

# EXPERIMENTAL DRUM SEINING FOR WETFISH IN CALIFORNIA

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The authors consider the problem of operating a vessel profitably in a fishery for a fixed-price resource. They believe that more profit can be made by increasing the efficiency of vessel operation, thereby increasing landings, and by decreasing manpower through mechanization. In this study, purse-seining operations were mechanized by using a hydraulically powered drum to handle the net and a fish pump to load the fish. This increased operating efficiency by lessening time required to catch the fish--and by decreasing manpower required for the vessel operation. The experiments showed that the cost of mechanizing could be offset by recovery from the crew's share of the catch while increasing wages for the remaining crewmen.

## THE PROBLEM

The San Pedro wetfish purse-seine fishery is the last major stronghold of the former California sardine fleet. Wetfish is a collective term for those species--anchovy, sardine, mackerel, and squid--used for canning and reduction that are bulk-loaded in the round, usually not refrigerated, and generally off-loaded with a suction pump. The vessels in this fishery are mainly ex-sardine seiners 45 to 90 feet long with carrying capacities of 25 to 150 short tons. About 24 of these vessels operate within a 100-mile radius from San Pedro, California. Perrin and Noetzel (1970) showed that this fishery was becoming increasingly unprofitable primarily because of rising costs of operations and demands for higher wages--while prices for the raw materials remained nearly constant. This situation is fairly common in countries where the standard of living is rising at a rapid rate and raw products prices, controlled by world markets, tend to rise at a lesser rate. The solution is to increase the productive efficiency of the operating units by increasing the production per unit of operating time and by decreasing the cost of operation.

Such changes in efficiency can be realized in a number of ways, including increasing the size and speed of the vessels, changing fishing strategy, and mechanizing the operation to use manpower more efficiently. In the case of the San Pedro wetfish fleet, each of these approaches was considered.

The first was rejected for the time being because it was felt that the necessary capital for improved vessel design would not be forthcoming until the fishery's profitability was more apparent. The second could be a lengthy project, using operations research methods, and would require many logbook-type operating data over a long period. Such data are not now readily available (Petrich, 1965). It is the last of these three--mechanization--which will be reported here.

## Cooperative Group Formed

In September 1969, a cooperative group known as the Wetfish Operation Pool was formed within the California Marine Research Committee. It comprises California's Department of Fish and Game, the Fishermen's Cooperative Association of San Pedro, the Fishermen's Unions, and the Operations

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Research Group of the National Marine Fisheries Service, La Jolla, California. This pool, under a joint funding arrangement, chartered a San Pedro wetfish boat, 'Sunset', to experiment with mechanizing the fishing operation. The objective was to reduce by 40 to 50% the number of men required for working the vessel. Additional advantages sought were to decrease the time of the fishing operation, especially desirable for species available to the gear for only limited times during the day, and to develop a safer and less backbreaking method.

### MECHANIZATION OF PURSE-SEINE OPERATIONS

A review of world purse-seining methods shows methods for handling the different phases of this fishing which, if combined, probably could achieve the desired results. These include a seine drum for reducing labor in handling the net, net modifications to permit easier handling of the catch, and pumping devices to load fish from net to vessel. It is hard to say what innovation has had the greatest effect upon purse seining but, quite likely, it would be one of the mechanical methods of handling the net.

Purse seining has developed from a completely manual operation through an intermediate phase using powered roller to ease pulling the net--to, more recently, the introduction of side haulers, power blocks, or the net drum. The power block and the net drum originated at about the same time in the Pacific Northwest.

The power block, invented by Mario Puretic of San Pedro, California, revolutionized the handling of purse seines and has achieved worldwide recognition.

The drum seine, an invention of Nick Kelly from British Columbia (Philips, 1971), has not received the same acceptance for several reasons. The drum, because of its extremely rapid net-retrieving capability, was outlawed from the Alaskan salmon fishery as a conservation measure, whereas the Puretic block was legal and gained rapid acceptance. The drum was legal, however, in Canada and

in the Washington salmon fishery, where it was accepted by boats that did not spend part of their time fishing in Alaskan waters. The power block has greater versatility with the type of net it can handle and is less costly to instal. However, vessels that used the drum have been very satisfied with its performance and recommend it over the block.

