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Status and distribution of Alosine stocks in Chesapeake Bay

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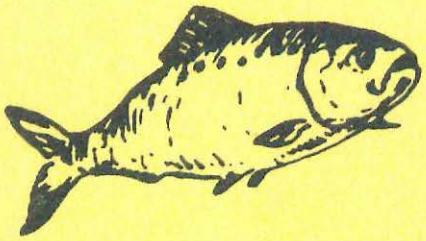
PROCEEDINGS

OF

A WORKSHOP ON

AMERICAN SHAD



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AMHERST, MASSACHUSETTS

STATUS AND DISTRIBUTION OF ALOSINE STOCKS IN CHESAPEAKE BAY

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The Virginia Institute of Marine Science has assessed the stocks of alosine fishes in the Virginia waters of Chesapeake Bay since 1967. Total landings have declined from the late 1960s to the present. The number of pound nets fished declined from 332 to 200 units during 1967 to 1973, but has since increased slightly to 245 nets in 1976. Stake gill net effort increased in the James, York, and Rappahannock Rivers from 1969 to 1975 but declined in 1976 due to a limited fishing season in the James River as a result of Kepone contamination.

The combined American shad catch-per-unit-of-effort (c/f) by stake gill nets in the James, York, and Rappahannock Rivers increased from 1969 to 1972, but then decreased until it rose sharply again in 1976. The c/f in the James River for shad declined from 30,000 lb. in 1972 to 5,000 lb. in 1975, but increased to 21,000 lb. in 1976. The c/f for shad in the York and Rappahannock Rivers similarly declined from 1971 to 1975 but did not recover in 1976 to the extent observed in the James River. The c/f of shad by pounds nets in the Rappahannock River declined from 7,384 lb. in 1968 to 125 lb. in 1976, and the c/f of river herring (alewife and blueback) decreased 91% from 1967 to 1976.

All shad fishing gear in the Potomac River reflected a downward trend in c/f from 1968 to 1976, and river herring c/f has declined about 87% from 1967 to 1976.

Introduction

Alosine fishes on their annual spawning run have been an important food and economic resource to fishermen in the Chesapeake Bay and Virginia since colonial times. When settlers first appeared in the Chesapeake Bay area, the Indians were taking large quantities of American shad for food during the spawning season. The settlers themselves soon began to harvest shad for profit. As methods of capture improved, shad landings increased from 3.1 million lb in 1880 to 11.5 million lb in 1897, but have declined steadily since that time. In 1908 American shad was the most numerous fish landed in Virginia (Walburg and Nichols, 1967).

Virginia landing data indicate that while the stocks of shad continued to decline, prices rose. In 1935, 2.9 million lb of American shad had a market value of $275,000 (Johnson,1938) for a seasonal average of $0.085/lb, whereas, the seasonal average in 1976 was $0.314/lb.

River herring (alewife and blueback) command about 1/7 the market price of American shad; however, their larger landings compensate for the lower price. The Virginia catch of river herring increased from 6.9 million lb in 1880 to 37.8 million lb in 1908. Landings then decreased but were relatively stable,averaging about 18 million lb from 1909 to the mid 1960's (Joseph and Davis,1965). Landings have since declined steadily and only 4 million lb were taken in 1976.

This paper reports the present status of the alosine stocks in Virginia and attempts to explain trends of the past 10 years. This paper is a portion of a completion report "The Biology and Management of River Herring and Shad in Virginia," in partial fulfillment of Contract No. 04-5-043-11 with the National Marine Fisheries Service.

Methods

To determine the estimated catch by pound nets the Rappahannock River was divided into two sections; lower river (miles 10-30) containing pound nets with approximately 600 ft leads (hedging), and upper river (miles 31-55) containing pound nets with 200-250 ft leads.

The number of active pound nets was determined by aerial counts (Table 1; Fig. 1). Logbooks were placed with cooperating commercial fishermen to obtain daily catch records. The number of pounds of any given species (by sex for American shad) caught by cooperating fishermen in a half-month period was divided by the number of pound nets operated by that fisherman to yield the index catch per pound net. This index was then multiplied by the number of active nets in that section of the river. Thus, the total catch (W_S) per half-month per river section was calculated as:

$$W_S = N_S \ (W_i/N_i)$$

where W_i = pounds per index net, N_i = number of index nets, and N_S = number of active pound nets.

Table 1. Number of active pound net stands in Chesapeake Bay and its Virginia tributaries during January - June, 1976.

Area		Jan. 29	Feb. 24	Mar. 5	Mar. 23	Apr. 13	Apr. 29	May 20	June 8	June 23
A	James R.	0	0	0	1	0	0	0	0	0
B	Back R.	0	0	0	0	1	2	4	4	3
C	Poquoson R.	0	0	0	0	0	0	0	0	0
D	York R.	1	1	1	4	5	3	9	10	9
E	Mobjack Bay	0	1	3	5	7	8	8	7	6
F	Piankatank R.	0	0	1	3	4	2	5	5	4
G	Rappahannock R.	1	9	27	43	54	56	42	37	28
H	Great Wicomico R.	0	0	1	5	5	6	5	7	6
I	Potomac R. (south side)	0	1	10	22	53	52	43	51	41
J	Cape Henry to Fort Wool	0	1	0	2	3	3	4	2	4
K	Old Point to Tue Marsh	0	1	2	7	9	9	11	8	1
L	York Spit	0	0	0	0	3	2	5	4	3
M	New Point to Stingray Point	1	1	8	14	23	23	22	23	24
N	Windmill Point to Smith Point	3	0	11	22	38	55	52	45	38
O	Above Hungar Creek	0	0	0	0	0	0	0	0	0
P	Below Hungar Creek	9	6	5	7	14	24	31	29	30
	Total	15	21	69	135	219	245	241	232	197

