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Technical Paper

The *Technical Paper* series contains highly technical reports about various species of fish and related topics, such as the effects of herbicide and climate on fish and their environment. Typical subjects include advances in knowledge arising as by-products of broader studies; progress or data reports; surveys, description of equipment, gear, and techniques; proceedings of technical conferences or workshops; and technical bibliographies. Publications are usually typeset and have a standard size of 20 × 26 cm (7 7/8 × 10 1/4 in.); length varies. Intended audiences are research scientists and technically trained management personnel. First issued in 1966, the series merged with the *Special Scientific Report—Wildlife* series in 1985 and was renamed *Fish and Wildlife Technical Report.*

1. KAWAMURA, T. 1966. Distribution of phytoplankton populations in Sandy Hook Bay and adjacent areas in relation to hydrographic conditions in June 1962. 37 pp.

   Describes physiography and hydrography of Sandy Hook Bay and related rivers, New Jersey. Lists phytoplankton species, communities, and populations. Compares bay and river plankton communities. Discusses phytoplankton species succession in summer, 1962, and standing crop of bay and river, determined by chlorophyll a method. Divides area into five regions and mentions the relation between biological and hydrological conditions.

2. YAMAZI, I. 1966. Zooplankton communities of the Navesink and Shrewsbury rivers and Sandy Hook Bay, New Jersey. 44 pp.

   Describes sample collection and analysis, hydrographic conditions, and quantitative distribution of zooplankton. Discusses qualitative distribution of plankton, including plankton communities. Appends a species list, map of the area, and other data.

3. CROCE, N. D. 1966. Observations on the marine cladoceran *Penilia avirostris* in northwestern Atlantic waters. 13 pp.

   Presents and discusses results of study regarding cladoceran reproduction: 1) number of eggs or embryos, 2) number of eggs or embryos and parent size, 3) number of embryos and parent size, 4) youth and reproduction, and 5) parthenogenic and sexual reproduction.

4. ROBBINS, O., JR. 1966. Flathead Lake (Montana) fishery investigations, 1961-64. 45 pp.

   Creel census investigations on Flathead Lake in Montana were conducted from 1961 to 1964 to determine use and harvest, activities of fishermen, and characteristics of the fish resources. Data on fishermen's activities were collected by personal interview and postal questionnaire surveys devised particularly for use on this lake. Information is presented on launching sites; starting and stopping times; residence of fishermen; catch success; fishing pressure distribution; annual use; and numbers, lengths, and weights of fishes.

5. REGAN, D. M. 1966. Ecology of gila trout in Main Diamond Creek in New Mexico. 24 pp.

   Data on gila trout (*Salmo gilae*) ecology were collected from a 2.5-mile section of Main Diamond Creek in New Mexico, in the upper range of the Transition Zone. Stream flow, water temperature, and chemical characteristics were measured. Also studied were fish population, growth rate, condition factor, food use, scale regeneration, and meristic and morphometric characters.

6. FOWLER, L. G., J. H. MCCORMICK, JR., AND A. E. THOMAS. 1966. Studies of caloric and vitamin levels of salmon diets. 14 pp.

   Feeding trials were conducted with fingerling fall chinook salmon (*Oncorhynchus tshawytscha*) to determine the effect of an all-meal diet at four levels of vitamin supplementation and at five caloric levels. Meat supplementation and substitution of soybean oil meal for cottonseed meal in the basal meal ration were also tested.

7. DUPREE, H. K. 1966. Vitamins essential for growth of channel catfish. 12 pp.

   Symptoms were identified in channel catfish (*Ictalurus punctatus*) fed diets deficient in the water-soluble vitamins pyridoxine, pantothenic acid, riboflavin, thiamine, folic acid, nicotinic acid, B-12, or choline. Fat-soluble vitamin A and vitamin K deficiency symptoms were observed after feeding diets that contained beta-carotene and 4.0 mg of menadione (synthetic vitamin K) per 100 g of food (dry weight).

8. ELLIOTT, J. W., L. G. FOWLER, AND R. E. BURROWS. 1966. Effects of age, growth, and diet on characteristics of salmon fingerlings. 11 pp.

   Body composition, blood chemistry, plasma protein composition, and physical blood properties were measured at monthly intervals for two groups of fall chinook salmon fingerlings (*Oncorhynchus tshawytscha*). Fish were fed exclusively either a meat or meal diet. Age, growth, diet, and disease were found to affect one or more of the measured characteristics of these fish.

9. DUPREE, H. K., AND K. E. SNEED. 1966. Response of channel catfish fingerlings to different levels of major nutrients in purified diets. 21 pp.

   Weight gains and feed conversions by channel catfish (*Ictalurus punctatus*) fingerlings were measured for two groups, each fed a different diet: 1) diet containing casein, and 2) diet containing wheat gluten and soybean proteins. Weight gain was correlated with diet protein content and percent cellulose flour. Water temperature effects on weight gain and feed conversions were noted. Serum protein and hematocrit values were examined for both groups, and serum protein paper chromatograms were compared with those of control fish from a local river.

10. ARNOLD, D. E. 1966. Marking fish with dyes and other chemicals. 44 pp.

    Literature on marking fish with chemicals is reviewed, with a critical commentary and suggestions for desirable areas of research. Various substances such as radioisotopes, latex, liquid plastic, metallic compounds, tetracycline antibiotics, inks, paints, and dyes are discussed, together with the methods used to apply them. Methods include deep injection, subcutaneous injection, tattooing, immersion, daubing, and feeding. More than 100 dyes and other chemicals that have been used for marking aquatic animals are listed, and the results of published and unpublished experiments using each one are summarized. Data on experiments by the author using acridin orange, Bismarck brown, and rhodamine B for immersion staining are presented.

11. SQUIRE, J. L., JR. 1967. Surface temperature gradients observed in marine areas receiving warm water discharges. 8 pp.

    Discusses the results of a survey of four areas where heated water from steam-generating plants is injected into marine environments.

12. KENNEDY, H. D. 1967. Seasonal abundance of aquatic invertebrates and their utilization by hatchery-reared rainbow trout. 41 pp.

    A 2-year study of the composition of bottom fauna, its seasonal and annual variations, and its use by hatchery-reared rainbow trout (*Salmo gairdneri*) was made in experimental stream channels of Convict Creek, Mono County, California. Food use was measured with stomach analysis. Gross comparisons were made of the distribution and abundance of aquatic fauna with water velocity, mean depth, and substrate particle size. Forage ratios and frequency of occurrence of the primary food organisms are given.