The drum appeared ideal for our needs with the San Pedro wetfish experiment. This was because the crew requirements were not dictated by the need for sufficient manpower to stand watches and repair gear on extended voyages. These vessels seldom are away from port for more than 24 hours. Second, the drum would reduce considerably the time in the set. It is a very important point because several principal wetfish species show near the surface only for a short time during day or night. The ability to make several sets in rapid succession may mean the difference between a partial or full load for the vessel.

Basically, the drum is a large reel powered either mechanically from the main engine or by a hydraulic motor. A purse seine is wound on the drum with the purse line left threaded through the purse rings. In addition to the drum, a mechanically or hydraulically driven level wind is used consisting of two upright rollers through which the net passes as it is retrieved.

In some vessels, the drum and level wind are installed on a rotating table so the net can be set over the stern and retrieved over the side. There are pros and cons to this innovation. Whether or not the benefits warrant the additional installation cost should be studied. We selected a drum installation consisting of a fixed drum with a level wind across the stern.

### Fish Pump

The second major item of equipment gaining wide acceptance in purse seining is the fish pump. Several models are available. We chose for its ready availability the Marco<sup>1</sup> capsule pump. Fish pumps can load fish more rapidly than the conventional brailing net. Also, they require less manpower and eliminate the safety hazards of brailing.

<sup>1</sup> Use of trade names throughout this article does not imply endorsement by the National Marine Fisheries Service.

In addition to drum and pump, we incorporated into our experiment a hydraulically powered, reel-type pursuing winch; a boom to handle corklines; and a "ring stripper" that automatically feeds the purse rings on to the drum during retrieval phase of operation.

#### DESCRIPTION OF SAN PEDRO INSTALLATION

The vessel made available to the Wetfish Operation Pool under a charter arrangement was M/V Sunset, a former California sardine seiner. It is of wooden construction with overall length of 90 feet, beam of 21 feet, and carrying capacity of approximately 150 tons. Sunset is powered by a 250-hp diesel producing a cruising speed of about 9 knots.

When delivered to us, she was rigged for wetfish seining with a power block driven by

a small hydraulic pump running off the main engine. Other deck machinery included a mechanically driven double capstan winch for pursuing and brailing. Because the existing hydraulic system was too small to handle the proposed additions to the machinery, the first modification was installation of an auxiliary engine and a 100-gallon per minute (gpm), 1800 psi hydraulic system. The auxiliary was a General Motors 160 hp. 6-71 diesel engine driving stacked 60- and 40-gpm hydraulic pumps off the power takeoff. In addition, a separate 30-gpm pump was mounted off the shaft. The 60-gpm pump was to drive the drum and fish pump; the 40-gpm pump was used for the winch, and the 30-gpm pump was used to operate the level wind.

The next modification was to attach a "beaver tail" (Fig. 1) to the shoe to protect rudder and propeller from the net. Beaver tails are commonly used in the Northwest

