# Bibliography of fishery investigations on large salmonid river systems : with special emphasis on the Bois Brule River, Douglas County, Wisconsin. No. 166 1989

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# BIBLIOGRAPHY OF FISHERY INVESTIGATIONS ON LARGE SALMONID RIVER SYSTEMS

## with special emphasis on the Bois Brule River, Douglas County, Wisconsin

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**COVER:** *Electroshocking on the Bois Brule River.*


# ABSTRACT

This report provides 966 literature citations pertinent to management of salmonids in lotic systems. Of these citations, 229 (24%) include brief annotations to highlight their salient aspects to management of the Bois Brule River and other northern Wisconsin trout rivers. The subject index lists citations under 41 topic headings in 5 categories: Biology (10 headings), Ecology (9), Management (13), Sport Fishery Assessment (4), and Physical Environment (5). A salmonid species index is also provided.



KEY WORDS: Brook trout, brown trout, rainbow trout/steelhead, coho salmon, chinook salmon, salmonids, lotic systems, management, research, biology, ecology, sport fishery assessment, physical environment, annotations.

# Bibliography of Fishery Investigations on Large Salmonid River Systems With Special Emphasis on the Bois Brule River, Douglas County, Wisconsin

by Robert B. DuBois

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# INTRODUCTION

The Bois Brule River, popularly known as the Brule River, is a spring-fed tributary to western Lake Superior. The river provides a popular and complex sport fishery for 5 naturally reproducing species of salmonids that collectively have both anadromous and stream-resident components. The sport fishery is directed towards substantial runs of spring and fall steelhead (*Oncorhynchus mykiss,* formerly *Salmo gairdneri*), a late summer/fall lake run of brown trout (*Salmo trutta*), and self-sustaining upper river populations of stream-resident brown and brook trout (*Salvelinus fontinalis*). Fall fisheries for coho (*Oncorhynchus kisutch*) and chinook salmon (*O. tshawytscha*) are developing as well. Pink salmon (*O. gorbuscha*) have reproduced in the Brule River system since the late 1970s but have not contributed significantly to the sport catch.

Sport fishing quality for the primary trout species appears to be on the decline, causing growing concern among anglers and Wisconsin Department of Natural Resources (DNR) fisheries management personnel responsible for the stewardship of this unique resource. In 1983 the DNR Bureau of Research initiated a broadly directed, 2-year pilot study of the Brule River fishery to identify and prioritize problems in need of research. Part of this pilot study involved an extensive literature review to locate published information (collectively referred to as papers in this introduction) on a variety of topics pertaining to the ecology and management of large-river, mixed-stock salmonid fisheries. Selected results from that literature review are brought together in this report to provide a collection of references for regional fish managers and trout stream researchers to use as a starting point for deeper investigations.

In assembling this bibliography, I placed special emphasis on reviewing literature having direct bearing on (1) the pilot study and potential long-range research on the Brule River and (2) fishery management areas of concern specific to the Brule River, including competition among juvenile salmonids, disease problems (particularly furunculosis), effects of sea lamprey control and predation, impact of high turbidity on salmonids and invertebrates, and development of more effective fish sampling gears and creel census systems. The information presented does not, therefore, cover all aspects of riverine salmonid ecology and management in equal proportion. However, for most topic areas, I believe that a useful cross-section of papers is presented.

The selection process for obtaining material for review was unavoidably subjective, and due to the breadth of the subject area, a large number of potential reference materials were not included. The period of coverage is 1929 through 1987, although some 1988 material is included. I carefully screened very early work for present-day applicability. In general, only papers published in English were reviewed. In some cases, I included material involving salmonid species that are not found in the Brule River, but that have similar life history strategies, if the potential applicability of such material to the management of the Brule River fishery was readily apparent. Almost every paper cited in this bibliography appeared in a scientific journal, miscellaneous publication, technical report, or M.S. or Ph.D. thesis. Term papers, manuscript reports, and other preliminary information were not included, except in rare circumstances when such material was significant and no other sources were available.

To further enhance the usefulness of this bibliography, papers of potential relevance to management of the Brule River and other northern Wisconsin trout rivers were annotated. These papers had clear regional applicability of findings or immediate relevance to research and management investigations in progress. No standardized annotation format was used, because the relevant aspects of many papers were unique.

Citations for 966 papers are presented, of which 229 (24% of total) are annotated. Citations are arranged alphabetically by senior author and are numbered sequentially. Annotations immediately follow the associated citations.

