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OBSERVATIONS ON GAS BUBBLE DISEASE AMONG ADULT SMALLMOUTH BASS AND SQUAWFISH IN THE LOWER SNAKE AND MID-COLUMBIA RIVERS

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OBSERVATIONS ON GAS BUBBLE DISEASE AMONG ADULT SMALLMOUTH BASS AND SQUAWFISH IN THE LOWER SNAKE AND MID-COLUMBIA RIVERS

By

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ABSTRACT: In 1975 and 1976, 179 smallmouth bass (Micropterus dolomieui) and 85 northern squawfish (Ptychocheilus oregonensis) were collected by angling from the lower Snake and mid-Columbia Rivers, southeastern Washington. All fish were examined externally for gas bubble syndrome. Emboli were found beneath membranes of the operculae, body and fins of 128 bass (72%) and 71 squawfish (84%). Hemorrhage was also noted on the caudal, anal and pectoral fins of several bass. Presence of gas bubble syndrome corresponded to the spring runoff when total dissolved gas supersaturations in river water exceeded 115 percent. Effectiveness of measures to reduce supersaturation levels for protection of salmonid outmigrants could be reflected in resident river fish.

Hydroelectric dams on the Columbia and Snake rivers have created a source of environmental stress, causing gas bubble "disease" among fish populations (Collins et al. 1975, Ebel 1977). Water passing over spillways during the spring runoff entrains air, imparting excessively high levels of dissolved gasses to the river below. Distances between successive dams, which are linked together by reservoirs, are usually too short for river water to equilibriate to normal saturation levels. Therefore, high saturations of gasses are maintained as the water reaches each successive downstream structure. The problem occurs annually in the lower Snake River and in the mid-Columbia River above McNary Dam in Washington State.

Research and regulatory agencies have combined their efforts to resolve the problem. Laboratory bioassays now provide quantitative data on tolerance levels to supersaturated water for most anadromous (Bouck et al. 1976) and resident (Fickeisen and Montgomery 1978) species of Columbia River fish. Regulation of water spillage during periods of natural seaward migration, timing the release of juvenile hatchery salmonids, and recent structural modifications at dams such as spillway deflectors, are intended to reduce the impact of supersaturation on fish populations. However, the standard of 115% total dissolved gas saturation recommended in 1974 to protect juvenile salmonids from direct lethal effects during the spring freshet (Rulifson and Pine 1976) is infrequently met.

This is a report of field observations on external signs of gas bubble syndrome among adult smallmouth bass (Micropterus dolomieui) and northern squawfish (Ptychocheilus oregonensis) in the lower Snake and mid-Columbia rivers during spring freshets of 1975 and 1976.

Methods

The Columbia Basin Bass Club of Richland, Washington cooperated in collecting smallmouth bass and squawfish by angling with artificial lures. All fish were taken between Lower Monumental Dam on the Snake River and John Day Dam on the Columbia River. Fish were examined for external signs of exposure to high dissolved gas saturations, according to procedures described by Stroud and Nebeker (1976). Location, type, and extent of syndrome were noted and recorded before fish release.

Results and Discussion

A total of 179 smallmouth bass and 85 northern squawfish were examined during May, 1975 and May through August, 1976. Of these fish, 128 bass (72%) and 71 squawfish (84%) displayed external evidence of exposure to super-saturated water. The primary indication was the presence of gas bubble emboli beneath the surface membrane, which ranged from 25 to 300 bubbles in fins to over 800 bubbles on the body and fins. Opercular emboli were also typical, and hemorrhaging of the caudal, anal and pectoral fins was common.

Supersaturation levels in the forebays of Lower Monumental, Ice Harbor, and McNary dams during the spring of 1975 and 1976 varied with location (Fig. 1). Generally, supersaturation was highest above Lower Monumental Dam on the Snake River and lowest above McNary Dam on the Columbia River, below the confluence with the Snake River. Total gas saturations at a point above McNary Dam normally exceed the present 115% EPA standard during the annual spring spate, even though the water first passes through the stretch of Lake Wallula where it tends to equilibriate.

Few studies have examined nonmigratory fish species in the Columbia and Snake rivers for gas bubble syndrome during annual periods of air

supersaturation. (If sounding was adequately used as a compensating mechanism, few resident fish would be expected to develop gas bubble emboli.) Many fish have the ability to sound and utilize hydrostatic compensation to avoid severe exposures to supersaturated water in rivers (Weitkamp 1976). However, my observations on smallmouth bass, an important game species, and northern squawfish, an abundant predator species, indicate that stress was reflected in a relatively high proportion of the resident fish community each spring and summer.

Signs of gas bubble affliction among a considerable number of sexually mature smallmouth bass collected by angling does not indicate subsequent mortality. Whether fish survive in riverine situations after exposures to supersaturated water sufficient to elicit external gas emboli is unknown.