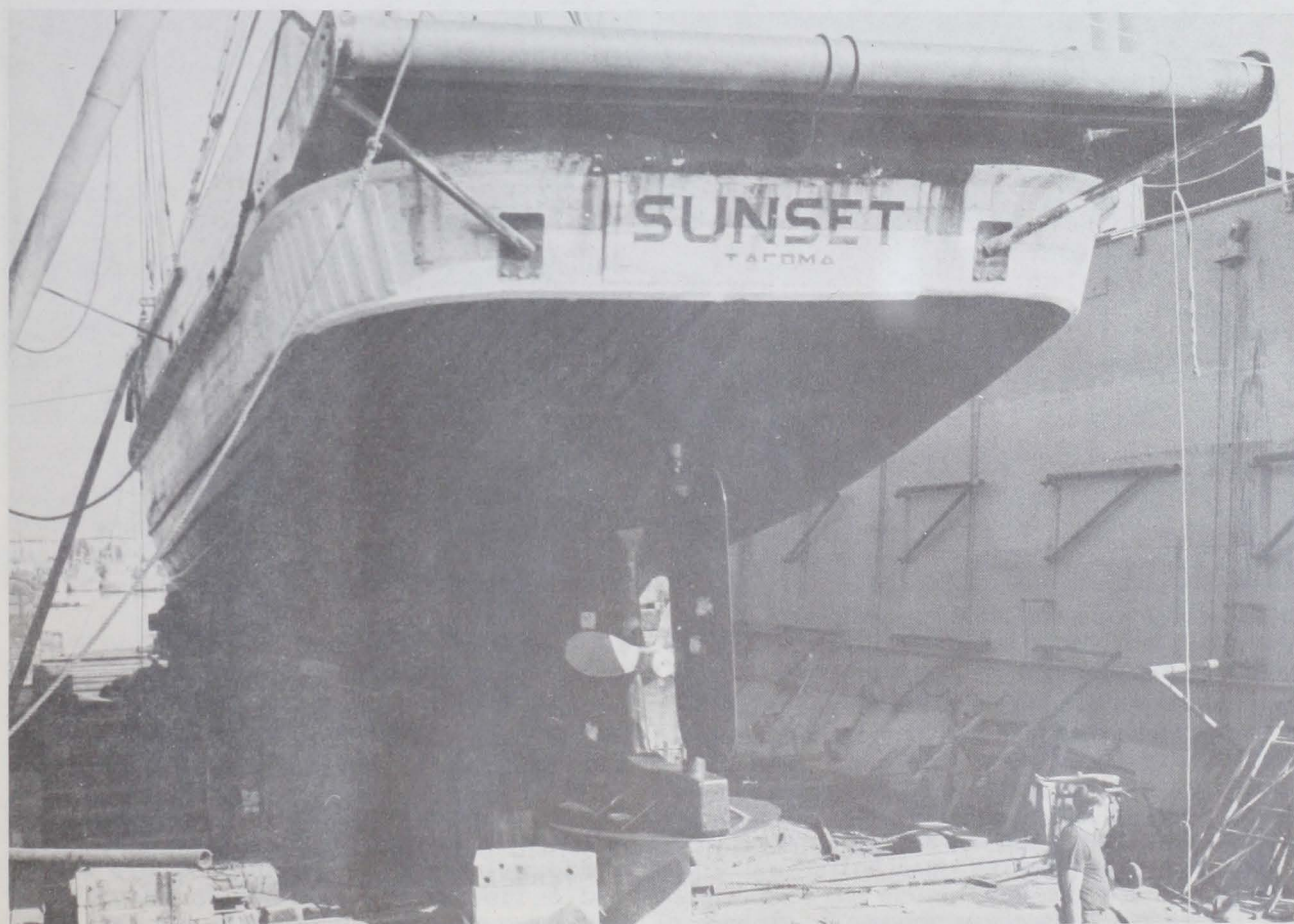


Fig. 1 - "Beaver tail" shown installed to bottom of shoe. Stem idling roller is also shown installed. (D. Aasted)

but have not found their way into our wetfish fleet. Because of the drum, the net passes over the counter and down the side of the vessel, and some protection is needed to keep the webbing from becoming tangled up in the propeller.

The third modification was to remove the turntable from the stern and to fabricate and instal in its stead the drum and level wind (Fig. 2). This unit was designed and built by Post Point Marine of Bellingham, Washington. The drum is aluminum with 8-foot diameter flanges and an 11-foot length core, 22 inches in diameter. The drum is driven by two Hydrostar hydraulic motors. The level wind

The existing double capstan winch formerly used for pursing was removed and replaced by a hydraulically powered double drum dragging-seine winch. Because the tow line for the net is wrapped on the core of the drum, only two drums are needed for the pursing winch if the net is to be operated full-pursed; in practice, we operate the net half-pursed so that only one drum is used.

#### Fish Pump & Separator

The fish pump selected was a Marco U-235, 10-inch capsule pump. To handle it, we installed a 24-foot boom from which we also handled the corks of the fish bag. The wire



Fig. 2 - Drum and level wind on M/V Sunset. (R. Green)

consisted of two upright rollers mounted in a track across the stern. The level wind is driven by a chain and cable arrangement from a hydraulically powered sprocket. The controls for the drum and level line are mounted on the portside of the drum to allow operator a good view of the net. A complete hydraulic system diagram for Sunset is given in Figure 3.

basket-type fish-water separator was mounted on the starboard side adjacent to the opening to the fish hatch. This pump and separator had previously been tested aboard the vessels NEW ROMA, Monterey, California, and S. T. GUISEPPI, San Pedro; it was satisfactory provided sufficient hydraulic capacity from the vessel was available.