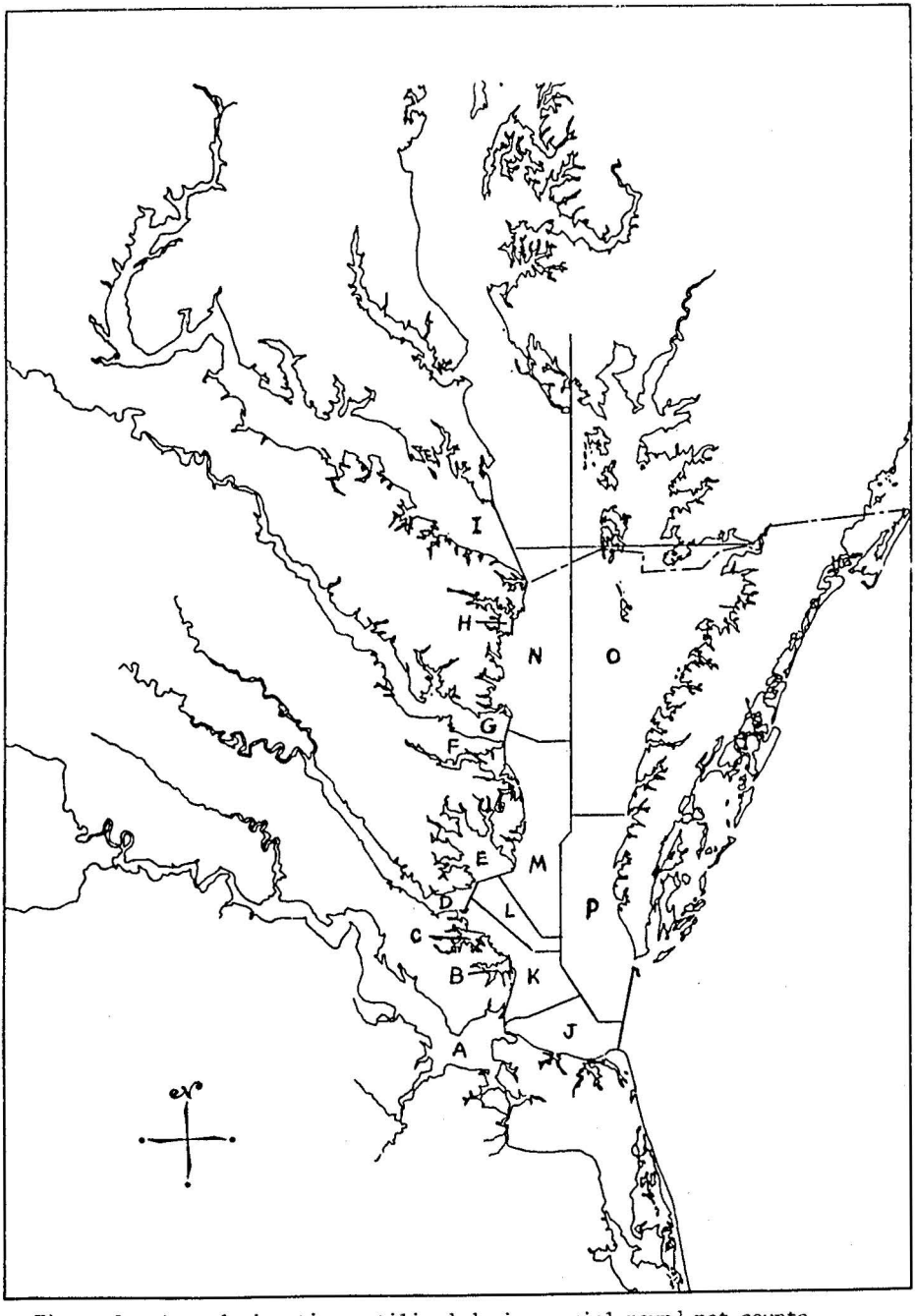

Figure 1. Area designations utilized during aerial pound net counts.

This procedure, summed across sections and time, gave the total estimated pounds of American shad (by sex), hickory shad and river herring landed by pound nets (Hoagman and Kriete,1975).

Prior to 1975, the river was not divided into sections and estimates of total catch were derived from the product of a single mean index catch and the number of active nets, summed overtime (Hoagman et al.,1973).

Yearly c/f for pound nets in the Rappahannock River was derived by dividing total catch by the number of net days to obtain catch per day per net. This figure was then multiplied by the number of fishing days in the season to obtain catch per net per season. The yearly c/f for the Potomac River was derived by dividing the average number of active pound nets observed into the total landings.

Stake gill net catch estimates were based on an index value of lb/linear ft. The number of stands and the number of sections per stand per 5-mile block of river were recorded during the peak of the spawning run (Table 2).

Logbooks collected from cooperating fishermen were used to establish the index value. The index was determined by dividing the total pounds caught by the index fisherman in each half-month, by the number of feet of gill net fished. Thus, catch weight per 5-mile section per half-month (W_s) for American and hickory shad was calculated as:

$$W_s = L_s \ (W_i/L_i)$$

Table 2 Number of stake gill net stands fished in Virginia rivers 1974-1976 (A) and number of linear feet per five mile block (B) in 1976. Figure in parentheses includes stands below mile 10.

A.

River System	Number of Gill Net Stands 1974	1975	1976
James	128 (157)	148	88 (113)
York	139	146	140
Rappahannock	85	121	127

B.

River	Mile	Number of Stands	Number of Sections	Average Length/Section	Total Feet
James	05-10	25	585	30	17,550
	10-15	8	168	30	5,040
	15-20	55	1,030	30	30,900
	20-25	21	360	30	10,800
	25-29	4	95	30	2,850
	Totals	113	2,238		67,140
York	05-10	1	25	30	750
	10-15	42	969	30	29,070
	15-20	47 + 900 ft(1) AGN	944	30	29,220
	20-25	11	265	20	5,300
	25-29	39	592	19	11,248
	Totals	140	2,795		70,288
Rappahannock	15-20	1	19	50	950
	20-25	8	151	50	7,550
	25-30	36	828	50	41,400
	30-35	22	413	38	15,694
	35-40	21	570	38	21,660
	40-45	16	273	38	10,374
	45-50	12	157	38	5,966
	50-55	2	20	30	600
	55-60	8	79	30	2,370
	60-65	0	0	--	--
	65-70	1	4	30	120
	Totals	127	2,514		106,684

(1) AGN = Anchor Gill Net

where L_s = total linear feet of gill net per 5-mile section, W_i = total weight caught in index nets, and L_i = total linear feet of index nets. Total catch weight was estimated (Hoagman and Kriete,1975) by summing across sections and time.

Daily catch by stake gill nets, prior to 1975, was determined by multiplying the daily c/f of index stands by the total number of stands. Seasonal catch was then determined from the sum of the daily catches. Effort was determined by a count of the actively fishing stands during the peak of the fishing season. Yearly c/f of gill nets in the James, York and Rappahannock rivers was derived by dividing total catch by gill net counts. In the Potomac River gill net c/f was obtained by dividing total catch by the number of licenses sold, since gill net counts were not made in this river.

The catch estimates herein reflect only landings above mile 10 in the three major Virginia rivers (James, York and Rappahannock). Mile 10 was operationally defined as the point in the river above which adult alosines would be committed to spawn.

The data for the Potomac River landings and effort were supplied by the Potomac River Fisheries Commission and reflect reported landings for the entire river.