In laboratory experiments, D. H. Fickeisen, (Battelle, Pacific Northwest Laboratories, Richland, Washington, unpublished data) found that adult smallmouth bass survived more than 24 hr but less than 96 hr at 130% supersaturation. Bouck et al. (1976) reported similar results with largemouth bass (M. salmoides). Northern squawfish exhibited gas bubble disease signs within one week after exposure to 125 to 135% saturation, and their resistance was apparently similar to that of juvenile salmon and steelhead trout (Bentley et al. 1976).

Bass normally spawn in 0.7 to 5.6 m of water from late May to early July (Scott and Crossman 1973). In the Snake and Columbia rivers, smallmouth bass typically spawn during the spring in inshore and slough areas at times corresponding to the annual freshet (Montgomery, Fickeisen and Becker, 19). Exposure to supersaturated water apparently does not inhibit or restrict spawning activity. However, it may influence subsequent survival of bass eggs and fry.

Emboli occur in and may block arteries that normally supply nutrients and oxygen via the circulating blood to developing eggs prior to spawning (Fig. 2). Moreover, bass sac fry may be susceptible to formation of large gas bubbles. Bass fry were not collected and examined in this study. However, I have observed large gas blisters to form in the abdomen of rainbow trout (Salmo gairdneri) sac fry and cause mortality at 113% gas saturation in hatchery troughs (Fig. 3).

Assessment of impact from supersaturated water in field situation should include collection and examination of adult and juvenile resident fishes. Effectiveness of measures to reduce supersaturation levels for protection of salmonid outmigrants could be reflected in a corresponding reduction in gas bubble syndrome among resident fish.

Acknowledgments

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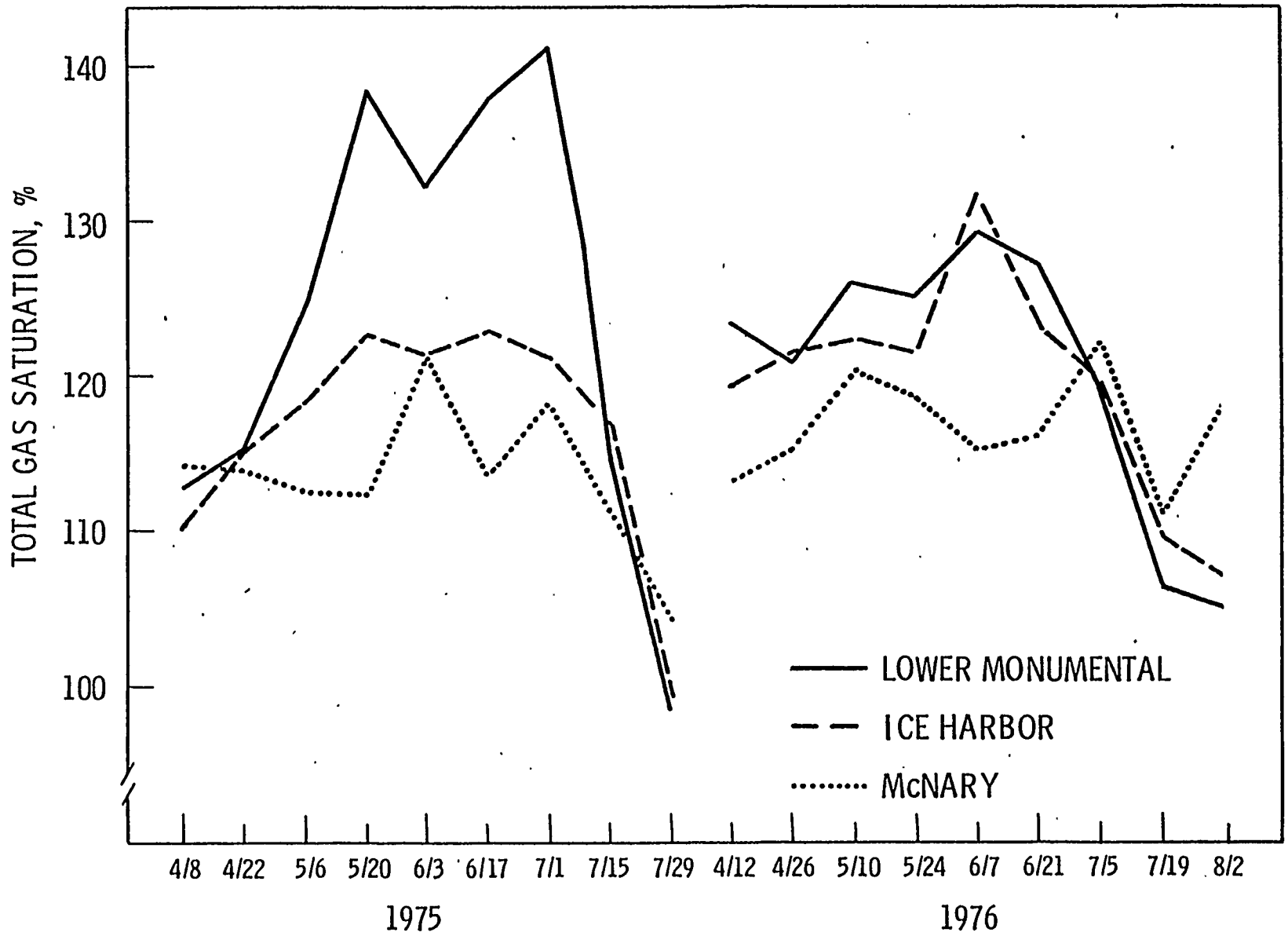
TOTAL GAS SATURATION, %
140
130
120
110
100
LOWER MONUMENTAL
ICE HARBOR
McNARY
4/8
4/22
5/6
5/20
6/3
6/17
7/1
7/15
7/29
4/12
4/26
5/10
5/24
6/7
6/21
7/5
7/19
8/2
1975
1976

Fig. 7

Fig. 2

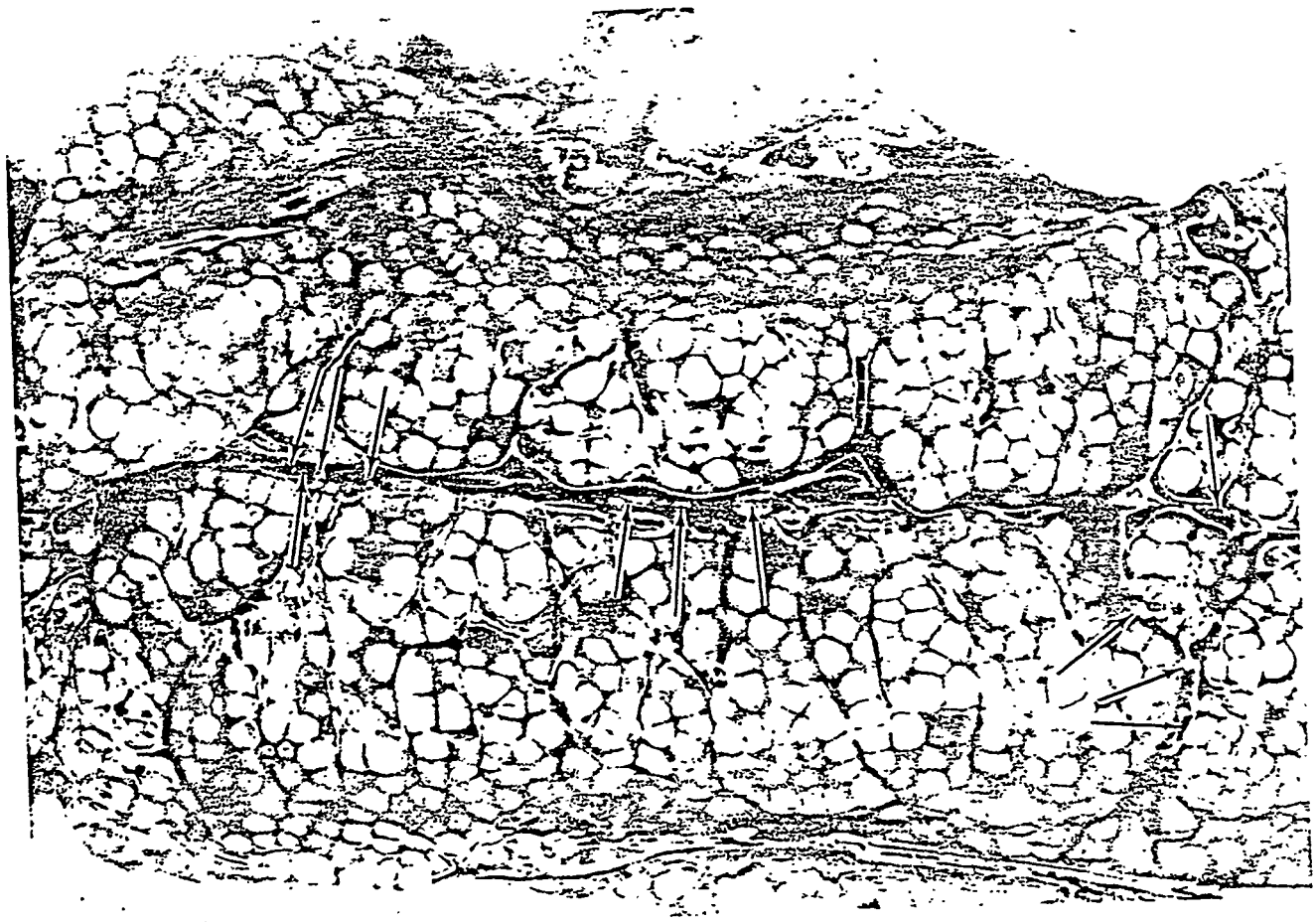

Fig. 3