#68

Ref 43

US EPA

My AFS Sign in Register

AMERICAN FISHERIES SOCIETY conservation and sustainability Online Journals

Journals Subscribe For Authors Information Online Help Search Journals: Quick Search Go

Volume 101, Issue 4 (October)

< Previous Next >

Current Completed Issue
Archive
Issue in Progress

< Previous Article Next Article >

Volume 101, Issue 4 (October 1972)

Add to Favorites | Email | Download to Citation Manager | Track Citations | Permissions

PDF

Transactions of the American Fisheries Society 1972; 101: 740-743
doi: 10.1577/1548-8659(1972)101<740:OOTROY>2.0.CO;2

Observations on the Reactions of Young American Shad to a Heated Effluent

BARTON C. MARCY JR, PAUL M. JACOBSON, and RICHARD L. NANKEE
Essex Marine Laboratory, Inc., Essex, Connecticut 06426

Abstract

No abstract available.

Cited by

Karin E. Limburg. (2001) THROUGH THE GAUNTLET AGAIN: DEMOGRAPHIC RESTRUCTURING OF AMERICAN SHAD BY MIGRATION. *Ecology* **82**:6, 1584-1596
Online publication date: 1-Jul-2001.
CrossRef

P. N. Claridge, and D. C. Gardner. (1978) Growth and movements of the twaite shad, Alosa fallax (Lacepede), in the Severn Estuary. *Journal of Fish Biology* **12**:3, 203-211
Online publication date: 1-Apr-1978.
CrossRef

Journal Information

Online ISSN: 1548-8659
Print ISSN: 0002-8487
Frequency: Bimonthly
Links:
Editorial Board
Submit Manuscript

© 2010 American Fisheries Society, 5410 Grosvenor Lane, Bethesda, MD 20814.
Tel: 301/897-8616 Fax: 301/897-8096 . E-mail: journals@fisheries.org
Technology Partner - Atypon Systems, Inc.

LITERATURE CITED

JACKSON, SAMUEL W., JR. 1957. Comparison of the age and growth of four fishes from Upper and Lower Spavinaw Lakes, Oklahoma. Proc. 11th Annual Conf. S.E. Ass. Game, Fish Comm., 1957: 232–349.

LAWRENCE E. MCSWAIN
RICHARD M. GENNINGS

Georgia Department of Natural Resources
Game and Fish Division
Route 3, Box 582
Albany, Georgia 31701

Observations on the Reactions of Young American Shad to a Heated Effluent

The construction of the Connecticut Yankee Atomic Power Company's nuclear-fueled plant at Haddam, Connecticut, has created a possible environmental hazard for emigrating young-of-the-year American shad, *Alosa sapidissima*. This facility is located 27 km from the river mouth, well below the major shad spawning areas (Marcy, 1972). Our sampling shows that young shad begin emigrating downstream in early August when the water temperatures are highest. The majority of the population is present in the Haddam area when added heat from the plant's effluent may influence their safe passage (Fig. 1).

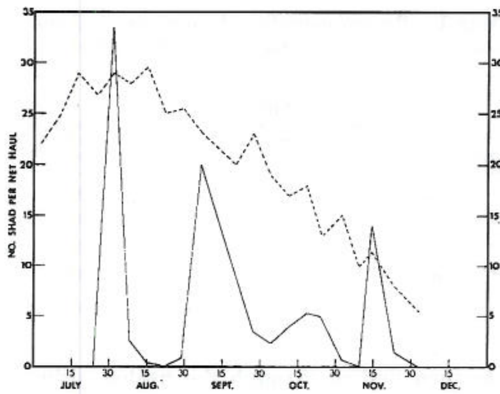

FIGURE 1.—Number of young shad collected per net haul near the Connecticut Yankee Atomic Power Company's heated effluent during 1970. The broken line indicates ambient water temperature.

Approximately 23 m^3/sec (825 cfs) of condenser cooling-water, heated to 12.5 C above ambient, decreases 1 C as it flows from the plant down a 1.83 km discharge canal. The warm water can be detected, generally on the surface, on the flood tide 3.2 km upstream and on the ebbtide 4.8 km downstream of the discharge point. The heated effluent does not reach the bank opposite the discharge canal except on slack tide. On this tide the surface temperature has been recorded at 10 C above ambient with a maximum rise of 4 C at a depth of 1.2 m in the 4.6 to 6.1 m deep channel (Boyd, 1970; Merriman, 1970).