13. FOWLER, L. G., AND J. L. BANKS. 1967. Test of different components in the Abernathy salmon diet. 18 pp.

    Substitute components in the Abernathy salmon diet were tested in 2 years of feeding trials with fall chinook salmon fingerlings (*Oncorhyncus tshawytscha*). Components tested were turbot, dogfish, and salmon meals; soybean, peanut, corn, cottonseed, and safflower oils; dried buttermilk and skim milk; and wheat germ meal. Storage of diets is mentioned.

14. BUSS, K., AND J. MILLER. 1967. Interspecific hybridization of esocids: hatching success, pattern development, and fertility of some F_1 hybrids. 30 pp.

    Literature is reviewed and the success of reciprocal crosses is recorded, including drawings and photographs showing development of progeny. Fertility of some F_1 hybrids was investigated. Five Esocidae—muskellunge (*Esox masquinongy*), northern pike (*E. lucius*), chain pickerel (*E. niger*), redfin pickerel (*E. americanus americanus*), and grass pickerel (*E. americanus vermiculatus*)—were used as parent species to make 20 reciprocal crosses. The young were maintained from 1 to 4 years, and the fertility of six reciprocal hybrids was established.

15. LENNON, R. E. 1967. Brook trout of Great Smoky Mountains National Park. 18 pp.

    Discusses the ecology of brook trout (*Salvelinus fontinalis*) in Great Smoky Mountains National Park, including distribution, sex ratios, fecundity, morphology, diseases, and stocking. Range and limiting factors such as water temperatures are examined, and management recommendations are provided.

16. HASSLER, T. J., J. M. NEUHOLD, AND W. F. SIGLER. 1967. Effects of alkyl benzene sulfonate on rainbow trout. 15 pp.

    Toxicity of detergent levels to rainbow trout (*Salmo gairdneri*) was determined by probit analysis. Effects on gill tissues and blood were noted and measured. The LC50 was 3.48 mg/L ABS after 24 h exposure and 2.53 mg/L after 120 h.

17. EISLER, R. 1967. Tissue changes in puffers exposed to methoxychlor and methyl parathion. 15 pp.

    Adult northern puffers (*Sphoeroides maculatus*) were exposed for periods up to 45 days to either 30 parts per billion (ppb) of the organochloride insecticide methoxychlor, 20,200 ppb of the organophosphorous

insecticide methyl parathion, or to a combination of 15 ppb of methoxychlor and 10,100 ppb of methyl parathion. Periodically, fish from each group were analyzed for whole blood and serum constituents and for content of sodium, potassium, calcium, magnesium, zinc, and iron in selected tissues.

18. WALBURG, C. H. 1969. Fish sampling and estimation of relative abundance in Lewis and Clark Lake. 15 pp.

    Catches by gill nets, frame nets, trap nets, 4.9- and 8.2-m otter trawls, seines, and a 220-V electroshocker, from 1962 to 1964, were compared to determine practical methods for annual measuring of the fish population in Lewis and Clark Lake.

19. MULLAN, J. W., AND R. L. APPLEGATE. 1969. Use of an echosounder in measuring distribution of reservoir fishes. 16 pp.

    A recording white-line depth sounder was used to study annual fish distribution in two deep reservoirs on the White River, Arkansas, and Missouri. Varying seasonal activity levels of fish, attenuation of the sound beam at depths greater than 100 ft, and lack of precision in the identification of echo traces precluded rigorous interpretation of echograms. The inherent picture sense of echograms provided seasonal perspectives of fish distribution with respect to 1) diel movement, 2) depth and basin location, 3) limnetic concentrations, and 4) oxygen-temperature conditions.

20. HEIMSTRA, N. W., D. K. DAMKOT, AND N. G. BENSON. 1969. Some effects of silt turbidity on behavior of juvenile largemouth bass and green sunfish. 9 pp.

    Activity, feeding, attack, and scraping behavior of juvenile largemouth bass (*Micropterus salmoides*) and green sunfish (*Lepomis cyanellus*) in aquariums were measured under conditions of clear water, 4–6 Jackson Turbidity Units (JTU), and 14–16 JTU for 30 days. Turbidity effects on social hierarchies were studied.

21. NELSON, W. R. 1969. Biological characteristics of the sauger population in Lewis and Clark Lake. 11 pp.

    Age and rate of growth, sex ratio, maturity, fecundity, movement, and exploitation rates were determined for the sauger (*Stizostedion canadense*) population in Lewis and Clark Lake and the Missouri River between Gavins Point and Fort Randall dams. Suggested management measures for sauger include introduction of forage fish to improve growth, increased angler harvest, and reduction of water level fluctuation on spawning grounds to improve year-class strength.

22. SIEFERT, R. E. 1969. Biology of the white crappie in Lewis and Clark Lake. 16 pp.

    Describes general studies of the biology of white crappie (*Pomoxis annularis*). Topics include: 1) spawning dates, 2) reproduction success, 3) young-of-the-year emigration, 4) young-of-the-year length, 5) early stage larvae diet, 6) growth, 7) sexual maturation, and 8) preferred diet.

23. THOMAS, A. E., AND J. M. SHELTON. 1968. Operation of Abernathy Channel for incubation of salmon eggs. 19 pp.

    A spawning and incubation channel constructed in 1959 on Abernathy Creek near Longview, Washington, has been used for seasons to incubate fall chinook salmon (*Oncorhynchus tshawytscha*) and chum salmon (*O. keta*) eggs. Studies included effects of sedimentation, egg planting density, and stage of egg development at planting on survival.

24. DEAN, J. L. 1969. Biology of the crayfish *Orconectes causeyi* and its use for control of aquatic weeds in trout lakes. 15 pp.

    Life history, ecology, and weed control activities of crayfish (*Orconectes causeyi*) are discussed. Describes populations, reproduction, sex ratios, damage, and relation with agriculture. Mentions crayfish control of some species of following genera of aquatic plants: *Potamogeton, Myriophyllum, Elodea, Ceratophyllum, Ranunculus, Chara,* and filamentous algae.

25. SANDERS, H. O. 1969. Toxicity of pesticides to the crustacean *Gammarus lacustris*. 18 pp.

    Static bioassays were conducted to determine the relative acute toxicities of some insecticides, herbicides, fungicides, and a defoliant to the scud *Gammarus lacustris*. Toxic effects were measured by determination of Median Lethal Concentration (LC50) for 24-, 48-, and 96-h exposures at 70° F.

26. FOWLER, L. G., AND J. L. BANKS. 1969. Tests of vitamin supplements and formula changes in the Abernathy salmon diet, 1966–67. 19 pp.