Two indexes are presented. The first is a subject index where 41 specific topic headings are arranged alphabetically under 5 general subjects. Cited literature is referenced by number in one of two tiers under each topic heading: the top tier (marked with a solid triangle symbol, ▶) presents annotated citations, and the second tier presents unannotated citations (▷). The solid triangle symbol also appears at the beginning of each annotation in the body of the report. Most papers are listed under more than one topic heading. A paper was listed under a topic heading if the topic was substantially addressed in the paper. A salmonid species index follows the subject index.

# SUBJECT INDEX

## BIOLOGY



## ECOLOGY





▶indicates annotated citations, ▷indicates unannotated citations.

**Food Habits**

▶10 36 272 351 411 434 437 453 456 489 494 604 662 754 791 847 899 937 938

▷2 6 7 74 122 135 160 162 164 235 252 258 264 270 407 418 438 440 452 454 461 539 584 586 587 591 593 622 650 684 726 739 789 806 811 854 905

**Habitat Requirements, Evaluation, Use**

▶30 129 130 212 286 380 480 730 880 919 923 925

▷24 41 42 48 71 72 74 93 94 101 109 110 127 151 152 163 169 211 214 215 241 276 278 308 373 383 386 455 461 501 522 524 530 531 626 635 676 680 698 700 701 716 718 719 725 731 752 766 795 805 806 816 846 850 863 924 934 953

**Homing, Imprinting, Straying**

▶44 363 773 853 942

▷78 96 97 362 396 449 653 683 713 813 834 835

**Migration, Movements**

▶1 10 31 44 67 118 120 140 238 281 299 331 363 488 489 601 618 648 649 662 754 772 791 828 837 853 919 942

▷20 35 62 74 84 119 153 158 170 172 205 217 236 237 257 261 282 318 330 353 360 362 366 389 410 439 467 477 500 516 519 529 549 576 602 614 654 655 656 670 684 712 713 721 738 744 750 753 787 794 797 810 825 826 836 867 870 885 898 910 915 950 960 961 962

**Riparian and Instream Vegetation**

▶18 30 283 313 426 480 817 865 866 880

▷89 161 377 423 435 557 587 609 610 627 644 663 701 703 863 924

**Stream Ecosystem**

▶888

▷89 161 209 210 375 435 609 610 627 634 699

## MANAGEMENT

**Culture, Stocking, Strains**

▶272 430 512 537 578 600 623 751 754 772 782 893 919

▷34 87 92 95 131 134 147 165 175 187 189 195 205 208 222 242 243 250 312 346 353 379 400 405 406 424 433 470 476 484 513 518 527 562 575 582 599 605 625 666 683 685 705 707 729 786 857 894 895 896 898 901 910 957

**Decision-making, Economics**

▶355 686 829 853

▷19 40 107 108 150 185 200 207 301 321 338 348 401 431 540 561 569 596 630 681 682 711 733 788 830 906

**Fish Sampling Gears, Methods, Data Analysis**

▶10 37 202 286 303 306 309 354 363 368 378 488 489 550 624 751 782 785 923 925 965

▷20 23 41 49 59 77 80 172 193 217 221 225 279 291 300 301 307 319 334 336 349 350 383 384 385 399 439 442 462 464 466 485 496 514 525 526 534 545 549 566 577 594 603 607 639 698 701 702 704 737 744 755 763 765 768 778 792 844 881 885 921 941 964

**Fishways, Traps, Weirs**

▶231 281 378 648 649 662 772 785 791

▷20 25 49 58 59 74 186 279 439 485 500 753 881 904 921

**General Strategies**

▶46 55 85 88 272 275 391 505 600 686 751 791 817 853

▷75 82 100 106 113 126 187 197 198 204 228 267 293 337 339 348 364 486 504 507 528 533 541 567 588 606 613 618 621 630 631 685 689 697 703 735 742 756 790 855 883 890 897 906 911 916 951

**Habitat Enhancement, Preservation, Restoration**

▶129 130 144 146 296 313 343 398 415 420 426 427 623 673 817 907 927 930 931

▷47 83 90 93 95 109 132 194 215 232 240 253 269 278 280 304 315 324 335 344 345 361 377 397 422 423 431 468 479 510 530 535 538 587 598 625 627 644 657 658 680 703 717 725 748 761 779 793 843 849 851 862 878 891 924 928 929 953 955

**Marking, Tagging**

▶26 266 274 498 624 648 649 720 772

▷25 57 61 111 112 145 246 248 249 265 277 292 333 349 371 585 597 616 646 667 677 695 696 744 780 794 836 842 956 958 959