Moss (1970) demonstrated in an experimental tank that young shad respond to rapid temperature changes of about 1 C. Several studies have shown that other clupeids respond to small temperature differentials: adult alewife, *Alosa pseudoharengus*, and blueback herring, *Alosa aestivalis* respond to 0.5 C differentials (Collins, 1952); Pacific herring, *Clupea harengus pallasii* to 0.2 C (Shelford and Powers, 1915); and dwarf herring, *Jenkinsia lamprotaenia* to 0.1 C (Breder, 1951). Our study presents field observations on the reactions of young shad to a heated effluent and attempts to define their upper temperature limit under the conditions existing in the lower Connecticut River.

MATERIALS AND METHODS

We determined the upper temperatures at which young shad naturally occurred by collecting 7,983 specimens in 922 biweekly seine and trawl hauls from 1967 to 1971 at 21 stations from Northampton, Massachusetts 138 km to the river mouth.

We made observations on the upper lethal temperature and direct mortality by drifting young shad and blueback herring (60–95 mm TL) in a floating live box through the heated effluent on 23 September and 14 October 1970. The tests were made just after the peak abundance of young in the Haddam area (Fig. 1). The live box was 175 × 86 × 41 cm deep with a screen stern and bow window. Test fish were collected by seine 2.0 km upstream of the discharge canal prior to ebbtide and immediately transferred to the live box. The live box was drifted for approximately 1 hr during ebbtide to the discharge point where the bow window was opened. The live box

TABLE 1.—*Percent mortality of American shad and blueback herring in the effluent and ambient live box tests, and environmental conditions, 23 September–4 November 1970*

Date	Test type	Ambient water temperature (C)	Effluent water temperature (C)	ΔT[1] (C)	Power level (mwe)	Dissolved O_2 (ppm) Ambient	Dissolved O_2 (ppm) Effluent	Blueback herring Number tested	Blueback herring Mortality number (%)	American shad Number tested	American shad Mortality number (%)
9/23	Effluent	22.7	32.9	10.2	488	7.8	7.3	366	266 (61.7)	8	1 (12.5)
10/14	Effluent	19.0	32.2	13.2	596	9.0	8.3	3	3(100.0)	68	68(100.0)
10/29	Ambient	11.9	–	–	605	10.6	–	4	0 (0)	1	0 (0)
11/4	Ambient	10.8	–	–	604	10.0	–	76	0 (0)	2	0 (0)

[1] Difference between ambient and effluent temperature.

was then drifted through the heated effluent. A dual-track-chart temperature recorder registered temperatures at the surface and the bottom of the live box. Dissolved oxygen was recorded before and during each drift. Photographs were taken of the fish at 5-sec intervals. Dead fish were counted after a 30-min recovery period in ambient water below the effluent.

The drift time between the seining and effluent areas served as a control on each effluent test. A drift was made on 29 October and on 4 November in ambient water near the bank opposite the discharge canal. All procedures described for the effluent drifts were duplicated in the ambient drifts.

Avoidance reactions to effluent of different temperatures were studied with a chamber (2.4 × 4.6 × 2.1 m deep) constructed of 1.3 × 2.5 cm wire-mesh, ovate on both ends with a plywood top and bottom. Submerged vertically in the water column and held in position by a floating platform, the cage was operated at depths between 2.4 and 3.7 m. Five tests were made in the effluent and six in ambient water in September and October 1971. Shad 70–92 mm TL were caught by bag seine from the shore opposite the discharge canal, and 15 to 77 specimens were transferred into the cage. Underwater observations, from 20 min to 2 hrs, of the thermal stratification and the behavior of the fish were made by two divers using SCUBA gear, metric rules, and hand-held thermometers.

RESULTS AND DISCUSSION

Young American shad, collected by seine and trawl, were found in water temperatures ranging between 10 C and 31 C, but only one specimen was ever found in water warmer than 30 C.

Test drifts of young shad and blueback herring in the live box through the heated effluent showed different results (Table 1). Although effluent temperatures were similar, fish tested on 23 September had a lower mortality than on 14 October. The lower mortality was probably related to a higher acclimation temperature and lower Δ T on 23 September. The lower Δ T was a function of a reduced power level. The slight drop in dissolved oxygen concentration encountered by fish entering the effluent was not considered to be a major factor causing the mortalities. There was no evidence of stress or mortality during the 1-hr control drifts between the seining and effluent areas or in the ambient drifts made near the bank opposite the discharge canal.