    Discusses results of diet trials on fall chinook salmon (*Oncorhynchus tshawytscha*) fingerlings. Abernathy and Oregon pellets were tested, as well as the following supplements: 1) vitamins C, E, and K, 2) paraaminobenzoic acid, 3) B_{12}, 4) cod liver oil, 5) blood meal, 6) distiller's solubles, 7) crab meal, 8) salt, 9) hake meal, 10) salmon meal, 11) dried buttermilk, 12) dried skim milk, 13) low and high protein cottonseed meals, and 14) rancid fish meals.

27. DUPREE, H. K. 1969. Influence of corn oil and beef tallow on growth of channel catfish. 13 pp.

    Fingerling channel catfish (*Ictalurus punctatus*) were offered a series of 18 purified diets that contained liquid corn oil, solid corn oil, and beef tallow at 4, 8, and 16% of the dry diet; and white dextrin at 8 and 16% of the dry diet. Effect of the dietary variables was based on proximate analysis for

protein, ash, moisture, lipid, and iodine absorption number of the lipid of entire fish at the start and end of the experiment.

28. CLARK, J., W. G. SMITH, A. W. KENDALL, JR., AND M. P. FAHAY. 1969. Studies of estuarine dependence of Atlantic coastal fishes. 132 pp.

    Presents basic data from a survey including eight cruises from Cape Cod, Massachusetts, to Cape Lookout, North Carolina, from December 1965 to December 1966. Data reported include temperatures, salinities, zooplankton volumes, and midwater trawl collections of fishes.

29. HASSLER, T. J. 1969. Biology of the northern pike in Oahe Reservoir, 1959 through 1965. 13 pp.

    Variations in length, weight, and maturity of northern pike (*Esox lucius*) in Oahe Reservoir were associated with sex and year class. Effects of impoundment on year-class sizes are discussed.

30. ELROD, J. H., AND T. J. HASSLER. 1969. Estimates of some vital statistics of northern pike, walleye, and sauger populations in Lake Sharpe, South Dakota. 17 pp.

    Catch-effort data derived from gill net samples were used to estimate relative abundance, age composition, sex ratio, growth rate, survival rate, and relative year-class strength of northern pike (*Esox lucius*), walleye (*Stizostedion vitreum*), and sauger (*S. canadense*) populations in Lake Sharpe, Missouri River, South Dakota, during the first 3 years of impoundment (1964–66).

31. HERMAN, R. L. 1969. Oxytetracycline in fish culture—a review. 9 pp.

    Reviews literature on the use of oxytetracycline in fish culture. Subjects include growth promotion, disease treatment, toxicity, and skeletal marking.

32. BULLOCK, G. L., AND D. COLLIS. 1969. Oxytetracycline sensitivity of selected fish pathogens. 9 pp.

    Selected representatives of several genera of gram-negative fish pathogenic bacteria were tested for in vitro and in vivo sensitivity to oxytetracycline hydrochloride (Terramycin).

33. HERMAN, R. L. 1969. Oxytetracycline toxicity to trout. 4 pp.

    To establish oral toxicity of oxytetracycline to trout, rainbow (*Salmo gairdneri*) and brook trout (*Salvelinus fontinalis*) were given different levels in their food. In addition, rainbow trout were force-fed known amounts.

34. CURRAN, D., AND R. L. HERMAN. 1969. Oxytetracycline efficacy as a pretreatment against columnaris and furunculosis in coho salmon. 6 pp.

    Coho salmon (*Oncorhynchus kisutch*) fed 100 mg oxytetracycline per kilogram per day beginning 3 days before exposure to pathogens were protected against infection by *Chondrococcus columnaris* and drug sensitive *Aeromonas salmonicida*.

35. ROBINSON, J. A., F. P. MEYER, AND J. H. FRIBOURGH. 1969. Oxytetracycline efficacy against bacterial infections in blue and channel catfishes. 7 pp.

    Presents and discusses results of in vitro studies, in vivo studies with experimental infections, and in vivo studies with natural infections to test the efficacy of oxytetracycline for blue (*Ictalurus furcatus*) and channel catfish (*I. punctatus*).

36. AMEND, D. F. 1969. Oxytetracycline efficacy as a treatment for furunculosis in coho salmon. 6 pp.

    Coho salmon (*Oncorhynchus kisutch*) were infected with *Aeromonas salmonicida* (furunculosis) and treated with oxytetracycline at different stages of disease severity to determine the drug efficacy.

37. HERMAN, R. L., D. COLLIS, AND G. L. BULLOCK. 1969. Oxytetracycline residues in different tissues of trout. 6 pp.

    Oxytetracycline, as TM-50, was fed to rainbow (*Salmo gairdneri*), brook (*Salvelinus fontinalis*), and brown trout (*Salmo trutta*) held at 3 temperatures, 6–7, 9–10, and 12–13 °C. Liver, muscle, plasma, and kidney tissues were assayed to determine excretion rates.

38. FRIBOURGH, J. H., J. A. ROBINSON, AND F. P. MEYER. 1969. Oxytetracycline residues in tissues of blue and channel catfishes. 7 pp.

    Reports results of investigations at the Fish Farming Experimental Station concerning oxytetracycline concentrations and residues in blue (*Ictalurus furcatus*) and channel catfish (*I. punctatus*) tissues following oral administration of the drug under natural feeding conditions.

39. FRIBOURGH, J. H., J. A. ROBINSON, AND F. P. MEYER. 1969. Oxytetracycline levels produced in catfish serum by three methods of treatment. 6 pp.

    Compares concentration and residue of oxytetracycline in channel catfish (*Ictalurus punctatus*) blood following injection, force-feeding, and natural feeding of the antibiotic.

40. FRIBOURGH, J. H., F. P. MEYER, AND J. A. ROBINSON. 1969. Oxytetracycline leaching from medicated fish feeds. 7 pp.

    Tests were conducted at the Fish Farming Experimental Station to determine residue levels in selected tissues following the feeding of oxytetracycline to channel (*Ictalurus punctatus*) and blue catfish (*I. furcatus*), and its efficacy against bacterial infections. Discusses whether or not significant leaching of the drug occurred, and the

effects of pellet surface to volume ratio, water temperature, and hydrogen ion concentration of the medium on leaching.

41. WADE, R. A. 1969. Ecology of juvenile tarpon and the effects of dieldrin on two associated species. 85 pp.

    Presents and discusses results of bioassay studies of dieldrin on the sheepshead minnow (*Cyprinodon variegatus*) and sailfin molly (*Poecilia latipinna*). Means and variances of seventy-six, 48-h TL_m bioassays for effects of dieldrin at three temperatures, three salinities, and two hydrogen-ion concentrations are presented. Symptoms in the two fish species are described. The ecology of the juvenile tarpon (*Megalops atlanticus*) is discussed, including distribution and consequences of habitat alteration.