**Radio Telemetry**

▶118 120 331 521 563 589 828 886 942

▷65 119 168 467 477 564 870 943 944

**Regulations**

▶4 33 180 181 184 414 419 425 429 447 511 537 559 570 692 693 728 853 952

▷11 12 13 40 45 56 124 178 179 182 183 201 244 246 284 290 325 328 369 401 404 408 417 421 428 459 474 475 502 543 552 605 638 685 705 714 715 732 756 769 798 799 800 801 802 803 804 872 884 908 917 939 957

**Research Inputs**

▶156 414 420 774 823 946

▷15 217 224 294 401 495 574 703 793

**Sea Lamprey Control**

▶68 69 171 220 229 231 316 444 481 542 590 633 771

▷22 63 247 580 595 879

*Continued on next page*

**Stock Identification**

▶482 483 578

▷203 216 486 541 641 710 780 786 864

**Water Quality Assessment**

▶387 642 845

▷255 310 403 503 628 675 940

## PHYSICAL ENVIRONMENT

**Chemistry, Temperature**

▶38 233 380 648 649 662 760 772 817 873 874 875 876 877 926

▷74 101 223 262 308 393 524 627 636 691 808 843 863 882 896 918 940 963

**Discharge, Flow**

▶233 311 380 648 649 662 760 772 781 817 873 874 875 876 877 926 927

▷24 74 127 163 264 524 636 666 670 700 718 719 731 752 814 882 890 915

**Geology, Topography**

▶18 51 234 273 648 649 772 817

▷555 699 871

**Pollution, Toxics, Acid Deposition**

▶38 256 272 579

▷91 114 149 282 342 492 608 745 920 953 963

**Turbidity, Sedimentation**

▶18 21 60 230 234 327 722 807

▷352 381 386 463 723 724 762

## SPORT FISHERY ASSESSMENT

**Angler Attitudes, Preferences**

▶81 355 374

▷50 86 107 138 148 201 226 245 348 473 478 569 581 612 732 735 788 815

**Creel Surveys**

▶31 33 81 99 123 188 272 340 341 648 649 661 772 831 852 853

▷3 5 64 107 141 142 190 227 284 359 376 439 441 443 499 546 547 548 632 740 741 809 833 966

**Effort, Exploitation, Harvest, Yield**

▶4 31 33 123 188 340 341 363 488 512 648 649 661 772 852 853

▷54 76 142 217 227 268 284 289 326 353 359 412 424 439 441 446 496 510 543 554 632 687 705 710 714 715 736 737 742 744 747 756 796 809 860 869 884 906

**Historical Perspective**

▶85 184 448 512 537 553 648 649 660 772 823

▷43 50 580 627 770 779 822

# SALMONID SPECIES INDEX



*Continued on next page*

***Salvelinus fontinalis* (Brook Trout)**

2 3 4 6 7 31 40 53 74 76 94 98 99 100 127
134 143 144 145 146 147 156 169 175 176 182
183 184 196 199 205 211 212 213 214 215 223
247 254 264 266 269 272 281 286 287 288 297
299 308 314 318 326 327 329 332 334 343 372
380 393 399 400 402 408 410 411 412 413 414
415 416 420 421 422 423 424 426 428 429 439
446 452 466 484 492 501 502 506 509 510 511
512 514 539 551 553 554 556 567 568 571 583
584 585 593 604 614 615 617 621 631 636 645
652 658 659 660 661 662 666 685 691 707 709
716 730 731 746 749 750 755 757 758 766 777
781 789 797 799 801 816 817 840 846 847 852
891 905 914 923 927 932 933 935 937 939 945
949 952 954

***Salvelinus malma* (Dolly Varden)**

74 76 223 225 240 266 318 377 551 626 631
652 673 730 749 750 777 814 850 911 935

***Salvelinus namaycush* (Lake Trout)**

45 53 88 175 223 266 318 402 512 524 551 567
615 652 691 707 730 749 750 777 822 823 935
952

# LITERATURE CITATIONS


**1** Alexander, D. R. and H. R. MacCrimmon. 1974. Production and movement of juvenile rainbow trout (*Salmo gairdneri*) in a headwater of Bothwell's Creek, Georgian Bay, Canada. J. Fish. Res. Board Can. 31:117-21.

▶Annual production of juvenile rainbow trout in this Lake Huron tributary was estimated at 13.2 g/m$^2$. Most smolts (91%) emigrated at age I.