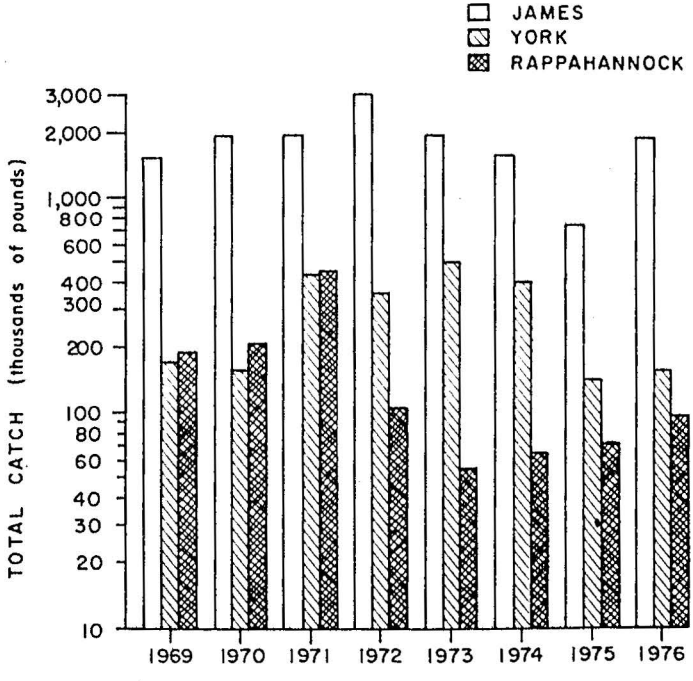

Figure 2. Estimated total catch of American shad by stake gill nets by river by year.

No pound net records are available for the James and York rivers. No gill net records were obtained from the Rappahannock River in 1967 or James River in 1967 or 1968.

Results and Discussion

Catch-Effort Estimates: 1976

James River

The 1976 American shad fishery in the James River was abbreviated. The river was closed to all forms of fishing in December 1975 as a result of Kepone contamination. This ban was modified on 28 February 1976 to allow fishing for shad only from the river mouth to mile 29. Many fishermen were reluctant to invest money on a very questionable fishing season.

Gill nets yielded an estimated 1.2 million lb of American shad during the abbreviated fishing season. This figure also includes fish taken between mile 5 and 10. Gill net stands above mile 10 yielded an estimated 0.9 million lb of American shad, a 29% increase over 1975. Fishermen attribute the increase to (1) a change from multifilament nylon to monofilament nets and (2) shad behavior; they remained in the vicinity of the James River bridge (mile 10) for several weeks. This wave was only near mile 25 in mid-April when the river was closed to fishing.

Prices for both sexes remained high throughout the shortened season, partly due to scarcity of American shad in other areas of the state and the growing practice of "boning" shad. We know of no one from Virginia, actively boning shad with any degree of proficiency. Professional "boners" move from state to state during the shad season following the peak of the landings from south to north. The peak landings of the shortened season occurred during the last of March to the first of April (Table 3).

As in 1975, the greatest concentration of stake gill nets was between mile 15-20 (30,900 linear ft) and represented 62% of the nets above mile 10 (Table 2).

Landings of females were 13.4 times greater than for males during the 1976 season. This is attributed to selectivity of netting utilized by the shad fishermen which ranged from 4 7/8 to 5 inch stretched mesh. These meshes more readily capture the slightly larger females than males and females command a slightly higher market price than males.

York River

Pound nets in the York River were located below mile 10 and therefore no catch indices were derived from these nets.

Stake gill nets caught an estimated 159,000 lb of American shad in the York River system; this is a decrease of 35% from 1975 with only a 3% decrease in effort.

Peak shad landings occurred during the second half of March (Table 4). As a result of gear selectivity, the yield of females was greater than males (8.8:1). Fishermen discarded fewer males at the net than in 1975 because the general scarcity of American shad kept dockside prices high all season. The higher prices also reduced the practice of cutting roes from females. The roes were usually destined for local markets, mostly to restaurants. The cut fish were then sold as scrap or discarded at the nets (Hoagman and Kriete, 1975).

Estimates of hickory shad caught by stake gill nets decreased 56% from 1975 (Table 4). About 25% of the 1,484 lb of hickory shad landed were cut for the roes. The smaller hickory shad do not carry the market value of American shad. Thus, the taking of hickory shad roes was to supply a market demand unfulfilled by the American shad roe.

In an attempt to assess the drift gill net fishery for shad, catch reports were obtained from a drift net fisherman who fished on a regular basis. During 1976, this fisherman landed 6,700 lb of American shad (5,100 lb female and 1,500 lb male) in 40 days of fishing. In the three-year period 1974-1976, this fisherman averaged 253 lb of American shad per day fished. We cannot reliably expand this catch to give an estimate of the total catch by drift gill nets, but we plan to assess this fishery in 1976-1977.

Table 3 Estimated catch of American shad by stake gill nets for 5 mile sections in the James River 1976 in lb., by half-month intervals and by sex. Effort from Table 2B. Index in lb/ft of net.

Half Month Period	River Mile	American Shad				Total Estimated Catch
		Male		Female		
		Index	Estimated Catch	Index	Estimated Catch	
Feb. 2nd	05-10	[.058]	1,018	[.224]	3,931	4,949
	10-15		292		1,129	1,421
	15-29(a)		-		-	-
Total			1,310		5,060	6,370
Mar. 1st	05-10	[.321]	5,634	[2.638]	46,297	51,931
	10-15		1,618		13,296	14,914
	15-20	[.524]	16,192	[3.490]	107,841	124,033
	20-25		5,659		37,692	43,351
	25-29		1,493		9,947	11,440
Total			30,596		215,073	245,699
Mar. 2nd	05-10	[.359]	6,300	[5.881]	103,212	109,512
	10-15		1,809		29,640	31,449
	15-20	[.567]	17,520	[7.063]	218,247	235,767
	20-25		6,124		76,280	82,404
	25-29		1,616		20,130	21,746
Total			33,369		447,509	480,878
Apr. 1st	25-10	[.353]	6,195	[6.919]	121,428	127,623
	10-15		1,779		34,872	36,651
	15-20	[.246]	7,601	[6.222]	192,260	199,861
	20-25		2,657		67,198	69,855
	25-29		701		17,733	18,434
Total			18,933		433,491	452,424
Apr. 2nd	05-10	[.014]	246	[.452]	7,933	8,179
	10-15		71		2,278	2,349
	15-20	[.009]	278	[.519]	16,037	16,315
	20-25		92		5,605	5,697
	25-29		26		1,479	1,505
Total			713		33,332	34,045
Total by Sex			84,921		1,134,465	
Grand Total						1,219,386
			Less landings mile 05-10			- 302,194
			Grand total above mile 10			917,192

(a) None reported by index fishermen.

Table 4 Estimated catch of American and hickory shad by stake gill nets for 5 mile sections above mile 10 in the York River 1976 in lb., by half-month intervals. Effort from Table 2B. Index in lb/ft of net.

