Nightlighting — A Harvesting Strategy for Underutilized Coastal Pelagic Schoolfishes[1]

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Abstract

A fishing strategy is presented which proposes utilizing nightlighting techniques as a means for economically harvesting underutilized coastal pelagic fishery resources. Results of preliminary fishing trials are presented and the feasibility of introducing nightlighting techniques to supplement conventional fishing gear and methods are discussed. Nightlighting field experiments are also discussed which will contribute to the development of a netless harvesting system for use with the National Marine Fisheries Service proposed automated fishing platform.

INTRODUCTION

Coastal pelagic schooling fishes (i.e., herring, sardines, anchovies) are Gulf and Caribbean resources of considerable latent potential. Bullis and Carpenter (1968) estimated that the coastal pelagic fishes in the Gulf of Mexico represent a latent resource of more than 4 million tons, a potential 8 times larger than the present Gulf production of 0.5 million tons. The thread herring *(Opisthonema oglinum)* stocks alone have been estimated at about 1 million tons (Bullis and Thompson, 1967).

Early attempts at harvesting Gulf thread herring were reviewed by Butler (1961) and recent developments in this fishery were reported by Fuss (1968) and Fuss, Kelly, and Prest (1969). These reports point out that the behavioral characteristics of coastal pelagic fishes limit the times and places where they can be harvested with conventional gear.

This report summarizes the progress of light attraction field studies conducted by the National Marine Fisheries Service, Exploratory Fishing and Gear Research Base, Pascagoula, Mississippi. Our immediate objective was to determine the feasibility of developing light attraction techniques to supplement conventional fishing methods. Our long term obective was to develop a NMFS proposed netless harvesting system (Klima 1970 (a), 1970 (b)). Briefly, this system would utilize artificial lights, an electric field, and a fish pump to capture fish for automated processing aboard a containerized vessel.

PRELIMINARY STUDIES – REVIEW

Prior to the studies discussed in this report we participated in numerous

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nightlighting stations and gained considerable experience with a variety of light sources and sampling gear. Subjective observations indicated that fish could be attracted by a wide range of lamps and light intensities. A single high wattage point-source lamp created the most controllable aggregations. Underwater lamps were more efficient and effective than lamps deployed above the surface.

During nightlighting stations we used a 5-meter lift net in combination with a 1,000 watt underwater mercury vapor lamp and a 1,000 watt underwater quartz-iodide lamp (Wickham, 1970). The spectral radiation from the mercury vapor lamp is strongest in the blue-green region of the spectrum where the greatest light transmission for seawater occurs. This lamp creates a large light field and was used as our primary attraction source. The quartz-iodide lamp has its strongest radiation at the red end of the spectrum which is attenuated rapidly in seawater. This lamp, however, has an incandescent filament that can be dimmed with a variable power transformer. After enough fish aggregated around the mercury vapor lamp, we would switch over to the quartz-iodide lamp which would then be slowly dimmed to reduce the size of the light field and concentrate the fish above the 5-meter lift net. Although qualitative estimates were obtained, fish often extended beyond the capture zone or avoided capture and could not be sampled with this method.

Quantitative samples were needed before we could evaluate the commercial applicability of light attraction to develop harvesting methods for coastal pelagics. We had to determine the species and quantities of each that could be attracted by a single light source. Quantitative samples were also needed to establish the expected variability of fish available to light. We also needed to determine whether fish could be led with lights from separate attraction sites to a single point for more efficient harvesting.

EXPERIMENTAL FISHING TRIALS

We began our quantitative evaluation of light attraction in St. Joseph Bay, Florida during August and September 1969. This work (Wickham, 1971) provided the first quantitative species inventory on the variability of light attraction effectiveness and confirmation of its suitability for use with conventional purse seines.

The *Gulf Ranger,* a 49-foot single-boat rig bait purse seiner, was chartered for this study. Its purse seine was a "tom weight" type, 1,545 feet long and 71 feet deep, with a 1-1/4 inch stretched mesh webbing. A 1,000 watt underwater mercury vapor lamp and echo sounder transducer to monitor fish below the light were mounted on a frame suspended beneath a 16-foot outboard used as a light skiff during fishing operations. Power for the lamp and echo sounder was supplied by a portable gasoline powered 2.5 kilowatt, 115 volt A.C. generator mounted in the skiff. Communications between the skiff and purse seiner were maintained by portable FM radios.

Two charter periods during the new moon and one during the full moon were scheduled to provide data on the effects of the lunar phase on artificial lights. To assess the intranight variability in the attraction by artificial lights, sets were made at about 3-hour intervals following sunset.