**2** Alexander, G. R. 1977. Consumption of small trout by large predatory brown trout in the North Branch of the Au Sable River, Michigan. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1855. 26 pp.

**3** Alexander, G. R., W. J. Buc, and G. T. Schnicke. 1979. Trends in angling and trout populations in the Main Au Sable and North Branch Au Sable rivers from 1959-1976. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1865. 59 pp.

**4** Alexander, G. R. and J. R. Ryckman. 1976. Trout production and catch under normal and special angling regulations in the North Branch of the Au Sable River, Michigan. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1840. 14 pp.

▶Annual production and angler harvest of wild brook and brown trout were both substantially higher on water under normal regulations (7.0-inch minimum size limit, 10 trout creel limit, any lure permitted) than on special-regulation water (9.0-inch minimum size limit, 5 trout creel limit, artificial flies only).

**5** Alexander, G. R. and D. S. Shetter. 1967. Fishing and boating on portions of the Au Sable River in Michigan, 1960-1963. Trans. Am. Fish. Soc. 96(3):257-67.

**6** Allan, J. D. 1978. Trout predation and the size composition of stream drift. Limnol. Oceanogr. 23:1231-37.

**7** Allan, J. D. 1981. Determinants of diet of brook trout (*Salvelinus fontinalis*) in a mountain stream. Can. J. Fish. and Aquat. Sci. 38:184-92.

**8** Allan, J. D. and E. Russek. 1985. The quantification of stream drift. Can. J. Fish. and Aquat. Sci. 42:210-15.

▶Drift sampling (6 or 7 replicates) just after dark, when drift is normally greatest, required fewer replicates than benthic sampling for comparable precision.

**9** Allee, B. A. 1982. The role of interspecific competition in the distribution of salmonids in streams. pp. 111-22 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**10** Allen, K. R. 1951. The Horokiwi Stream: a study of a trout population. New Zealand Mar. Dep. Fish. Bull. No. 10. 231 pp.

▶This report on a world-famous investigation of a New Zealand trout population describes the physical, chemical, and biological (trout population, bottom fauna, nongame fishes, etc.) aspects of the trout's environment from an ecosystemic perspective. Thorough examinations of trout population dynamics, feeding, and angling history were conducted.

**11** Allen, K. R. 1955. Factors affecting the efficiency of restrictive regulations in fisheries management. 1: Size limits. New Zealand J. Sci. and Technol. 35:498-529.

**12** Allen, K. R. 1955. Factors affecting the efficiency of restrictive regulations in fisheries management. 2: Bag limits. New Zealand J. Sci. and Technol. 36:305-34.

**13** Allen, K. R. 1967. Some quick methods for estimating the effect on catch of changes in the size limit. Journal du Conseil Permanent International pour l'Exploration de la Mer 31(1):111-26.

**14** Allen, K. R. 1969. Limitations on production in salmonid populations in streams. pp. 3-18 *in* T. G. Northcote, ed. Symposium on salmon and trout in streams. H. R. MacMillan Lect. in Fish., Univ. B. C., Vancouver. 388 pp.


▶Indicates annotation.

**15** Allen, K. R. 1973. The application of research to the management of British Columbia sockeye salmon. Trans. Am. Fish. Soc. 102(1):172-77.

**16** Allison, L. N., J. G. Hnath, and W. G. Yoder. 1977. Manual of common diseases, parasites, and anomalies of Michigan fishes. Mich. Dep. Nat. Resour. Fish. Manage. Rep. No. 8. 132 pp.

**17** Anderson, D. W. 1983. Factors affecting brown trout reproduction in southeastern Minnesota streams. Minn. Dep. Nat. Resour. Invest. Rep. No. 376. 36 pp.

▶Late winter and spring flooding was the major cause of reproductive failure of brown trout in 6 southeastern Minnesota streams. None of the other factors examined (redd superimposition, substrate composition, siltation, water velocity, hydraulic gradient, intra-redd dissolved oxygen, and stream morphometry) were limiting to brown trout recruitment.

**18** Anderson, H. W., M. D. Hoover, and K. G. Reinhart. 1976. Forest and water: effects of forest management on floods, sedimentation, and water supply. U.S. For. Serv. Gen. Tech. Rep. PSW-18. 115 pp.

▶A comprehensive summary of forest hydrology literature, focusing on literature from the United States, is provided. The bibliography includes approximately 600 references.