42. CALABRESE, A. 1969. Effect of acids and alkalies on survival of bluegills and largemouth bass. 10 pp.

    To determine whether manipulation of hydrogen-ion concentration of the water could be used to selectively kill bluegills (*Lepomis macrochirus*) in farm-pond fish populations consisting of bluegills and largemouth bass (*Micropterus salmoides*), tests were conducted with both tap and pond waters in aquariums and with stream water in plastic-lined pools. The pH was changed by addition of hydrochloric acid, acetic acid, sodium hydroxide, and calcium hydroxide; tests were carried out in the pH range of 3.3 to 11.2.

43. FIJAN, N. N., T. L. WELLBORN, JR., AND J. P. NAFTEL. 1970. An acute viral disease of channel catfish. 11 pp.

    Describes symptoms of channel catfish (*Ictalurus punctatus*) fry and fingerlings affected with channel catfish virus disease (CCVD) at four widely separated fish farms in 1968. Discusses isolation of the virus and identifies it as cause of four epizootics. The CCVD virus was also tested in cultures of brown bullhead (*I. nebulosus*), rainbow trout (*Salmo gairdneri*), fathead minnow (*Pimephales promelas*), and bluegill (*Lepomis macrochirus*) fry cells.

44. BARKULOO, J. M. 1970. Taxonomic status and reproduction of striped bass (*Morone saxatilis*) in Florida. 16 pp.

    Striped bass (*Morone saxatilis*) from the Apalachicola and St. Johns rivers in Florida were compared taxonomically with striped bass from other drainages on the Atlantic coast and Gulf of Mexico. Both rivers contain endemic striped bass populations. Reproduction requirements and factors limiting the abundance of striped bass in Florida are discussed.

45. EISLER, R. 1970. Factors affecting pesticide-induced toxicity in an estuarine fish. 20 pp.

    Factors affecting mortality caused by orgnochlorine and organophosphorus insectides in the mummichog (*Fundulus heteroclitus*) include duration of exposure; concentration and class of chemical; degradation or alteration of experimental compounds in seawater; and temperature, salinity, and pH of the medium. Static bioassays with organochlorine (endrin, aldrin, dieldrin, heptachlor, *p,p'*-DDT, lindane, methoxychlor) and organophosphorus (malathion, DDVP, methyl parathion, Phosdrin, dioxathion) insecticides were conducted on mummichogs at 24‰ salinity, 20 °C, and pH 8.0.

46. EISLER, R. 1970. Acute toxicities of organochlorine and organophosphorus insecticides to estuarine fishes. 12 pp.

    Static 96-h bioassays with 12 insecticides and 7 species of estuarine teleosts (American eel, *Anguilla rostrata*; mummichog, *Fundulus heteroclitus*; striped killifish, *F. majalis*; bluehead, *Thalassoma bifasciatum*; striped mullet, *Mugil cephalus*; Atlantic silverside, *Menidia menidia*; northern puffer, *Sphaeroides maculatus*) were conducted at 24‰ salinity, 20 °C, and pH 8.0.

47. FOWLER, L. G., AND J. L. BANKS. 1970. Tests of substitute ingredients and effects of storage in the Abernathy salmon diet, 1968. 8 pp.

    Feeding experiments in 1968 with fall chinook salmon fingerlings (*Oncorhynchus tschawytscha*) investigated effects of varying amounts of Peruvian anchovy meal, herring meal, hake meal, dried skim milk, dried whey, salmon oil, and soybean oil in the diet. Various storage times were also noted.

48. JOHNSON, S. I., AND J. L. SQUIRE, JR. 1970. Surface currents as determined by drift card releases on the continental shelf off the northwestern United States. 12 pp.

    Measurements of surface current drift off Oregon and Washington were made from March 1964 through February 1966 with plastic drift cards dropped from Coast Guard airplanes at selected points. Discusses wind direction and intensity as indications of surface current flow.

49. HOUSER, A., AND H. E. BRYANT. 1970. Age, growth, sex composition, and maturity of white bass in Bull Shoals Reservoir. 11 pp.

    White bass (*Roccus chrysops*) in Bull Shoals Reservoir were studied from October 1963 through January 1966 to determine age, growth, sex composition, and maturity. Results are compared with data from other regions.

50. MULLAN, J. W., AND R. L. APPLEGATE. 1970. Food habits of five centrarchids during filling of Beaver Reservoir, 1965–66. 16 pp.

    Stomach contents were examined from 1,886 largemouth bass (*Micropterus salmoides*), 334 spotted

bass (*M. punctulatus*), 1,689 bluegills (*Lepomis macrochirus*), 918 green sunfish (*L. cyanellus*), and 579 longear sunfish (*L. megalotis*) from shoreline areas of Beaver Reservoir during 2 of the first 3 years of filling. Quality and quantity of food by seasons and size groups (<50, 50–100, 101–200, and >200 mm in total length) is related to abundance of the principal forage.

51. BRYANT, H. E., AND D. I. MORAIS. 1970. Identification of ingested gizzard shad and threadfin shad by gizzard dimensions. 5 pp.

    The remains of gizzard shad (*Dorosoma cepedianum*) and threadfin shad (*D. petenense*) in predator stomachs can be specifically identified by differences in their gizzard dimensions. A separation line equidistant from the gizzard length-width means of the two species in terms of standard deviations is presented, as well as a regression of total fish length on gizzard width.

52. MULLAN, J. W., D. I. MORAIS, AND R. L. APPLEGATE. 1970. Thermal, oxygen and conductance characteristics of a new and an old Ozark reservoir. 29 pp.

    Thermal, oxygen, and conductance characteristics are described for two impoundments of the White River in Arkansas and Missouri, from 1963 to 1967. Bull Shoals was filled in 1952 and is 18,400 ha at the top of the power pool; upstream Beaver Reservoir began filling in 1964 and reached 10,700 ha in 1966 (94% of the power pool area).

53. KENNEDY, H. D., L. L. ELLER, AND D. F. WALSH. 1970. Chronic effects of methoxychlor on bluegills and aquatic invertebrates. 18 pp.

    Bluegills (*Lepomis macrochirus*; average weight 7 g, average fork length 73 mm) were exposed to methoxychlor at concentrations of 0, 0.01, and 0.04 ppm in ponds for 13 weeks in late summer. Discusses methoxychlor effects on fish numbers, growth, pathologic changes in tissues and organs, and fish uptake of the insecticide. Describes differences in insect population densities between high-treatment, low-treatment, and untreated ponds. Pond-bottom mud was sampled for methoxychlor residues.