The purse seiner made sets, with its lights off, around the anchored light skiff. During the set, the light skiff anchor would be pulled up and the skiff would drift to the corkline away from the net opening. The skiff would remain inside the net with the light on until pursing was completed. The light skiff would then move over the cork line, reanchor clear of the seiner, and resume fishing the light. The total weight of each catch was estimated by the vessel captain and a sample was weighed, sorted, and identified.

Over 50 species of fishes and numerous invertebrates were identified in these sets. Three species, Spanish sardine *(Sardinella anchovia)*, Atlantic thread herring *(Opisthonema oglinum)*, and scaled sardine *(Harengula pensacolae)*, usually comprised the bulk of the larger catches. These species are estimated as having the greatest commercial potential among the latent coastal pelagic resources in the Gulf. The combined contribution of the three species alone was 50% or more by weight in 71% of the catches from our experimental sets.

There was considerable intranight variability among each night's sets, with differences from 100 to over 3,000 pounds between sequential sets. However, when the catch data for the entire study was averaged by the set time it was found that the 1,000 watt mercury vapor light was about equally effective for attracting fish throughout the night. The variability observed for individual sets probably resulted from variations in fish concentrations within the effective range of the light during the 3-hour experimental attraction period.

Nightly differences in total catch ranged from 500 to more than 6,000 pounds. This internight variability appeared to result primarily from differences in environmental factors such as location, water turbidity, and thunderstorms, to mention only a few. The present data are insufficient for an analysis of the effects of environmental factors on light attraction.

Although nightly catch totals from the single attraction source were not all based on a full night's fishing of three sets, they still averaged slightly better than 2,500 pounds per night for the entire study period. Catches made during the new moon periods alone averaged better than 3,000 pounds per night although only two of the seven nights fished consisted of a full three sets. Full moon catches were roughly one-third as large as those for the new moon, averaging 1,200 pounds per night. In terms of the potential fishing applications it should be noted that fish were successfully attracted during both the new and full moon. The full importance of moon phase in the commercial application of light attraction, however, will require considerably more comparative catch data.

This study also showed that a purse seine can be set around fish aggregations attracted to light and that the fish are not greatly disturbed by the encircling net. Purse seine sets around night lights, therefore, can be made slowly and since the fish remain relatively undisturbed in the light field, unsuccessful sets could almost be eliminated. An additional advantage of using light fishing in selected areas would be reduced search time. Despite its advantages, however, the use of light as an accessory technique to purse seining is not likely to be accepted by the fishing industry until the size of the catches can be increased and their variability reduced. One of the methods of solving these problems would be to lead the fish aggregations from multiple attraction sites into a single location for harvesting. The capability to lead fish with lights would also be useful for the development of the proposed netless harvesting system.

Preliminary observations made during this study indicated that fish aggregations follow a slowly moving light for short distances. This led to studies to evaluate the feasibility of leading fish with lights.

LEADING FISH WITH LIGHTS

Light leading experiments were undertaken in the summer of 1970 to determine the feasibility of leading fish both by lines of sequentially deployed lamps and by a single moving lamp.

To establish the possibility of leading fish from one light to another by sequentially turning the lamps on and off, we had to determine the maximum distance the lights could be separated without losing the fish.

We used two identical 1,000 watt mercury vapor lamps and two identical portable echo sounders. Lamp-echo sounder Unit No. 1 was deployed from the R/V *George M. Bowers* and Unit 2 from a 16-foot out-board skiff. Distance between the two lights was controlled by a line, marked at 10-meter intervals, attached to the light skiff and deployed from the *Bowers*. Simultaneous monitoring by echo sounder and visual observation at both lights was used to establish the successful movement of fish between lights.

Light No. 1 was used to attract the fish. The skiff would be allowed to drift out to a selected distance controlled by the measured line. No. 2 lamp would then be turned on at a preselected time and after a 5 minute warm-up period No. 1 lamp would be turned off. The fish were given 10 minutes to aggregate around the No. 2 lamp. Then No. 1 lamp was turned on again and following a 5-minute warm-up period, the No. 2 lamp was turned off. The skiff would then drift back to the next experimental position and the above procedure was repeated. Controls were conducted by separating the lamps at various distances and turning both lamps on and off simultaneously following the experimental time pattern.

Sequential light-leading experiments, conducted in the turbid waters of St. Andrews Bay, Panama City, Florida, revealed that both lights were acting as independent attraction sites. Sequential leading, therefore, was not possible in these turbid conditions but the two aggregations could be brought together and merged under a single light source by slowly pulling the two lights together.

Sea conditions and other program commitments permitted only one night of sequential light-leading experiments in clear Gulf waters at Stage II, a Navy research platform located off Panama City, Florida. A series of control periods revealed that only scattered individual fish were attracted to the lights. Fish attracted at Stage II were led to the *Bowers;* the methods will be described below. The same procedure used in the Bay was repeated, with fish being successfully transferred between the two light sources at distances up to 20 meters. Visual observations indicated that 20 meters was probably close to the maximum separation for these light sources and water conditions.