**19** Anderson, L. G. 1977. A classification of fishery management problems to and in the analysis and proper formulation of management problems. Ocean Dev. Int. Law 4(2):113-20.

**20** Anderson, T. C. and B. P. McDonald. 1978. A portable weir for counting migrating fishes in rivers. Can. Fish. and Mar. Serv. Tech. Rep. No. 733. 13 pp.

**21** Andrews, S. C., D. S. Houtman, and W. L. Lontz. 1979. Impact of nonpoint pollution control on western Lake Superior. Red Clay Proj.-Summary. EPA/905/9-79/002. 32 pp.

▶This nontechnical summary describes red clay erosion and slippage problems, evaluates the results of previously installed mitigation works, and offers recommendations for future efforts.

**22** Applegate, V. C. and E. L. King. 1962. Comparative toxicity of 3-trifluoromethyl-4-nitrophenol (TFM) to larval lampreys and eleven species of fishes. Trans. Am. Fish. Soc. 91(4):342-45.

**23** Armour, C. L., K. P. Burnham, and W. S. Platts. 1983. Field methods and statistical analyses for monitoring small salmonid streams. U.S. Fish and Wildl. Serv. Rep. No. FWS/OBS-83/33. 200 pp.

**24** Armour, C. L., R. J. Fisher, and J. W. Terrell. 1984. Comparison of the use of the Habitat Evaluation Procedures (HEP) and the Instream Flow Incremental Methodology (IFIM) in aquatic analyses. U.S. Fish and Wildl. Serv. Rep. No. FWS/OBS-84/11. 30 pp.

**25** Armstrong, R. W. and A. W. Argue. 1977. Trapping and coded wire tagging of wild coho and chinook juveniles from the Cowichan River system, 1975. Can. Fish. and Mar. Serv. Tech. Rep. PAC/T-77-14. 58 pp.

**26** Arnold, D. E. 1966. Marking fish with dyes and other chemicals. U.S. Fish and Wildl. Serv., Bur. Sport Fish. and Wildl. Tech. Pap. No. 10. 44 pp.

▶An excellent, though somewhat dated, general review of marking fish with dyes and other chemicals is presented. The bibliography contains over 150 references.

**27** Atkinson, J. 1979. Assessment of the Colpoys Bay rainbow trout population. Ont. Minist. Nat. Resour., Owen Sound Dist. 24 pp. (unpubl. rep.)

**28** Avery, E. L. 1974. Reproduction and recruitment of anadromous salmonids in Wisconsin tributaries of Lake Michigan. Wis. Dep. Nat. Resour. Final Rep. Study No. 108. Dingell-Johnson Proj. F-83-R. 32 pp.

▶The lack of significant natural reproduction of steelhead and coho salmon in Wisconsin tributaries to Lake Michigan is attributed to a general lack of suitable gravel substrates, cold winter water temperatures, and large water-level fluctuations.

**29** Avery, E. L. 1978. The influence of chemical reclamation on a small brown trout stream in southwestern Wisconsin. Wis. Dep. Nat. Resour. Tech. Bull. No. 110. 35 pp.

▶Significant improvements occurred in the growth, standing crop, and production of stocked brown trout after removal of all nontrout species in a small southwestern Wisconsin trout stream. Survival of trout was unchanged. A culvert-type fish barrier was effective in postponing re-invasion of nontrout species for at least several years.

**30** Avery, E. L. 1983. A bibliography of beaver, trout, wildlife, and forest relationships with special references to beaver and trout. Wis. Dep. Nat. Resour. Tech. Bull. No. 137. 23 pp.

▶This report provides 446 references on beaver ecology and the relationships of beaver to trout, waterfowl, and other wildlife. Annotations are included on 36 of the most important papers dealing specifically with beaver-wild trout relationships.

**31** Avery, E. L. 1983. Population dynamics of wild trout and associated sport fisheries in two northern Wisconsin streams. Wis. Dep. Nat. Resour. Tech. Bull. No. 141. 31 pp.

▶This study describes the structure and dynamics (spring and fall densities and biomass, age, and growth) of wild brook and brown trout populations in 2 northern Wisconsin streams; characterizes the associated sport fisheries; and discusses the management significance of

angler harvest of these populations. The seasonal movement of larger brown trout was of much greater magnitude and management importance than was such movement in recently studied central Wisconsin streams. The report states that no major or immediate revisions of harvest regulations are required to protect these wild brown trout populations, but more intensive studies of brook trout populations and their sport fisheries in northern Wisconsin are recommended.

**32** