FILTRATION EFFICIENCIES OF BOOTHBAY DEPRESSOR TRAWLS

Boothbay Depressor Trawls (Figure 1) are used to obtain yearly estimates of the abundance of larval herring, *Clupea harengus harengus* Linnaeus, in the coastal water of the Gulf of Maine. The Boothbay Depressor trawl is a relatively new device (Graham and Vaughan, 1966), and its use is contemplated by others. It differs from other nets towed for collecting larval fishes in that a large depressor blade is located below the mouth opening and a liner is hung in a larger meshed net some distance from the mouth. These features of construction were examined to determine whether they affected the filtration of water through the trawls. Flow determinations were made about the depressor blade and trawl mouth, and the flow of water through the liner mouth was compared to the ambient flow.

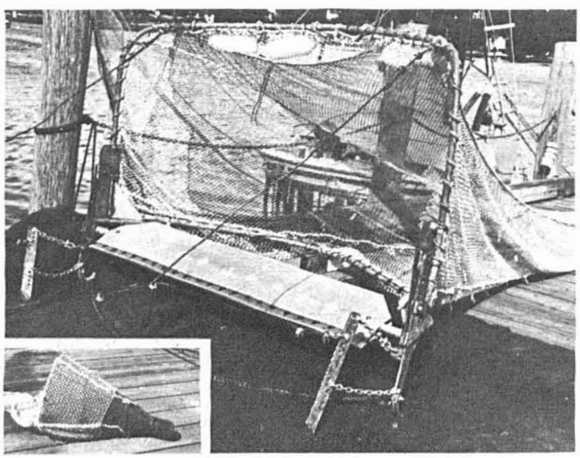

FIGURE 1.—Boothbay Depressor Trawl No. 1. Insert shows wire cod end.

Methods

Nets with a mesh opening of 3.2 cm stretched measure were lashed to pipe frames of 1 × 1.5 m, 1 × 2 m, 1.25 × 3 m, and 1.5 × 4 m (height × width), trawl No. 5, 1, 4, and 2, respectively. These large meshed exterior nets served to hang and protect the small-meshed liners (Table 1) of nylon webbing which retain the larvae. The diameter of the mouth opening for a liner was selected empirically. It was first hung throughout the length of its funnel-shaped exterior net. To reduce friction the liner was progressively shortened toward the cod end until the ratio of wire out to the depth sampled approached 3:1, during repeated tows at 4 to 6 knots. Construction details for the trawls and their respective nets are available from the author.

TABLE 1.—Descriptions of liners used with Boothbay Depressor Trawls.

Trawl type	Total length of liner	Mouth dimension of liner		Mesh diameter	Ratio of open areas
		Height	Width		Mesh/Mouth
	cm	*cm*	*cm*	*mm*	
No. 1	345	53	102	1	7.5
No. 1	579	89	113	2	7.7
No. 1	579	89	113	4	11.2
No. 2	700	152	274	2	5.3
No. 4	510	100	145	2	5.6
No. 5	510	100	145	2	5.6

The filtration efficiency of a No. 1 trawl containing a liner with a mesh opening of 4 mm was determined in a flume (circulating water channel) at the U.S. Navy's David Taylor Model Basin under experimental conditions as described by Mahnken and Jossi (1967). Velocities in the mouths of the pipe frame and the liner were measured by lowering a flow meter at intervals equivalent to its diameter and recording the velocity for each interval with a remote electronic counter. These velocities were then weighted by the area of each interval to obtain an average value for the entire mouth area. Also, a meter was fixed in the center of the forward opening of the wire cod end. Filtration efficiency was measured as the velocity recorded in the net divided by the velocity recorded in the flume; the quotient was expressed as a percentage. Dye was released within the mouths of the net and liner, and tabs were fixed to the blade and nets to trace the direction of the flow of water.

Several tests were made in the field to compare with the results from the flume. Field observations were carried out on (1) the same trawl used in the flume; (2) the trawl No. 2

having the lowest ratio of areas of mesh opening to mouth opening, and thus the lowest potential for efficient straining; and (3) the filtration of the liner mouth opening of trawl No. 5.

Eight flow meters were mounted within the pipe frame and one meter was mounted in the cod end of the same trawl and net (trawl No. 1) used in the flume. The eight meters were distributed peripherally and centrally within the mouth opening of the trawl to sample variations in straining by the net. Upstream and downstream tows were timed over a measured distance within a narrow estuarine channel and the results of the two tows were averaged to adjust for tidal currents. The experiment was repeated using a No. 2 trawl with a liner mesh opening of 2 mm, but flow meters could not be mounted within the liner mouths.

In constructing trawl No. 5, I made the dimensions of the depressor, of exterior net and liner equivalent to the mouth opening of the liner in trawl No. 4. Both the exterior net and the liner extended back from the trawl mouth. Six flow meters were dispersed within the mouth of the liner, one in the cod end, and two were mounted within a small frame outside of the net mouth. In this instance efficiency was considered to be the percentage of the average distance of the upstream and downstream tows recorded by flow meters inside and outside the liner.

I did not weight the velocities recorded in the field according to sectors of the mouth area metered in the net and liner as in the case of flume experiments. In the flume variations in flow were largely vertical, but in the estuary large lateral variations were known to occur. The number of flow meters necessary to make such integrations might have been sufficient to physically affect the flow through the net. A mean velocity recorded by the meters mounted within the mouths of the net and liner was used.

Results and Discussion

The No. 1 trawl was highly efficient at the flume velocities tested. The comparison of the velocities measured in the nets to the flume velocities (Table 2) gave an efficiency of approximately 100%. Efficiency in the cod end approximated 83%. The release of dye and the alignment of tabs showed that the flow of water could be traced horizontally through the net and the liner and that this flow was not diverted by the blade. Moving picture films of the trawl during the test are available from the author.

The results from field trials are similar to those obtained in the flume (Tables 3 and 4). Flow efficiencies at the net mouths of the pipe frame and at the liner mouth were comparable to those obtained in the flume. Efficiencies obtained in the cod end of the nets fluctuated around those (80-84%) from the flume. These results suggested that the depressor blade and the hanging of the liner within a larger net did not affect filtration efficiency. The efficiencies were independent of the velocity of towing and the ratio of the mesh to mouth openings, as would be expected with nets that were longer than twice the diameter of their mouth openings (Tranter and Heron, 1967). Further, it is unlikely that the efficiencies would decrease during sampling. Observations in the flume showed that the net and liner would be cleansed constantly during a tow by vigorous peristalsis of

TABLE 2.—Flume and metered velocities for the Boothbay Depressor Trawl No. 1.

	Net mouth		Liner mouth			Cod end			
	cm/sec		*cm/sec*			*cm/sec*			
Metered velocity	205	309	156	238	314	156	238	309	314
Flume velocity	208	308	156	231	317	126	200	248	262

TABLE 3.—Vessel and metered velocities of the Boothbay Depressor Trawl No. 1 and 2.

	Net mouth	Cod end				
	cm/sec	*cm/sec*				
No. 1 trawl:						
Vessel velocity	184	200	203	192	184	198
Metered velocity	186	187	187	185	188	190
No. 2 trawl:						
Vessel velocity	207	207	222			
Metered velocity	196	157	175			

TABLE 4.—Metered distances of tow for Boothbay Depressor Trawl No. 5.

	Liner mouth		Cod end	
	m		*m*	
Outside	856	763	854	763
Inside	864	821	601	763

their walls, similarly to that recorded for plankton nets of finer mesh (Tranter and Smith, 1968).

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