for 60 minute soak times.

Currents and light are the two major factors that need to be addressed. HBRUVS could probably be used in areas of the Gulf of Maine where significant tidal currents exist but further testing needs to be done with respect to light sources. Possible improvements would be banks of red LED lights or time-lapse flash cameras. One potential advantage of the inexpensive VBUV system as used by Willis et al is that fish can be measured more easily. The camera is focused down on the sea floor at a known height above the surface. Cameras in the HBRUVS system are directed horizontally and, without knowing the distance between the fish and the lens, it is more difficult to get a reliable estimate of length. The system will however give equally good estimates of relative numbers and diversity. More sophisticated (and expensive) stereo image systems with associated software have been developed for use with HBRUVS (Harvey et al 2002; Harvey et al., 2003; Abdo et al, 2006; Cappo et al., 2006).

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