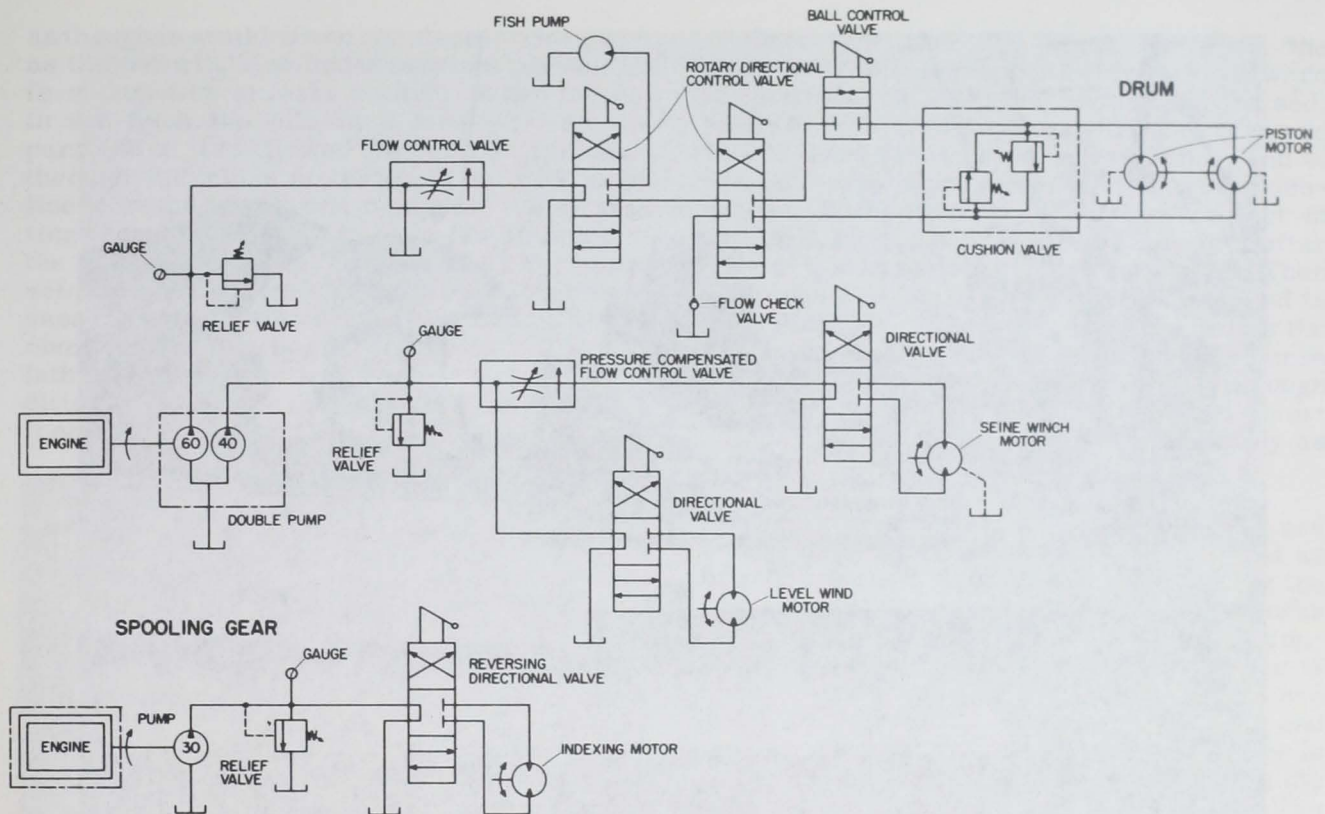


Fig. 3 - Diagram of hydraulics system installed on M/V Sunset.