Half Month Period	River Mile	American Shad Male Index	American Shad Male Estimated Catch	American Shad Female Index	American Shad Female Estimated Catch	Total Estimated Catch
Feb. 1st	05-10	[.031]	23	[.028]	21	44
	10-15		901		814	1,715
	15-20		906		818	1,724
	20-29 (a)					
Total			1,830		1,653	3,483
Feb. 2nd	05-10	[.045]	34	[.143]	107	141
	10-15		1,308		4,157	5,465
	15-20		1,315		4,178	5,493
	20-25	[.085]	451	[.102]	541	992
	25-29		956		1,147	2,103
Total			4,064		10,130	14,194
Mar. 1st	05-10	[.020]	15	[.375]	281	296
	10-15		581		10,901	11,482
	15-20		584		10,958	11,542
	20-25	[.129]	684	[.592]	3,138	3,822
	25-29		1,451		6,659	8,110
Total			3,315		31,937	35,252
Mar. 2nd	05-10	[.030]	23	[.679]	509	532
	10-15		822		19,739	20,561
	15-20		877		19,840	20,717
	20-25	[.202]	1,071	[.313]	6,959	8,030
	25-29		2,272		14,769	17,041
Total			5,065		61,816	66,881
Apr. 1st	05-10	[.013]	10	[.286]	215	225
	10-15		378		8,314	8,692
	15-20		380		8,357	8,737
	20-25	[.066]	350	[.824]	4,367	4,717
	25-29		742		9,268	10,010
Total			1,860		30,521	32,381
Apr. 2nd	05-10	[.003]	2	[.089]	67	69
	10-15		87		2,587	2,674
	15-20		88		2,601	2,689
	20-25	[.001]	5	[.098]	519	524
	25-29		11		1,102	1,113
Total			193		6,876	7,069
Total by Sex			16,327		142,933	
Grand Total						159,260

	Hickory Shad(b)		
Feb.-Apr.	10-20	.015	856
Mar. 2nd	20-29	.016	265
Apr. 1st	20-29	.022	346
Apr. 2nd	20-29	.001	17
Total			1,484

(a) None reported by index fishermen.
(b) Data from mile 10-20 were not reported in half month intervals.

Rappahannock River

Estimated 1976 pound net landings of 5,000 lb of American shad, 97,000 lb of alewife, and 150,000 lb of blueback relative to 1975 represented decreases of 47%, 39% and 61%, respectively (Table 5). Price seems to be the prime factor controlling number of fish retailed at dockside. No dockside sales were reported in 1976 indicating that market prices exceeded dockside prices.

Peak landings of female American shad occurred during the second half of April, but male landings had two minor peaks: second half of March and second half of April. Alewife and blueback peak landings occurred during the first half of April below mile 30 and the second half of April above mile 30.

Pound nets yielded an estimated 207 lb of hickory shad in 1976 (Table 5). This represented a 93% reduction in catch from 1975.

The number of stake gill nets increased slightly in 1966 with an 11% increase in total linear footage. The total estimated gill net catch of American shad was 42,000 lb, down 20,000 lb from 1975. This reduction is misleading if only total pounds landed and not c/f is considered in the comparison. The mesh sizes of stake gill nets above mile 35 were too large to effectively capture American shad (stretch mesh of 6 inches to 9 inches).

Table 3. Estimated catch of American and hickory shad and river herring by pound nets in the Rappahannock River 1976 in lb., by half-month intervals. Nets below mile 10 not included.

Half Month Period	Mile	Number Nets	American Shad: Female Index	American Shad: Female Estimated Total	American Shad: Male Index	American Shad: Male Estimated Total	River Herring Index	River Herring Estimated Total	Alewife Percent	Alewife Estimated Total	Blueback Percent	Blueback Estimated Total	Total Number Days Index Nets Hauled	Number of Index Nets
Feb. 2nd	10-30	1	(a)		(a)		(a)							
	31-55	7	2.67	19	-	-	239.0	1,673	100.0	1,673	-	-	3	3
Mar. 1st	10-30	6	3.3	20	1.3	8	(a)						5	3
	31-55	15	12.6	190	5.1	77	409.0	6,135	100.0	6,135	-	-	10	14
Mar. 2nd	10-30	13	13.3	173	13.3	173	2,450.0	31,850	25.3	8,058	74.7	23,792	11	3
	31-55	16	19.8	316	23.4	374	545.2	8,723	53.4	4,658	46.6	4,065	13	16
Apr. 1st	10-30	18	19.0	342	15.25	275	3,622.5	65,205	28.7	18,714	71.3	46,491	13	4
	31-55	19	14.9	284	9.3	177	1,665.4	31,643	37.1	11,740	62.9	19,903	13	16
Apr. 2nd	10-30	15	33.75	506	17.75	266	1,875.0	28,125	23.4	6,581	76.6	21,544	12	4
	31-55	18	30.6	551	14.7	265	3,479.3	62,627	59.2	37,075	40.8	25,552	13	11
May 1st	10-30	15	(a)		(a)		(a)						14	4
	31-55	18	26.9	484	10.8	194	578.6	10,415	19.8	2,602	80.2	8,353	8	11
May 2nd	10-30	12	(a)		(a)								8	4
	31-55	8	21.0	168	2.7	22							5	7
June 1st	10-30	13	(a)		(a)								7	3
	31-55	3	1.67	5									2	3
				3,058		1,831				96,696		149,700		
				4,889				246,396						

Hickory Shad			March 2nd Index	March 2nd Estimated Total	April 1st Index	April 1st Estimated Total	April 2nd Index	April 2nd Estimated Total
	10-30	see	(a)		(a)		(a)	
	31-55	above	.714	11	7.29	139	3.14	57

Total 207 lb.

(a) None reported by index fishermen.

These nets were set to capture striped bass and yielded only an occasional American shad. We also estimated (after conversations with fishermen) that 31% of the stake gill nets below mile 35 were set primarily to capture striped bass. Thus, the effective c/f for 1976 more closely approximates the c/f for 1975 than total landings might indicate. Peak landings of both sexes of American shad occurred during the second half of March (Table 6). As with shad landed by pound nets, few fish were retailed at dockside and few roes were cut because of the sustained high market value of shad in Baltimore and New York City.

There were no hickory shad reported by index stake gill net fishermen in the Rappahannock River for 1976. It is possible that the unusually small catch of hickory shad were sold with American shad and therefore, never reported. An estimated 3,000 lb of hickory shad were landed in 1975 in a 6-week period (15 March to 30 April) and it seems unlikely that such a drastic reduction would occur in only one year.

Potomac River

Potomac River landing data were supplied by the Potomac River Fisheries Commission, and reflect all landings under the jurisdiction of the commission.

Twenty-one thousand lb of American shad and 1.3 million lb of river herring were harvested from pound nets

in 1976 (Table 7). This was a 53% increase in American shad and 76% decrease in river herring relative to 1975 landings. Peak landings of male and female American shad and both species of river herring occurred during the month of April. Pound net effort was up 15% from 1975.

Gill netters harvested 94,000 lb of American shad, 100 lb of hickory shad and 700 lb of river herring (Table 7). This was a decrease for American shad from 1975, with the greatest portion of the decrease attributed to reduced landings of females (14%). Stake gill nets accounted for 61% of the shad, anchor gill nets for 27% and drift gill nets for 7%. The remaining 6% were reported in a combined form of stake and anchor gill net. Stake and drift gill net catches had a large ratio of females to males which reflected the use of nets set primarily for American shad; conversely, the smaller mesh anchor gill nets (3½ inches to 4½ inches) were set primarily for white perch, schooling striped bass and other demersal species. Stake and drift gill net catches peaked in April, a month later than peak landings from anchor gill nets. River herring landings were incidental because of the large mesh sizes utilized by gill net fishermen.

Catch-Effort Evaluation: 1967-1976

Stocks of alosine fishes have declined since 1967. Catch-per-unit-of-effort (c/f) is used as an indication of

Table 6 Estimated catch of American shad by stake gill nets in the Rappahannock River 1976 in lb., by half-month intervals. Effort from Table 2B. Index in lb/ft of net.

Half Month Period	River Mile	American Shad				Total Estimated Catch
		Male		Female		
		Index	Estimated Catch	Index	Estimated Catch	
Mar. 1st	15-20	.034	22	.120	79	101
	20-25		177		625	802
	25-30		971		3,428	4,399
	30-35		368		1,299	1,667
	35-30(a)					
Total			1,538		5,431	6,969
Mar. 2nd	15-20	.035	23	.268	176	199
	20-25		182		1,396	1,578
	25-30		1,000		7,656	8,656
	30-35		379		2,902	3,281
	35-70	.003	123	.007	288	411
Total			1,707		12,418	14,125
Apr. 1st	15-20	.015	10	.186	66	76
	20-25		78		969	1,047
	25-30		428		5,313	5,741
	30-35		162		2,014	2,176
	35-70	.001	41	.002	82	123
Total			719		8,444	9,163
Apr. 2nd	15-20	.022	14	.179	117	131
	20-25		115		933	1,048
	25-30		628		4,990	5,618
	30-35		238		1,938	2,176
	35-70(a)					
Total			995		7,978	8,973
May 1st	15-20	.006	4	.040	26	30
	20-25		31		208	239
	25-30		171		1,143	1,314
	30-35		65		433	498
	35-70(a)					
Total			271		1,810	2,081
Total by shad nets			5,230		36,081	41,311
Incidental catches by large mesh gill nets		.004	246	.009	553	
Grand Total			5,476		36,634	42,110

(a)None reported by index fishermen.

Table 7 Total catch of alosine fishes by gill nets (A) and pound nets (B) in the Potomac River 1976 in lbs.

A. Stake Gill Nets

Months	American Shad Female	American Shad Male	Hickory Shad	River Herring Alewife	River Herring Blueback
February	16	183		47	3
March	5,196	2,036		82	182
April	45,410	2,350	10	24	204
May	2,012	51			
Total	52,634	4,620	10	153	389
Grand Total	57,254		10	542	

Anchor Gill Nets

February	22	41	4	6	
March	7,901	6,492	11	21	47
April	6,998	3,599	1	3	23
May	129	39			
Total	15,050	10,171	16	30	70
Grand Total	25,221		16	100	

Stake & Anchor Gill Nets
(not reported separately by fishermen)

February	30	3
March	965	669
April	3,282	263
Total	4,277	935
Grand Total	5,212	

Drift Gill Nets (allowed only during April and May)

Months	American Shad Female	American Shad Male	Hickory Shad	River Herring Alewife	River Herring Blueback
April	4,336	1,323	85	3	8
May	764	117	0	0	3
Total	5,100	1,440	85	3	11
Grand Total	6,540		85	14	

Total of Gill Nets by species

	77,061	17,166	111	186	470
Grand Total	94,227		111	656	

B. Pound Nets

February	0	0	370	23
March	651	3,009	29,634	1,858
April	4,244	5,855	230,577	513,221
May	964	5,401	51,799	436,872
June	21	411	148	557
Total	5,880	14,676	312,528	952,531
Grand Total	20,556		1,265,059	

Total by species, all gear combined

	82,941	31,842	111	312,714	953,001
Grand Total	114,783		111	1,265,715	

the condition of the stocks rather than total landings because the latter may be the result of a change in stock density and/or fishing effort.

The discussions of c/f and landings that follow are based on estimates for the James, York and Rappahannock river fisheries, and actual landings from the Potomac River as reported to the Potomac River Fisheries Commission. No pound net records were available for the James and York rivers, thus no indices were derived for these rivers. No gill net records were obtained from the Rappahannock River in 1967 or from the James River in 1967 and 1968. Comparisons of landing and c/f for stake gill net for these rivers were therefore restricted to the years 1969 to 1976.

Pound net effort decreased steadily from 1967 to 1973 (Table 8A). Since 1973 the number of pound nets has increased, but has not returned to the level of 1967.

Stake gill net effort in the James, York and Rappahannock rivers increased since 1967 although individual rivers had independent fluctuations (Table 8B).

Total estimated landings of American shad by stake gill nets varied greatly among rivers and years. The largest catch in the James River (3 million lb) occurred in 1972 and the smallest (700,000 lb) in 1975 (Fig. 2) Catches during all other years remained relatively stable between 1.5 and 1.9 million lb. The largest catch

Table 8 Peak number of pound nets, from semi-monthly aerial pound net counts, by area by year and yearly peaks (A); and total number of stake gill net stands in Virginia rivers by year (B). Figures in parentheses include gill net stands below mile 10. NA = data not available.

A. Pound Nets[a]	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
James River	8	6	4	2	2	4	1	1	0	1
Back River	8	10	7	8	7	7	5	7	5	4
Poquoson River	3	3	3	1	1	2	2	2	1	0
York River	15	19	10	7	4	7	7	9	8	10
Mobjack Bay	10	8	8	6	5	3	5	10	11	8
Piankatank River	5	4	4	3	4	4	4	6	4	5
Rappahannock River	48	51	53	51	52	54	52	61	62	56
Great Wicomico River	3	5	3	2	1	3	4	5	7	7
Potomac River (south side)	83	86	69	58	63	58	47	36	45	53
Cape Henry - Fort Wool	12	11	9	9	5	4	6	5	5	5
Old Point - Tue Marsh Point	20	16	17	12	16	8	6	7	10	11
York Spit	11	10	12	7	7	4	5	3	2	5
New Point - Stingray Point	40	28	27	31	28	26	22	23	20	24
Windmill Point - Smith Point	58	50	49	35	26	31	31	38	44	55
Eastern Shore (Bay side)										
Above Hungar Creek	6	5	3	0	1	2	1	1	0	0
Below Hungar Creek	35	29	24	20	23	20	23	31	27	31
Peak Number of Nets during year	332	317	285	238	228	224	200	226	223	245

B. Stake Gill Nets[b]										
James River	NA	95[c]	83[c]	65[c]	82 (98)	99[c]	112 (115)	128 (157)	148 (171)[d]	88 (113)
York River	90	86	94	71	109	96	130	139	146	140.5 (141.5)[d]
Rappahannock River	NA	144	120	94	98	114	100	85	121	127
Total	NA	325	297	230	290 (306)	309	342 (345)	352 (381)	415 (438)[d]	355.5 (381.5)[d]

(a) Number indicates peak for area for given year.
(b) Includes nets above mile 10 only.
(c) May include below mile 10.
(d) Includes anchor gill net converted to equivalent stands.

(500,000 lb) in the York River occurred in 1973 and the lowest (100,000 lb) was in 1975. The peak landings for the 8-year period in the Rappahannock River occurred in 1971; since 1973 there has been a slight increase in landings each year in this river.

The combined c/f of American shad by stake gill nets (Potomac River excluded) increased from 1969 to 1972, then decreased from 1972 to 1975, and rose sharply in 1976 (Fig. 3B). Males are usually an insignificant proportion of the landings due to their poor market value, especially after Easter or the peak of the season. However, in 1972, males represented 40% of the combined c/f for all rivers (Fig. 3B).

James River

The number of pound nets in the James River declined steadily from eight in 1967 to none in 1975 and 1976. Reasons for the disappearance of pound nets most likely are: expense of the gear, labor involved in fishing the gear, and lack of interest by younger men to enter the business (Wilson and Davis, 1973).

Landings from the James River are typically 80% of all American shad harvested by stake gill nets in Virginia waters (excluding the Potomac River) and 77% of all female shad landed. Gill net effort declined from 1968 to 1970 and then increased through 1975. In 1976 effort again decreased (Table 8B) due to the fishing ban in the river

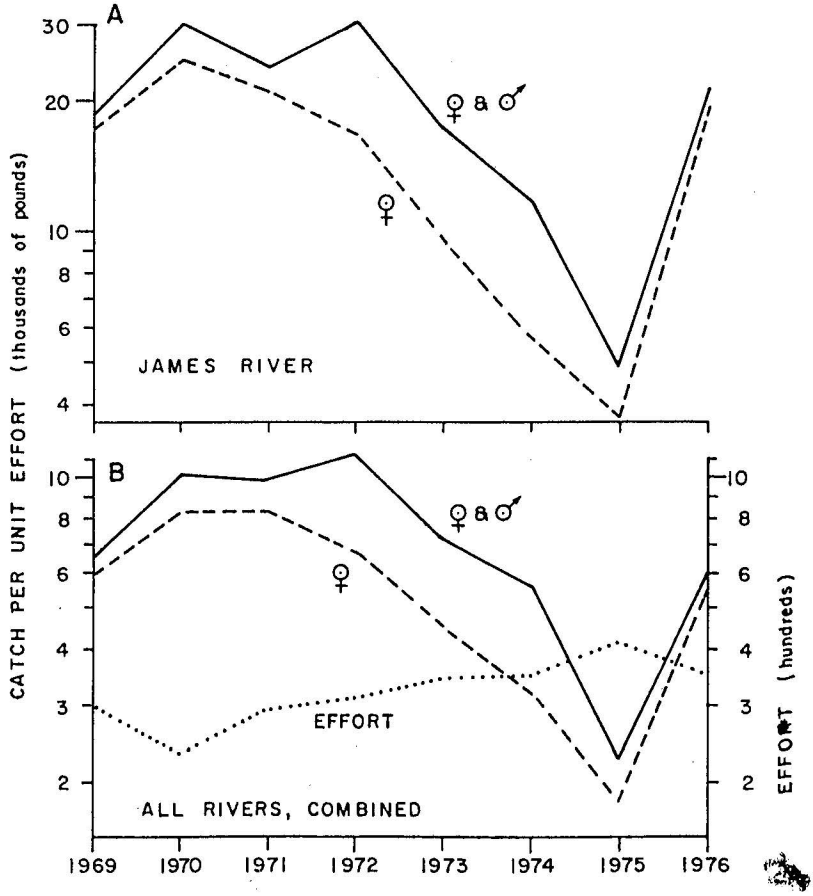

Figure 3. Estimated c/f of female and female-male American shad combined by year for (A) James River and (B) all rivers combined (excluding Potomac River).

as a result of Kepone contamination. The c/f increased from 1969 to 1970 and remained fairly stable until 1972. From 1972 until 1975 the c/f decreased from 30,000 lb to 5,000 lb but increased again in 1976 (Fig. 3A). The c/f for females during the same period increased from 1969 to 1970 but then declined until 1975. There was a dramatic increase in c/f of females from 3,800 lb in 1975 to 20,000 lb in 1976. Males represented 7% by weight of the landings in 1976.

The long term trend of c/f of American shad by stake gill nets in the James River exhibits almost the identical pattern as the combined c/f of the James, York and Rappahannock rivers (Fig. 3A), due to its large contribution to the total landings. It is expected that this trend will continue but it is too early to predict if the increase in c/f in 1976 will carry over into 1977.

York River

The number of active pound nets in the York River decreased from 19 nets in 1968 to four nets in 1971, then increased gradually to its present level of 10 nets (Table 8A). In 1976 all nets were located below mile 10 and, therefore, were not used in computing estimated catch of American shad or river herring for the York River.

The number of stake gill net stands fluctuated from 1967 to 1972 with an increase in 1972 that continued through 1975 (Table 8B).

The c/f of American shad in the York River increased from 1969 to 1971 and then stabilized until 1973 (Fig. 4B). The 1974 c/f decreased slightly from 1973 and then dropped 62% from 1974 to 1975.

During the 8-year period from 1969 to 1976, males consistently represented only 10% of the total landing. Gill net fishermen seeking shad select 5 to 5¼ inches stretch mesh nets since these mesh sizes primarily capture the larger, more valuable female fish which retain their higher market value longer than males. The males that are captured are often discarded at the net or sold as scrap.

Rappahannock River

The number of pound nets in the Rappahannock River increased 23% from 1967 to 1975 with a slight decrease in 1976 (Table 8A). The c/f of American shad by pound nets during the same period increased from 1967 to 1968 but declined drastically during 1968 to 1976 from 7,000 lb/net to 125 lb/net (Fig. 5). The estimated ratio of males to females, obtained from random samples from pound net catches, fluctuated from year to year.

The estimated yield of river herring by pound nets during the period 1967 to 1976 dropped 91% from 3.2 million lb to 0.3 million lb. The c/f of alewife during this same period decreased 92% from 29,000 lb to 2,000 lb with a stable period from 1971 to 1974. The c/f of blueback

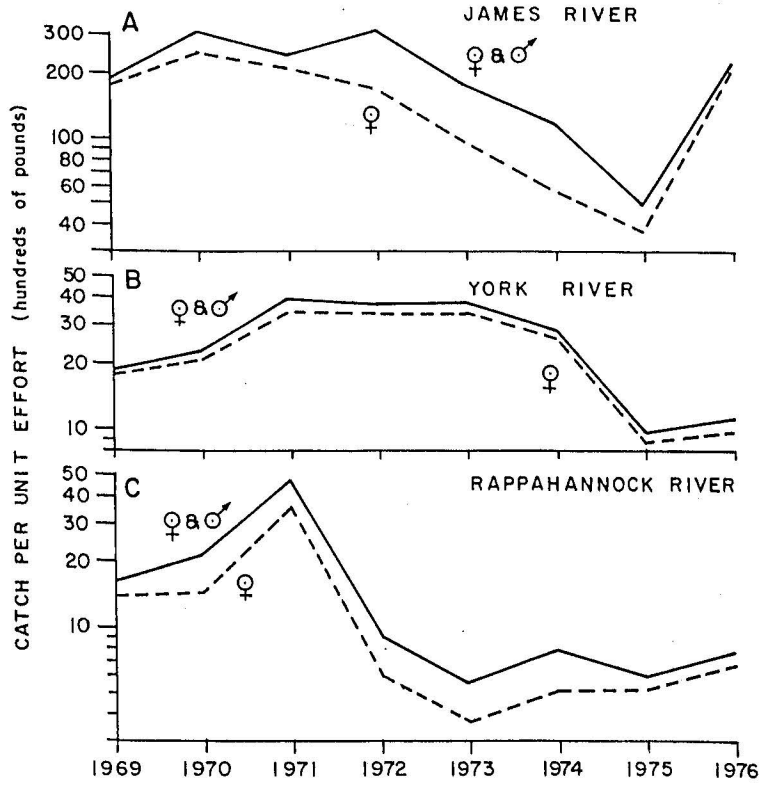

Figure 4. Estimated c/f of American shad female and sexes combined by year for the James (A), York (B) and Rappahannock (C) rivers.

Figure 5. Estimated c/f of male and female American shad by pound nets in the Rappahannock River by year.

declined 96% between 1967 and 1970 from 62,000 lb to 2,400 lb. There was a recovery in c/f of blueback in 1971 which remained fairly stable until 1975 when it once again began declining (Fig. 6).

Effort by stake gill nets on the Rappahannock River fluctuated during the 10-year period beginning in 1967 but seems to be on an upward trend at the present. All stake gill nets in the Rappahannock River in 1976 were not set with American shad as the target species. This fact will lower the estimated total catch but to what extent has not been determined.

The c/f of stake gill nets increased from 1,600 lb to 4,700 lb between 1969 and 1971 but dramatically decreased from 1971 to 1972. Although low, the c/f has remained relatively stable from 1972 through 1976 (Fig. 4C) and may reflect the use of gill nets set primarily for species other than alosines. During the entire period female shad contributed 75% by weight to the American shad landings in the Rappahannock River.

Potomac River

The number of active pound nets in the Potomac River decreased from 86 to 36 from 1968 to 1974 but increased steadily from 1974 to 1976 (Table 8A). Alosine landings declined from 8.7 million lb in 1967 to 1.4 million lb in 1976 (Fig. 7).

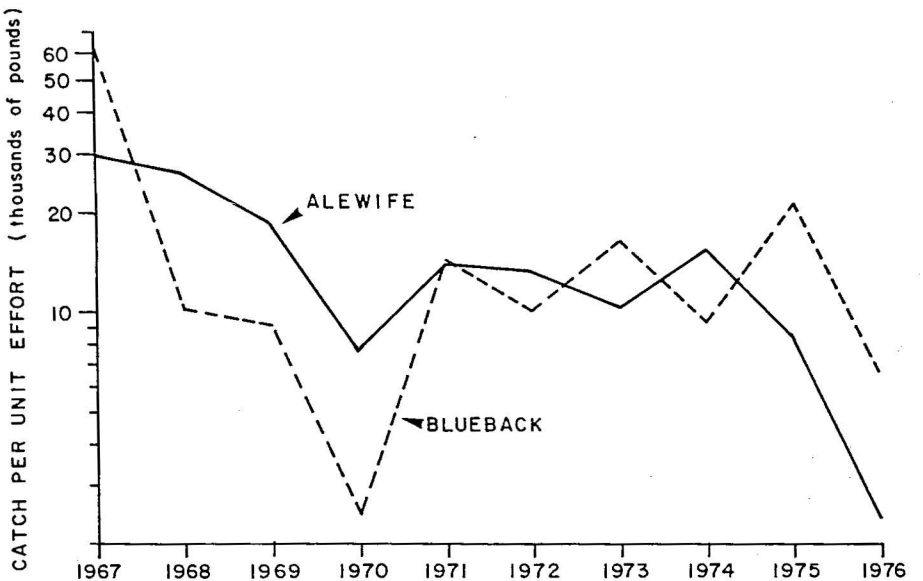

Figure 6. Estimated c/f of alewife and blueback by pound nets by year in the Rappahannock River.

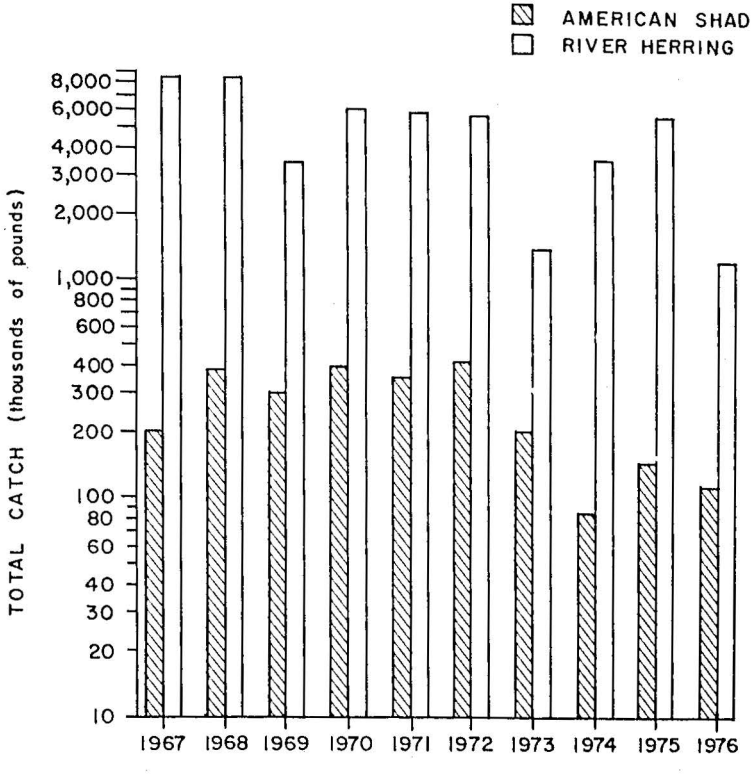

Figure 7. Total catch of American shad and river herring in the Potomac River by year; gill net and pound net combined.

The c/f of American shad by pound nets declined from a peak of 4,700 lb in 1968 to 400 lb in 1975, then recovered slightly to 600 lb in 1976 (Fig. 8). The c/f by stake and anchor gill nets increased from 1967 to 1970 and then declined from 600 lb to 80 lb during the 1970-1974 period (Fig. 8). The c/f trend of drift gill nets for American shad resembles that of stake and anchor gill nets except that the decline began one year earlier (Fig. 8).

Although there have been slight recoveries in c/f by all gears fishing for American shad the overall downward trend in c/f continued.

River herring (alewife and blueback) catches are not reported by species, but simply as alewife. Pound net c/f of river herring declined from 261,000 lb in 1967 to 52,000 lb in 1973. It increased from 1973 to 1975, but decreased to 35,000 lb in 1976 (Fig 9).

Stake and anchor gill nets (combined) and drift gill nets exhibited a decline in c/f from over 200 lb in 1967 to less than 1 lb in 1976 (Fig. 9) indicating that gill nets are no longer being fished for river herring; profit no longer warrants the effort. There has also been a shift in the number and type of gill net licenses sold, from those for stake gill nets to those for anchor gill nets; the latter gear is less expensive and more mobile.

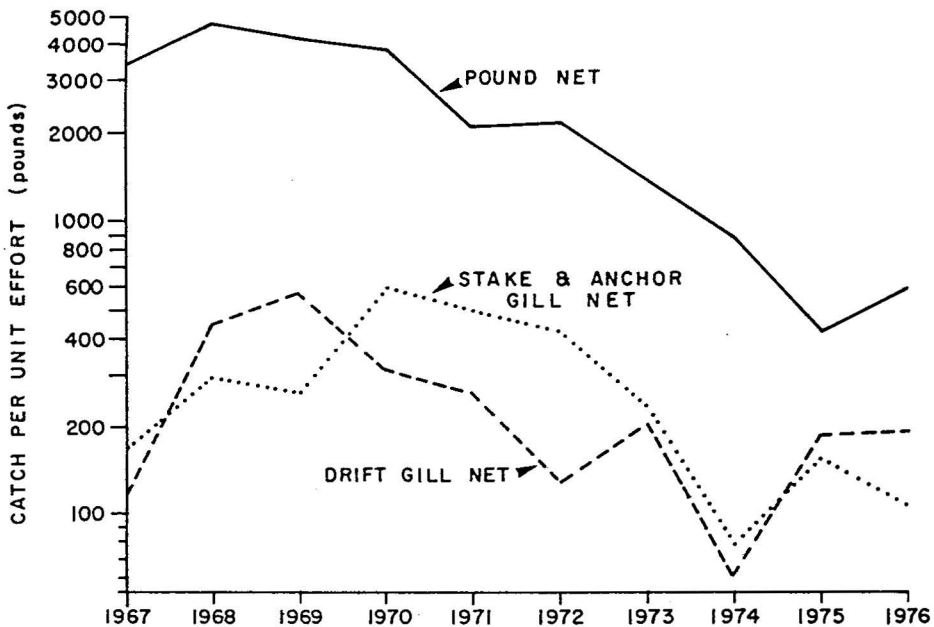

Figure 8. American shad c/f by pound nets, stake and anchor gill nets and drift gill nets by year in the Potomac River.

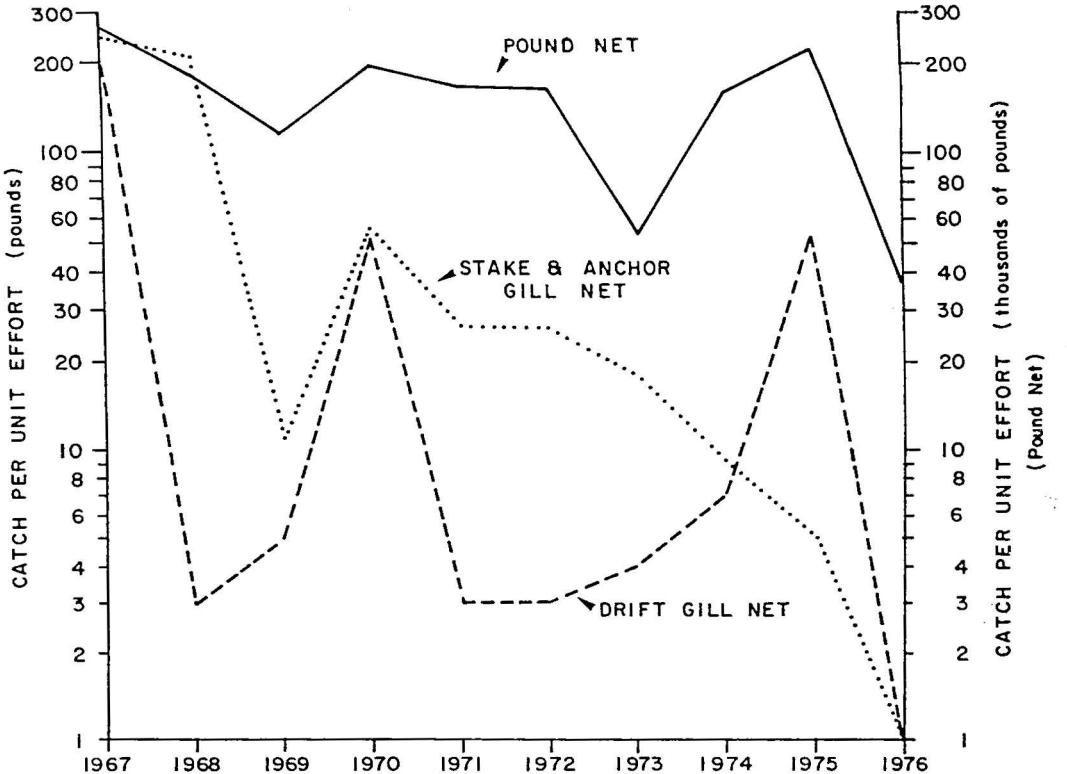

Figure 9. River herring c/f by pound nets, stake and anchor gill nets and drift gill nets by year in the Potomac River.

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