54. ANDERSON, H. G., JR. 1970. Annotated list of the parasites of bluefish *Pomatomus saltatrix*. 15 pp.

    Presents results of a study of bluefish (*Pomatomus saltatrix*) on the Atlantic coast. Includes information about 37 parasites.

55. KENNEDY, H. D., AND D. F. WALSH. 1970. Effects of malathion on two warmwater fishes and aquatic invertebrates in ponds. 13 pp.

    Bluegills (*Lepomis macrochirus*) and channel catfish (*Ictalurus punctatus*) were exposed to four applications of malathion at two concentrations in ponds during an 11-week summer period. Presents and discusses results of studies on fish numbers, fish growth or microhematocrit values, pathology, brain cholinesterase activity, and reproduction. Species composition and population densities of aquatic invertebrates were also examined.

56. GASAWAY, C. R. 1970. Changes in the fish population in Lake Francis Case in South Dakota in the first 16 years of impoundment. 30 pp.

    Describes species composition, total number of fish, number of fish by species, and forage fish populations in Lake Francis Case from 1952–1968. Growth and reproduction are also discussed.

57. WARES, P. G. 1971. Biology of the pile perch, *Rhacochilus vacca*, in Yaquina Bay, Oregon. 21 pp.

    Growth, reproduction, food habits, and parasites of pile perch (*Rhacochilus vacca*), were investigated in Yaquina Bay, Oregon, between April 1966 and July 1967. The research disclosed that pile perch live at least 10 years.

58. RUCKER, R. R. 1972. Gas-bubble disease of salmonids: a critical review. 11 pp.

    Explains gas-bubble disease and describes its symptoms and the gases that cause it. Discusses how the amount of gas can be measured and reduced. Saturation tables for atmospheric oxygen and nitrogen in water for 0 to 30 °C are presented.

59. CLARK, J., W. G. SMITH, A. W. KENDALL, JR., AND M. P. FAHAY. 1970. Studies of estuarine dependence of Atlantic coastal fishes. Data report II: southern section, New River Inlet, North Carolina, to Palm Beach, Florida. *R. V. Dolphin* Cruises 1967–68: zooplankton volumes, surface-meter net collections, temperatures, and salinities. 97 pp.

    Presents data from the second year of a 2-year survey of the Atlantic continental shelf to locate spawning areas, determine seasons, and follow movements of larval and juvenile stages from spawning grounds. Data include temperatures, salinities, zooplankton volumes, and surface-meter net collections of juvenile fishes.

60. BULLOCK, G. L. 1972. Studies on selected myxobacteria pathogenic for fishes and on bacterial gill disease in hatchery-reared salmonids. 30 pp.

    Morphological, physiological, and serological studies on 55 myxobacteria isolated principally from gill disease, tail rot, and other myxobacterial infections showed that a variety of myxobacteria occur in these infections. Myxobacteria were tested for agglutinin and agar gel precipitin reactions. Studies to induce and transmit gill disease were performed on fingerling trout. Levels of agglutinins against myxobacteria in yearling trout were measured, and cross-absorption studies were performed on 10 of these cultures.

61. FOWLER, L. G., J. L. BANKS, AND J. W. ELLIOTT. 1972. Tests of variations of the Abernathy salmon diet, 1970. 13 pp.

    Presents and discusses results of 1970 fall chinook salmon (*Oncorhynchus tshawytscha*) feeding trials. Diet elements tested and compared for efficiency were dry pellets, moist pellets, ratio of dried whey product and wheat germ meal, cottonseed meal, soybean oil, and two corn distillers' products. Effect of storage on nutritional adequacy of dry pellets was noted.

62. AMEND, D. F. 1972. Efficacy, toxicity, and residues of Nifurpirinol in salmonids. 13 pp.

    Nifurpirinol (NFP), also known by the code name P-7138, was tested for control of furunculosis, myxobacterioses, and vibriosis; and for its effects on rainbow trout (*Salmo gairdneri*), silver salmon (*Oncorhynchus kisuch*), and chinook salmon (*O. tshawytscha*) under various conditions. NFP was administered by immersion and by feeding, if fish would accept treated food. Toxicity of NFP was tested at different dosage levels, treatment frequencies, and water temperatures. NFP levels in tissues were measured.

63. PUTZ, R. E. 1972. Biological studies on the hemoflagellates *Cryptobia cataractae* and *Cryptobia salmositica*. 25 pp.

    Two hemoflagellates of fish, *Cryptobia cataractae* and *C. salmositica*, were studied to determine host range, vector relations, in vivo culture, in vitro culture, pathogenicity, and cryogenic preservation.

64. FOWLER, L. G., AND J. L. BANKS. 1972. Alteration tests of the Abernathy salmon diet, 1971. 12 pp.

    Presents and discusses results of 1971 fall chinook salmon (*Oncorhynchus tshawytscha*) feeding trials. Effects different levels of cottonseed meal, wheat and corn gluten meal, dried whey product with different lactose contents, methionine supplement, anchovy meal, and herring meal on fish growth were tested. Diets with different protein percentages were compared. Soybean lecithin and oil were compared as caloric sources.

65. TINDLE, R. C. 1972. Handbook of procedures for pesticide residue analysis. 88 pp.

    Describes and explains sample preparation, extraction, clean-up, and analysis techniques.

66. SANDERS, H. O. 1972. Toxicity of some insecticides to four species of malacostracan crustaceans. 19 pp.

    Acute and long-term (20-day) toxicities of 40 insecticides to four species of freshwater malacostracan crustaceans—scud (*Gammarus fasciatus*), crayfish (*Orconectes nais*), glass shrimp (*Palaemonetes kadiakensis*), and aquatic sowbug (*Asellus brevicaudus*)—were determined in static and intermittent-flow bioassays.

67. INGLIS, A., AND E. L. DAVIS. 1972. Effects of water hardness on the toxicity of several organic and inorganic herbicides to fish. 22 pp.

    Effects of water hardness on the acute toxicity of organic and inorganic herbicides were determined in static bioassays. Concentrations of total hardness (calculated as $CaCO_3$) of 13.0, 52.2, 208.7, and 365.2 ppm were tested in water containing calcium to magnesium ion ratios of 1:1 and 5:1. Bluegills (*Lepomis macrochirus*) were the principal test species. Organic herbicides tested included three formulations of 2,4-D, three formulations of endothall, and one formulation each of silvex pentachlorophenol and dichlobenil; inorganic herbicides included technical grades of sodium arsenite and copper sulfate.