A Whaley Engineering ring stripper was installed on the portside just aft of the pursuing davit (Fig. 4). This ring stripper is described by Green, Perrin and Petrich (in press); it has replaced similar devices throughout the Northwest, including the "hairpin" in which the rings are suspended from the mast. When properly positioned, the ring stripper holds all purse rings during retrieval. It allows purse line to run freely through them while feeding off one ring at a time as net is retrieved.

#### The Net

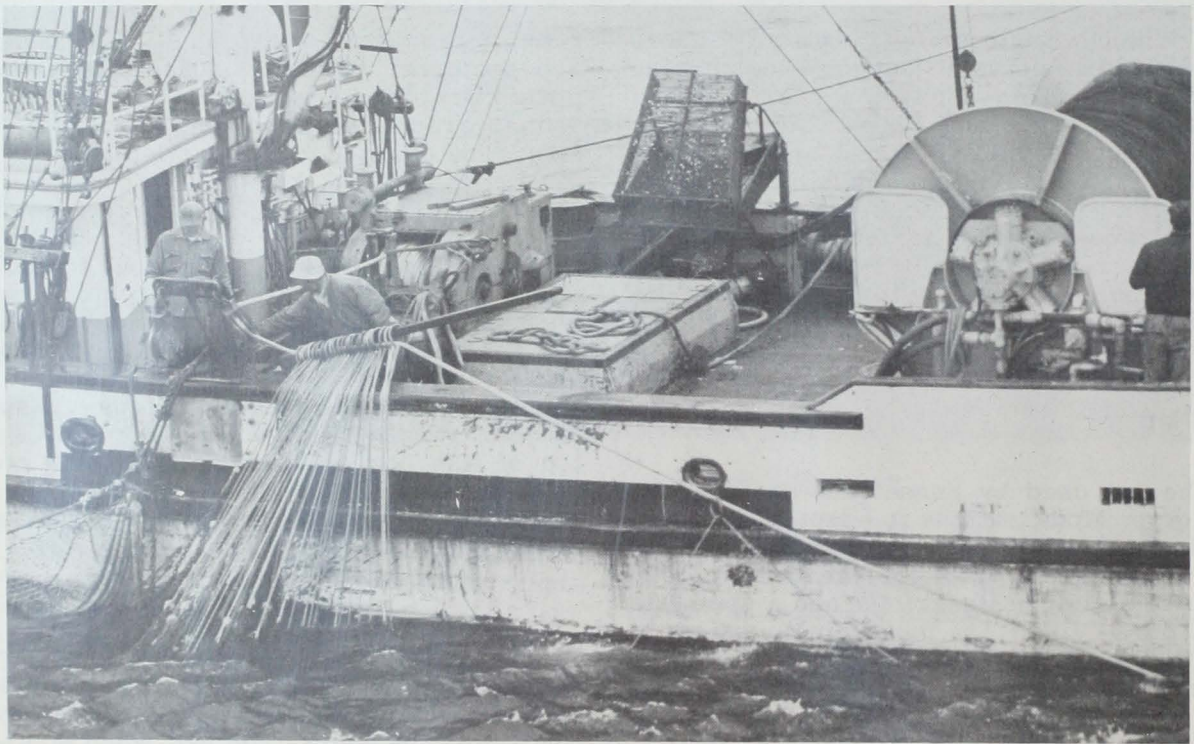
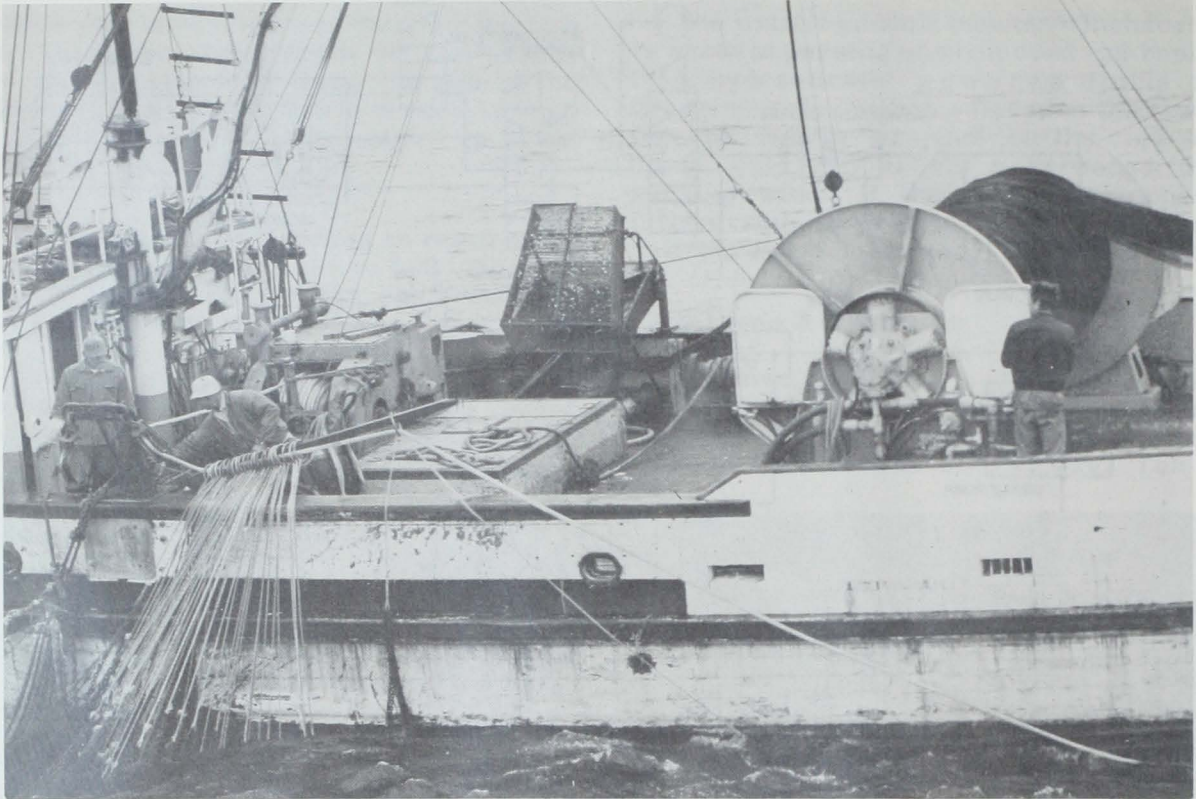
The net used by Sunset was designed for anchovy. Modifications to adapt it for drum seining involved replacing bridles with  $\frac{1}{2}$ -inch-diameter polydac rope, smaller diameter brass or stainless steel rings, and a synthetic rope purse line. The purse line consists of 50 fathoms of  $1\frac{1}{4}$ -inch-diameter braided nylon in area of main wear, followed by 150 fathoms of 1-inch diameter. The smaller brass or stainless steel rings are preferred because they are less abrasive to the synthetic

rope than are iron purse rings. Rope bridles are preferred to chain because they reduce possibility of bridles becoming tangled in net as it is wrapped on the drum, and they do not rust. The chain leadline was left unchanged.

Because of the large compressive force on the part of the net near the core of the drum, it was necessary to remove the corks from that half of corkline and to mount them on a separate corkline to reduce breakage. We replaced the sponges corks with Sanyo, and later with Swedish floats, model 6215, which proved more resistant to the crushing forces. Finally, pucker rings were added to top of fish bag so floatline above bag could be gathered together and suspended from the boom; this obviated need for skiff to come alongside to support corks.

#### OPERATION

The initial problem of loading net on drum was attacked by stacking net on stern in usual fashion, setting it in a straight line, and reeling it onto the drum. The net, when stacked, presents an awesome pile which does not look



Figs. 4A & B - Ring stripper in operation. Ring on stripper in top photo (4A) has slipped in 4B. Purse line is feeding through rings. (R. Green)

as though it would fit on the drum. However, as the net winds on under tension, the volume is reduced by at least a third. When the net is set from the pile in a straight line, the purse line is allowed to run out, threaded through the rings so that both net and purse line can then be wound on drum. When setting from the drum (Fig. 5), a few fathoms of the bag are left free on deck and attached to seine skiff in usual fashion. Several seconds pass before inertia of the drum can be overcome and the net begins to pay out. The few fathoms of webbing in the water provides additional resistance that would not be available from skiff alone.



Fig. 5 - The start of a set. Skiff has been dropped and net drum is free wheeling. (R. Green)

When setting from the drum, the greatest hazard is the possibility of a backlash. It requires an alert operator to keep a slight tension on the drum at all times. Make sure that sticks and other stiff objects are not caught in the webbing where they could hold two layers of the net together on the drum. If these precautions are rigorously observed, chances of backlash are very slight. However, because of this possibility, it is advisable to leave power skiff attached by its bow to the net until about a quarter of net is off the drum. Otherwise, if a backlash should occur while the skiff is turning and is broadside to the net, the skiff may be swamped. A tow line is wrapped on the core of the drum to allow setting in a larger circle than net will encompass.

Once tow line has been retrieved, the other end of purse line can be brought forward to the winch; or, if the net is partially pursed, as we have been doing, only one end of purse line is used for pursing, and the other end of net is wrapped on drum while pursing proceeds. With practice, the forward part of net will be pursed at same time that after part of net has been retrieved on drum. Then the rings are brought up and transferred to ring stripper. The balance of the net to the bag then is retrieved with the drum; the purse line is allowed to feed out from winch through rings on the ring stripper. The rings themselves pay out one at a time automatically as the webbing is retrieved (Fig. 4).

During pursing, the corks in bag are bunched and suspended from boom so that as bag is reached, the net is suspended by the last few rings on ring stripper with the corks hanging from boom. At this point, in the conventional manner, the net is passed forward of the drum and strapped in. When the fish are dried up, the pump is lowered into bag and the fish are pumped aboard. Once the bag is empty, the skiff comes alongside, takes the bag end and stretches it out in the water. The last few wraps of the drum are released to allow net to straighten out, and the bag is brought aboard on the drum.

The drum has other advantages: First, the set can be stopped at any point and retrieval begun. Second, because net is easy to handle, it can be let go in a straight line and retrieved to wash it; or, if repairs to the net are necessary, the vessel can hang from the net as on a sea anchor and repairs be effected.

## FISHING TRIALS

Vessel modifications and equipment installation, with exception of new winch, were completed in May 1970. The first phase of field trials was a series of water hauls to uncover any unanticipated problems in performance and handling of gear. These trials were held near Los Angeles Harbor in calm water and were completed within a week. Then we proceeded with fish trials to evaluate further the effectiveness of equipment and to see if more improvements were possible.

At the outset, several minor problems were encountered, including difficulty in handling the rings when pursing from one

end of the net only. These problems were solved. At first, the existing double capstan pursing arrangement was not satisfactory. When it was necessary to "hold" the purse line on the capstan, the friction on the synthetic rope was sufficiently great to damage the purse rope. Also, it was inconvenient to tie off the purse rope during these momentary "holds". The best solution was to replace the capstan winch with a modified drum-type pursing winch. A hydraulic powered winch was installed, and the difficulties with purse line were resolved.

During the 1970-71 anchovy fishery, we obtained comparative time-in-set and manpower requirement data from other vessels in the San Pedro wetfish fleet. The combination of drum and fish pump resulted in significant decreases in time required to complete sets in nearly all catch-size categories (Table 1); often, it was possible to get an additional set in the brief time that fish were available just before dawn. We found one problem that did not occur on conventionally rigged boats. During retrieval, the net rubbed continuously against the vessel's counter and the chain leadline caused some scoring of vessel's hull. This was solved during next haul-out by installation of suitable rubbing strips on bottom and portside. Another possible solution would be to mount the drum on a rotating platform and to change

Table 1 - Tons loaded per minute in set by size of catch

Size of catch (tons)	Tons/minute in set	
	SUNSET	Others in fleet
0-19	0.12	0.16
20-39	0.37	0.32
40-59	0.76	0.51
60-79	1.07	0.61
80-99	1.13	0.76
100 and over	1.18	0.98

Source: Unpublished logbook data furnished by the California Department of Fish and Game.

location of level wind so net is retrieved off portside. This also would permit drum to be used to dry up fish completely. The modification should be studied.