A composite of time-sequence-photographs of young shad and observations made during the 14 October effluent test suggested the following reactions when temperatures were increased from ambient to maximum effluent temperature: (1) the distribution in ambient water was maintained throughout the live box with no evidence of schooling (19.0 C), (2) as the live box entered the effluent, the fish immediately formed a tight school in the center as heated water entered from both ends (27.8 C), (3) after 1 min, fish began swimming rapidly in a circular pattern, followed by the break-up of the single school into smaller schools (30.0 C), (4) after 2 min, there was evidence of disorientation and small school break-up (31.2 C), (5) after 3–4 min, there was no evidence of schooling, swimming speeds were reduced, and there was continued disorientation with equilibrium loss (31.8 C),

TABLE 2.—*Depths and associated water temperatures for each submerged cage test. Numbers in boldface indicate schooling shad observed*

Water depth (cm)	Dates and temperature (C)							
	Effluent tests					Ambient (control) tests[1]		
	9/9	9/24	9/29	10/15	10/25	9/7	9/29	10/25
0	37.0	30.8	31.5	27.5	**26.0**	24.0	**22.0**	16.0
10	37.0	30.8	31.0	27.5	**26.0**	24.0	**22.0**	16.0
20	36.0	30.8	30.0	27.0	**26.0**	24.0	**22.0**	16.0
30	35.1	30.5	29.0	26.1	**25.2**	**24.0**	**22.0**	16.0
40	35.0	29.6	27.4	25.5	24.2	**24.0**	**22.0**	16.0
50	33.0	26.5	**27.4**	24.5	23.4	**24.0**	**22.0**	16.0
60	32.2	26.5	24.6	**23.5**	22.0	**24.0**	**22.0**	16.0
70	31.2	**24.2**	23.0	**21.2**	21.0	24.0	22.0	16.0
80	29.0	**24.0**	**22.7**	**20.0**	19.0	24.0	22.0	16.0
90	**29.0**	**23.5**	**22.5**	18.5	17.3	24.0	22.0	16.0
100	**29.0**	**22.6**	**22.5**	17.8	17.0	24.0	22.0	16.0
110	**28.2**	22.2	**22.5**	17.8	**17.0**	24.0	22.0	16.0
120	**28.2**	21.8	**22.5**	17.4	**17.0**	24.0	22.0	16.0
130	**28.0**	21.8	**21.2**	17.2	**17.0**	24.0	22.0	**16.0**
140	27.2	21.8	**21.2**	16.9	**17.0**	**24.0**	22.0	**16.0**
150	27.2	21.8	21.2	16.9	**17.0**	24.0	22.0	**16.0**
160	27.2	21.8	21.2	16.8	17.0	**24.0**	22.0	**16.0**
170	27.0	21.6	21.2	16.8	17.0	24.0	22.0	16.0
180	27.0	21.5	21.2	16.8	17.0	24.0	22.0	16.0
Number of fish	50	19	74	15	15	58	77	20

[1] Two tests conducted on each date.

and (6) death of all specimens occurred between 4 and 6 min (32.2 C). These field observations confirmed the laboratory work of Moss (1970) who demonstrated that young shad rapidly die when temperatures are suddenly raised from 24–28 C to 32.5 C.

Results and observations from the submerged cage tests showed that young shad avoided effluent temperatures above 30 C (Table 2). During the first three effluent tests, shad exhibited vertical movements (±40 cm) that coincided with rapid temperature changes resulting from oscillating levels of heated water. As the temperature rose to approximately 30 C, fish always moved downward. Shad exhibited no specific depth or temperature preference at both ambient (control) and effluent temperatures below 30 C.

Moss (1970) demonstrated that young shad avoided rapid temperature increases of about 4 C. Breder (1951) showed that dwarf herring avoided areas of a holding pool above 30 C, and that this temperature barrier acted as a "solid wall." None of the young clupeids, 3.6–40.0 mm TL, entrained in the condenser cooling-water system of the Haddam plant survived passage to the lower end of its discharge canal at water temperatures above 30 C (Marcy, 1971).

The upper natural temperature limit of young shad may be about 30 C. Young shad avoid potentially lethal temperatures above 30 C and are capable of traversing the heated effluent during their downstream migration.

ACKNOWLEDGMENTS

We wish to thank the staff of the Connecticut River Ecological Study and the Directors, D. Merriman and L. M. Thorpe. Drs. J. W. Atz, M. R. Carriker, D. M. Pratt, E. C. Raney, and R. R. Whitney gave advice and critically reviewed the manuscript. Special thanks are due R. R. Massengill, F. P. Richards, R. C. Galvin, and W. H. Dudek for field assistance and equipment design. The present paper is a product of the Connecticut River Ecological Study which was undertaken by the Connecticut Yankee Atomic Power Company in fulfillment of the terms of the construction permit granted by the State of Connecticut Water Resources Commission 21 October 1964.

LITERATURE CITED

BREDER, C. M., JR. 1951. Studies on the structure of the fish school. Bull. Amer. Mus. Nat. Hist. 98(1): 1–27.

BOYD, W. A. 1970. Hydrology report. *In*: D. Merriman (ed.), The Connecticut River investigation. 10th Semiannual Progr. Rep. Conn. Water Res. Comm.: 2–8.

COLLINS, G. B. 1952. Factors influencing the orientation of migrating anadromous fishes. U.S. Fish. Wild. Serv. Fish. Bull. 52(73): 373–396.

MARCY, B. C., JR. 1971. Survival of young fish in the discharge canal of a nuclear power plant. J. Fish. Res. Bd. Canada 28: 1057–1060.

———. 1972. Spawning of the American shad, *Alosa sapidissima* in the lower Connecticut River. Chesapeake Sci. 13(2): 116–119.

MERRIMAN, D. 1970. The calefaction of a river. Sci. Amer. 222(5): 42–52.

MOSS, S. A. 1970. The response of young American shad to rapid temperature changes. Trans. Amer. Fish. Soc. 99(2): 381–384.

SHELFORD, V. E., AND E. B. POWER. 1915. An experimental study of the movements of herring and other marine fish. Biol. Bull. 28: 315–334.

BARTON C. MARCY, JR.
PAUL M. JACOBSON
RICHARD L. NANKEE

Essex Marine Laboratory, Inc.
Essex, Connecticut 06426

Effects of Preservatives on Weights of Some Common Macrobenthic Invertebrates[1]

Limnologists and fisheries biologists are often interested in obtaining estimates of the standing crop of benthic invertebrates, expressed as dry or wet weight of organisms per unit area of bottom. In most cases quantitative samples of sediment are obtained with a grab sampler and the sediment is sieved through a fine-meshed screen. The residue left on the screen is then stored for some time, usually in 10% formalin. Later the organisms sorted from the residue may be kept in another preservative, a solution of formalin or an alcohol. A small amount of glycerine is often added with alcohol to prevent the organisms from becoming excessively brittle and to protect against their drying out if the water and alcohol should evaporate. Weighing of organisms frequently follows prolonged storage in one or two preservatives.

Following is a report of results of experiments concerning the effects of three common preservative solutions on the wet and dry weights of tubificid worms and chironomid larvae, organisms common in the benthos of many inland waters.

While there has been some previous investigation of changes in weight of invertebrates during preservation (Borutzky 1934), the problem is overlooked by many investigators. It seems to be often assumed that weights of preserved material closely approximate live weight and that little change occurs during preservations.

EFFECTS OF PRESERVATIVES ON WET WEIGHT

In an initial experiment living tubificid worms (mostly *Limnodrilus* spp.) were placed in nine small vials. Three vials each contained 20 ml of 10% formalin (4% formaldehyde), three held 20 ml of an aqueous solution of 70% ethanol and 5% glycerine, and the other three vials each contained 20 ml of 70% ethanol with 5% glycerine.

The worms were removed from the preservatives within 5 minutes, soon after they had died, and soaked in tap water for 30 minutes. This was necessary to remove preservative from the tissues, as it is impossible to determine a reproducible weight for an organism from which alcohol is evaporating. Trials involving soaking for various lengths of time indicated that 30 minutes was sufficient for worms and midge larvae. Larger organisms may require soaking for a longer period.

After soaking, the worms were placed on screens in specially modified centrifuge tubes (Fig. 1) and spun for 1 minute to rid them of externally adhering water. About 30 seconds of the spinning time were used in reaching maximum speed (3200 rpm); the last 30 seconds were required to decelerate. This procedure for removing external water is similar to that used by King and Ball (1964, 1967). It is believed to be more accurate, especially when several organisms are being weighed at a time, than the oft-cited tech-

[1] Contribution Number 77, Center for Great Lakes Studies, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201.