68. PARSONS, J. W. 1973. History of salmon in the Great Lakes, 1850–1970. 80 pp.

    Describes the decline and extinction of Atlantic salmon (*Salmo salar*) in Lake Ontario in the 1800's; the failure to establish, by salmon culture, permanent or sizable populations of Atlantic or Pacific salmon in any of the Great Lakes in 1867–1965; and the success of plantings of silver (*Oncorhynchus kisutch*) and chinook salmon (*O. tshawytscha*) in the Great Lakes during 1966–70—particularly in Lake Michigan.

69. CARR, J. F., J. W. MOFFETT, AND J. E. GANNON. 1973. Thermal characteristics of Lake Michigan, 1954–55. 143 pp.

    The thermal regime of Lake Michigan is described on the basis of analysis of 1,671 bathythermograph casts made in 1954 and 1955. The beginning, duration, geographic extent, and ending of thermal stratification were determined from 51 thermal profiles from all areas of the open lake.

70. ALLEN, H. E. 1973. Seasonal variation of nitrogen, phosphorus, and chlorophyll a in Lake Michigan and Green Bay, 1965. 23 pp.

    Total and dissolved phosphorus, nitrate, and chlorophyll a were measured at four stations in northern Lake Michigan (inshore Michigan, offshore Michigan, offshore Wisconsin, and inshore Wisconsin) and one station in southern Green Bay during 16 sampling periods in 1965. Nutrients were measured at depths of 2, 5, and 10 m and chlorophyll a at 2 m.

71. JUNE, F. C. 1974. Ecological changes during the transitional years of final filling and full impoundment (1966–70) of Lake Oahe, an upper Missouri River storage reservoir. 57 pp.

    Gives synoptic data and trends on water discharge, water level, sedimentation, turbidity, transmissivity,

temperature, specific conductance, dissolved oxygen, and plankton.

72. SELGEBY, J. H., AND W. E. JONES. 1974. Physical and chemical characteristics of Lake Oahe, 1968–69. 18 pp.

    The physical and chemical characteristics presented provide a description of Lake Oahe and establish bases for certain characteristics which may alter as the reservoir ages. Parameters measured include water temperature, wind-driven currents, water depth, duration of thermal stratification, dissolved oxygen, nitrate nitrogen, soluble phosphorus, and silica levels.

73. JONES, W. E., AND J. H. SELGEBY. 1974. Invertebrate macrobenthos of Lake Oahe, 1968–69. 11 pp.

    Presents and discusses results of a study during 1968–69. Objectives of the sampling program were to determine benthos distribution and abundance in the main stem; determine longitudinal, seasonal, and depth distribution in a major tributary embayment; and establish a monitoring station and sampling system to evaluate later changes in benthos.

74. SELGEBY, J. H. 1974. Limnetic crustacean zooplankton of Lake Oahe, May–October 1969. 11 pp.

    Describes composition and abundance of crustacean zooplankton throughout the ice-free season at selected locations in Lake Oahe.

75. GABEL, J. A. 1974. Species and age composition of trap net catches in Lake Oahe, South Dakota, 1963–67. 21 pp.

    Catch was dominated by eight species in order of abundance: black crappie (*Pomoxis nigromaculatus*), bigmouth buffalo (*Ictiobus cyprinellus*), white crappie (*Pomoxis annularis*), common carp (*Cyprinus carpio*), river carpsucker (*Carpiodes carpio*), freshwater drum (*Aplodinotus grunniens*), smallmouth buffalo (*Ictiobus bubalus*), and goldeye (*Hiodon alosoides*).

76. NELSON, W. R., AND M. F. BOUSSU. 1974. Evaluation of trawls for monitoring and harvesting fish populations in Lake Oahe, South Dakota. 15 pp.

    Trawls of various designs and sizes were compared to evaluate their use for monitoring and harvesting fish populations in Lake Oahe. Different sizes of semiballoon trawls and high-rise trawls were tested, and small-mesh trawls and trap nets were compared.

77. NELSON, W. R. 1974. Age, growth, and maturity of thirteen species of fish from Lake Oahe during the early years of impoundment, 1963–68. 29 pp.

    Body-scale relation, calculated length, length-weight relation, age at maturity, and sex ratio of 13 major species collected in Lake Oahe from 1963 to 1968 with trap nets and bottom trawls are described.

78. MOEN, T. E. 1974. Population trends, growth, and movement of bigmouth buffalo, *Ictiobus cyprinellus*, in Lake Oahe, 1963–70. 20 pp.

    Presents and discusses results of bigmouth buffalo (*Ictiobus cyprinellus*) studies. Growth data include sexual and age variation, and sex ratios.

79. MILLER, G. L., AND W. R. NELSON. 1974. Goldeye, *Hiodon alosoides*, in Lake Oahe: abundance, age, growth, maturity, food, and the fishery, 1963–69. 13 pp.

80. HIGHAM, J. H. 1974. The commercial fishery in Lake Oahe, North and South Dakota, 1964–70. 15 pp.

    Lists 10 species commercially harvested and discusses seasonal and annual production variation in bigmouth buffalo (*Ictiobus cyprinellus*). Includes usual fishing season length and principal fishing gears.

81. STAROSTKA, V. J., AND W. R. NELSON. 1974. Age, growth, sexual maturity, and food of channel catfish in central Lake Oahe, 1968–69. 13 pp.

    Channel catfish, *Ictalurus punctatus*, were collected with gill nets, trawl, and trap nets at three localities in Lake Oahe for the study of year-class strength, growth in length and weight, age composition, sexual maturity, and food.

82. GABEL, J. A. 1974. An experimental trap net fishery, Lake Oahe, South Dakota, 1965. 9 pp.

    Large trap nets were evaluated as commercial gear for capturing buffalo fish during July–September 1965. Both 7.0-cm and 12.7-cm mesh (extended measure) were used in back of a bailing crib of nets to determine the effects of 12.7-cm mesh in reducing the catch of sport species and nonmarketable size groups of commercial species.

83. WRIGHT, F. T. 1975. Atlantic salmon (*Salmo salar*): an annotated bibliography. 22 pp.

    Presents a bibliography with international sources on detection, diagnosis, identification, and control of diseases of Atlantic salmon (*Salmo salar*).

84. VOGELE, L. E. 1975. Reproduction of spotted bass, *Micropterus punctulatus*, in Bull Shoals Reservoir, Arkansas. 21 pp.

    Spotted bass (*Micropterus punctulatus*) were studied in Bull Shoals Reservoir during 1966–71 to determine some environmental requirements for successful spawning and to estimate their reproductive potential. Environmental factors studied included water levels, temperatures, and transparency.

85. HEARTWELL, C. M. III. 1975. Immune response and antibody characterization of the channel catfish (*Ictalurus punctatus*) to a naturally pathogenic bacterium and virus. 34 pp.