Observations during earlier light attraction studies indicated that fish aggregations would remain with a moving light for short times and distances. To further evaluate the effectiveness of using a moving light for leading fish, we conducted a series of trials in the Gulf of Mexico off Panama City, Florida. These trials indicated that large aggregations of fish could be led over 0.5 mile with either a drifting light or one moving at several knots independent of wind or current direction. When light leading with the skiff under power, it was necessary to start moving slowly until the fish stopped circling and moved along with the light. The skiff was then gradually speeded up and the fish were watched closely to prevent losing them. On two occasions there were barriers, probably tide rips or thermoclines, through which the fish would not pass. At these times the light had to be quickly brought back to the fish or they would disperse and be lost. The first time we experienced these barriers almost the entire school was lost before it was noticed that the fish had stopped. Spanish sardine appeared to be more sensitive to these barriers than blue runner *(Caranx crysos).*

LIGHTS AND ARTIFICIAL STRUCTURES

Passive fishing gear (i.e., traps, bait and nightlights) require that fish pass within the effective zone of attraction before they can be captured. The catch depends on the size of the zone of attraction and the fish density therein. The characteristics of a nightlight's capture zone and the resulting catch are not consistent. Variables such as turbidity, ambient light, current velocity, fish density, biological rhythms and many others influence the effectiveness of the gear and/or the susceptibility of the fish to capture.

The catch variability observed in our experiments probably resulted from different fish densities in the water mass within which the light was an effective attraction stimulus. Consequently, we became interested in methods for increasing fish densities in the areas where the nightlights would be deployed.

Coastal pelagic fishes are known to form large aggregations around various types of structures, (i.e., drilling platforms, floating logs).

We have recently conducted successful studies on their attraction to artificial structures (Klima and Wickham, 1971).

A series of trials were conducted at Stage II to determine whether the dense fish aggregations that form around drilling platforms and artificial structures during the day could be led away from these structures with lights after dark. We discovered that during the new moon these aggregations dispersed at night away from the structures, and that an hour after sunset lights usually attracted few fish. If the lights were turned on before sunset, however, large numbers of fish remained around the structure after dark. These aggregations could then be led away from the structures with a moving light. On one occasion we led a large aggregation to 0.5 mile from Stage II. A purse seine set made on this aggregation produced about 10,000 pounds of coastal pelagic fishes, 80% Spanish sardine, and 20% mixed scaled sardine, round scad and blue runner, after an estimated 5,000 pounds of fish were lost over the cork line.

PROTOTYPE LIGHT ATTRACTION HARDWARE

We have begun to design and develop prototype light attraction equipment for application with conventional fishing gear and the netless harvesting system. Two self contained systems, the Fish Light Attraction Catamaran (FLAC I), and the Fish Light Attraction Buoy (FLAB I), were given preliminary field tests. Patents have been filed for both systems. FLAC I was designed for use with conventional purse seine gear. Its underwater lamp can be raised for towing and to facilitate passage over a purse seine cork line. Since the FLAC I system is designed for towing, it would be suitable for leading fish away from artificial structures, drilling platforms, and other areas with high density fish concentrations inaccessible to purse seines and other conventional gear. The FLAB I system is a stationary light buoy intended as a component in the sequential light leading array envisioned for the netless harvesting system. During field tests the performance of both FLAC and FLAB met our original expectations. Additional self-contained light sources are scheduled for construction and these will be used during experimental fishing trials.

SUMMARY AND CONCLUSIONS

Our experiments and field trials have established the feasibility of utilizing light attraction for harvesting coastal pelagic fishes in the Gulf of Mexico. Light attraction can be used with conventional purse seines and the proposed netless harvesting system. We have caught upwards of 4,000 pounds of fish in 3 hours from a single light with nightly totals exceeding 6,000 pounds. Multiple lights properly spaced acted as independent attraction points and the fish attracted to them can be led together by either sequentially deployed lamps or with a single moving light. Light attraction was significantly improved through the use of artificial structures to increase the density of fish. We have shown that aggregations of fishes in areas inaccessible to harvesting gear can be held together after sunset and led to suitable harvesting areas by lights. Also, prototype light attraction systems are being developed which will improve harvesting of coastal pelagic schoolfish. Before the fishing industry can be encouraged to invest in light attraction hardware, however, we must conduct experimental fishing trials to determine the production levels which can be expected and to evaluate the effects of environmental and biological variables.

We are now planning experimental fishing trials using light attraction with a conventional purse seiner to obtain production estimates and develop fishing procedures. We are also planning to assemble the various components of the netless harvesting system and begin experimental fishing to test and evaluate design concepts and hardware and to provide production data for system comparison with conventional harvesting methods.

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