## ECONOMICS

The purpose of the experiment was to evaluate the profitability of mechanizing small to medium purse seiners. The cost of the essential modifications to Sunset is given in Table 2. Labor performed by the vessel, crew, or National Marine Fisheries Service personnel during the installation is not included. Shipyard labor cost and contract labor costs are included since the costs cover specialized skills not readily available

Table 2 - Cost of essential modifications for mechanizing M/V SUNSET

Drum, complete with level wind and stern roller	\$17,000
Capsule fish pump and separator	3,500
Beaver tail	836
Modifications to net	680
Ring stripper	1,375
Dragger winch	6,039
Diesel auxiliary	2,500
Hydraulic system	4,571
Miscellaneous	1,759
Total	\$38,260
Yearly cost \$7,652 + (15% interest) 1,148 =	\$ 8,800

among average fishing crew. Table 3 illustrates possible recovery on this investment assuming investment is amortized over 5 years and financing costs run 15%. It is obvious that unless a larger share of catch is allocated to vessel, it is not profitable for owner to make this investment. However, with the illustrative distribution of vessel earnings given in the table, it can be seen that the investment can be recovered and



Table 3. Economics of drum seining for anchovy (X1000). Annual vessel gross \$138,000. Trip expenses \$14,000<sup>1</sup>. Net proceeds \$124,000

Share arrangement	Conventional seining with 10-man crew		Drum seining with 5-man crew					
	Boat 40%	Crew 60%	Boat 40%	Crew 60%	Boat 45%	Crew 55%	Boat 50%	Crew 50%
Share	49.6	74.4	49.6	74.4	55.8	68.2	62.0	62.0
Owner's costs <sup>2</sup>	32.2		32.2		32.2		32.2	
Drum and related costs			8.8		8.8		8.8	
Profit before taxes	17.4		8.6		14.8		21.0	
Crew share 1 man		7.4		14.9		13.6		12.4

<sup>1</sup>Means of 14 vessels, 1971 anchovy season.

<sup>2</sup>From Perrin and Noetzel (1970) increased by 40% coinciding with similar increases in annual vessel gross and trip expenses.

profitability of vessel increased. At same time, the average crewman share will increase greatly compared with his expected earnings on a conventional vessel.

During her first year of operation (1970-71) under this experiment, Sunset's earnings were compared with other boats of the fleet. Of 14 vessels that made bookkeeping records accessible, Sunset ranked seventh in gross income, fifth in boat share, and fourth in crew share. The average number of crewmen during this period was 5.4 on Sunset, and 9.9 on the other vessels. The share arrangement on Sunset was boat 50% and crew 50%. The mean share arrangement for the others was boat 40%, crew 60%.

Additional benefits that do not show in the fiscal data are the increased comfort and safety of crewmen with drum seining operation. It is no longer necessary for crew to

stand in net pile with water dripping on them from above, nor to submit to the arduous and hazardous conditions of brailing. The use of ring stripper and dragger winch obviate most dangers associated with handling the rings. Since the rings never come aboard, but remain on side, the peril of working under the rings is removed. Further, the hydraulic dragger winch installation permits purse line to be handled without having loose coils of line on deck. The line can be stopped at any point during the operation. It is relieved automatically by hydraulic system if tension becomes too great.

#### CONCLUSIONS

1. The drum seining method of mechanizing purse seining operations is readily adaptable to the California wetfishery. The use of the drum speeds up the actual fishing time and decreases the number of men required to handle the gear.

2. Additional improvements that were tested and found to be of benefit are:

- (a) The fish pump for brailing the fish into the vessel, which reduces the time and the manpower needed;
- (b) the ring stripper, which simplifies handling the purse rings; and
- (c) a hydraulic dragger type winch, which results in savings in manpower and a safer operation.

3. A vessel equipped with this equipment and operating with a reduced number of crewmen is capable of equalling or exceeding the performance of a power-block-equipped vessel.

4. The capital outlay for the drum seining modifications can be recovered by changing the vessel crew share arrangement of the vessel income.

5. The vessel crew earnings can be expected to increase with reduction in crew size. At the same time, they benefit from a reduction in the labor required during fishing and an improvement in safety.

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