Channel catfish (*Ictalurus punctatus*) were inoculated with *Chondiacoccus columnaris* and channel catfish virus, and primary and secondary responses were noted. Total serum proteins and selected isozyme systems were analyzed by acrylamide gel electrophoresis. Antibody activity was examined and antibacterial serums were subjected to immunoelectrophoresis.

86. BRAUHN, J. L., R. C. SIMON, AND W. R. BRIDGES. 1976. Rainbow trout growth in circular tanks: consequences of different loading densities. 16 pp.

    Investigates ammonia nitrogen resulting from high densities of rainbow trout (*Salmo gairdneri*) as a cause of reductions in growth, yield, and food-use efficiency.

87. JUNE, F. C. 1976. Changes in young-of-the-year fish stocks during and after filling of Lake Oahe, an upper Missouri River storage reservoir, 1966–74. 25 pp.

    Young-of-the-year fish stocks of Lake Oahe were sampled with a 30.5- × 2.4-m haul seine at semimonthly intervals, from July to September during 1966–74. Data are presented and discussed for species numbers and abundance, and for the effects of forage fish on total fish abundance. Describes population trends and growth rates for the two most abundant species, yellow perch (*Perca flavescens*) and emerald shiners (*Notropis atherinoides*). Suggests factors causing general decline in species numbers and abundance after filling the reservoir.

88. FOLMAR, L. C. 1977. Acrolein, dalapon, diochlobenil, diquat, and endothal: bibliography of toxicity to aquatic organisms. 16 pp.

    Toxicity tables for the herbicides acrolein, dalapon, dichlobenil, diquat, and endothal list the test organisms, types of tests, experimental conditions, and test results. Each table is followed by a list of references.

89. WEDEMEYER, G. A., AND W. T. YASUTAKE. 1977. Clinical methods for the assessment of the effects of environmental stress on fish health. 18 pp.

    Clinical methods are presented for biological monitoring of hatchery and native fish populations to assess the effects of environmental stress on fish health. Detailed analysis methods, together with guidelines for sample collection and for the interpretation of results, are given for tests on blood (cell counts, chloride, cholesterol, clotting time, cortisol, glucose, hematocrit, hemoglobin, lactic acid, methemoglobin, osmolality, and total protein); water (ammonia and nitrite content); and liver and muscle (glycogen content).

90. BENNETT, D. E., AND R. S. WYDOSKI. 1977. Biology of the redtail surfperch (*Amphistichus rhodoterus*) from the central Oregon coast. 23 pp.

    Investigates the redtail surfperch for 1) biology—annulus formation, total length, weight, age group, and growth; 2) reproduction—season, number, mean size, and mortality of embryos; 3) food; and 4) parasites.

91. JOHNSON, W. W., AND H. O. SANDERS. 1977. Chemical forest fire retardants: acute toxicity to five freshwater fishes and a scud. 7 pp.

    Toxicities of four chemical forest fire retardants, Fire-Trol 100 and 931 (ammonium sulfate or polyphosphate with an attapulgite clay thickener) and Phos-Chek 202A and 259 (diammonium phosphate with a guar gum derivative thickener) were determined by static and flow-through toxicity tests for fry and fingerling coho salmon (*Oncorhynchus kisutch*) and rainbow trout (*Salmo gairdneri*); fingerling fathead minnows (*Pimephales promelas*), bluegills (*Lepomis macrochirus*), and largemouth bass (*Micropterus salmoides*); and mature scuds (*Gammarus pseudolimnaeus*).

92. BERLIN, W. H., L. T. BROOKE, AND L. J. STONE. 1977. Verification of a model for predicting the effect of inconstant temperature on embryonic development of lake whitefish (*Coregonus clupeaformis*.) 6 pp.

    Eggs stripped from lake whitefish (*Coregonus clupeaformis*) spawning in Lake Michigan were incubated in the laboratory at temperatures similar to those on whitefish spawning grounds in Lake Michigan during December–April. Observed times from fertilization to attainment of each of 21 developmental stages were used to test a model that predicts the rate of development of daily fluctuating temperatures; the model relates rates of development for any given stage j, expressed as the reciprocal of time (R_j), to temperature (T). The generalized equation for a developmental stage is $R_j = ab^T c^{T2}$.

93. HEBERGER, R. F., AND J. B. REYNOLDS. 1977. Abundance, composition, and distribution of crustacean zooplankton in relation to hypolimnetic oxygen depletion in west-central Lake Erie. 17 pp.

94. MORTON, J. W. 1977. Ecological effects of dredging and dredge spoil disposal: a literature review. 33 pp.

    Comprehensively reviews literature on physical, chemical, and biological effects of dredging and dredge spoil disposal in estuaries, and identifies other spoil disposal methods.

95. WALBURG, C. H. 1977. Lake Francis Case, a Missouri River reservoir: changes in the fish population in 1954–75, and suggestions for management. 12 pp.

    Discusses water-level fluctuations as a cause of a decline in fish abundance over 23 years. Recommends water-level management for managing fish abundance.

96. POSTON, H. A. 1978. Neuroendocrine mediation of photoperiod and other environmental influences on physiological responses in salmonids: a review. 14 pp.

    Describes physiological responses to environmental influences such as water temperature, water salinity and diet salt, and photoperiod. Discusses the relation between neurohormones and pituitary hormones, the timekeeping role of the pineal gland in rhythmic metabolism, and variables affecting the influence of the pineal gland on metabolism. Presents implications of environmental control in salmonid culturing.

97. WOODWARD, D. F., AND F. L. MAYER, JR. 1978. Toxicity of three herbicides (butyl, isooctyl, and propylene glycol butyl ether esters of 2,4-D) to cutthroat trout and lake trout. 6 pp.

    Discusses the effects of three herbicides on cutthroat trout (*Salmo clarkii*) and lake trout (*Salvelinus namaycush*) at different concentrations, water temperatures, water hardnesses, and pH's. Recommends maximum safe concentrations. Alevin survival and fry growth were also studied.

98. WELLS, L. 1980. Food of alewives, yellow perch, spottail shiners, trout-perch, and slimy and fourhorn sculpins in southeastern Lake Michigan. 12 pp.

    Stomachs of 1,064 alewives (*Alosa pseudoharengus*), 1,103 yellow perch (*Perca flavescens*), 246 spottail shiners (*Notropis hudsonius*), 288 trout-perch (*Percopsis omiscomaycus*), 454 slimy sculpins (*Cottus cognatus*), and 562 fourhorn sculpins (*Myoxocephalus quadricornis*) from Lake Michigan were examined for food contents.

99. MCADA, C. W., AND R. S. WYDOSKI. 1980. The razorback sucker, *Xyrauchen texanus*, in the Upper Colorado River Basin, 1974-76. 15 pp.

    Surveys razorback sucker (*Xyrauchen texanus*) populations in the upper Colorado River. Includes data on spawning season, estimated fecundity, sizes, and estimated ages.

100. TIMMONS, T. J., W. L. SHELTON, AND W. D. DAVIS. 1980. Gonad development, fecundity, and spawning season of largemouth bass in newly impounded West Point Reservoir, Alabama-Georgia. 6 pp.

    Presents results of a study on largemouth bass (*Micropterus salmoides*) in 1977. Includes discussion of percentage of body weight contributed by ovaries and frequency distributions of ovarian egg diameters as indicators of spawning season.

101. NELSON, W. R. 1980. Ecology of larval fishes in Lake Oahe, South Dakota. 18 pp.

    The time and location of spawning, food of larvae, and habitats used as nursery areas by young-of-the-year fishes were studied from 1972 to 1975 in South Dakota waters of Lake Oahe, a main-stem Missouri River reservoir. Sampling locations were in the tributary rivers—the Grand, Moreau, and Cheyenne—and their embayments. Makes management recommendations for ensuring adequate reproduction of most fishes.

102. KELLY, G. A., J. S. GRIFFITH, AND R. D. JONES. 1980. Changes in distribution of trout in Great Smoky Mountains National Park, 1900-1977. 10 pp.

    Compares and contrasts distributions of brook trout (*Salvelinus fontinalis*), rainbow trout (*Salmo gairdneri*), and brown trout (*S. trutta*) from 1900-77. Predicts future distribution trends.

103. JOHNSON, B. T. 1980. Laboratory procedure for estimating residue dynamics of xenobiotic contaminants in a freshwater food chain. 16 pp.

    A laboratory method of measuring accumulation, transfer, elimination, and degradation of xenobiotic contaminants is described for organisms in a freshwater food chain (microorganisms, filter-feeder, and fish). A flow-through diluter-system, ^{14}C-labeled contaminants, gas and thin-layer chromatography, autoradiography, and liquid scintillation spectrometry are used in making residue determinations. Accumulation factors and various index values are developed for measuring and estimating potential accumulation of xenobiotic contaminants by aquatic organisms.

104. SANDERS, H. O., D. F. WALSH, AND R. S. CAMPBELL. 1981. Abate: effects of the organophosphate insecticide on bluegills and invertebrates in ponds. 6 pp.

    Application of the organophosphate insecticide Abate 3 times to duplicate 0.04-ha earthen ponds at 18 g/ha (4 μg/L)—the recommended application rate—and 180 g/ha (40 μg/L) was studied for effects on bluegill (*Lepomis macrochirus*) mortality, reproduction, brain acetylcholinesterase (AChE) activity, and growth. Biomass of invertebrates was also examined.

105. GREAT LAKES FISHERY LABORATORY. 1981. Chlorinated hydrocarbons as a factor in the reproduction and survival of lake trout (*Salvelinus namaycush*) in Lake Michigan. 42 pp.

    Presents and discusses results of studies on performance and survival of fry hatched from eggs of Lake Michigan lake trout (*Salvelinus namaycush*) exposed for 6 months to PCB's and DDE at concentrations similar to those present in offshore waters and zooplankton of Lake Michigan. Evaluates fry mortality, growth, swimming performance, predator avoidance, temperature preference, and metabolism.

106. VOGELE, L. E. 1981. Reproduction of smallmouth bass, *Micropterus dolomieui*, in Bull Shoals Lake, Arkansas. 15 pp.

Smallmouth bass (*Micropterus dolomieui*) were studied in Bull Shoals Lake to determine the nesting requirements and reproductive capabilities of the species in a reservoir. Underwater observations were conducted weekly in five study areas during the spawning seasons of 1969-76.

107. JOHNSON, B. T., EDITOR. 1982. Impact of xenobiotic chemicals on microbial ecosystems. 36 pp.

Environmental microbiology testing includes both the effect of microorganisms and microbial processes on chemical substances and the effect of chemical substances on microorganisms and microbial processes. Discusses environmental relevance, types, and ecological significance of microbial effects testing that may be used in developing environmental risk assessments.

108. ROTTIERS, D. V., AND R. M. TUCKER. 1982. Proximate composition and caloric content of eight Lake Michigan fishes. 8 pp.

Presents results of tests on proximate composition (percentage lipid, water, fat-free dry material, ash) and caloric content of eight species of Lake Michigan fish: lake trout (*Salvelinus namaycush*), coho salmon (*Oncorhynchus kisutch*), lake whitefish (*Coregonus clupeaformis*), bloater (*C. hoyi*), alewife (*Alosa pseudoharengus*), rainbow smelt (*Osmerus mordax*), deepwater sculpin (*Myoxocephalus quadricornis*), and slimy sculpin (*Cottus cognatus*). Data are analyzed for sex and age variation, and variation between fish collected in different years.

109. WELLS, L., AND S. C. JORGENSON. 1983. Population biology of yellow perch in southern Lake Michigan, 1971-79. 19 pp.

Reports results of a study based mainly on gill-net collections of yellow perch (*Perca flavescens*) made during July and August 1971-79 in southern Lake Michigan. Includes data on geographical variation in abundance, average length, age classes, growth, weight, spawning season, and mortality.

110. SANDERS, H. O., M. T. FINLEY, AND J. B. HUNN. 1983. Acute toxicity of six forest insecticides to three aquatic invertebrates and four fishes. 5 pp.

Technical grade and field formulations of six experimental forest insecticides—methomyl, carbaryl, aminocarb, trichlorfon, fenitrothion, and acephate—were tested for acute toxicity against three species of aquatic invertebrates (a daphnid, *Daphnia magna*; scud, *Gammarus pseudolimnaeus*; and larvae of a midge, *Chironomus plumosus*), and four species of fish (bluegill, *Lepomis macrochirus*; rainbow trout, *Salmo gairdneri*; fathead minnow, *Pimephales promelas*; and channel catfish, *Ictalurus punctatus*).

111. ECK, G. W., AND L. WELLS. 1983. Biology, population structure, and estimated forage requirements of lake trout in Lake Michigan. 18 pp.

Data collected during successive years (1971-79) of sampling lake trout (*Salvelinus namaycush*) in Lake Michigan were used to develop statistics on lake trout growth, maturity, and mortality, and to quantify seasonal lake trout food and food availability. These statistics were then combined with data on lake trout year-class strengths and age-specific food conversion efficiencies to compute production and forage fish consumption by lake trout in Lake Michigan during the 1979 growing season.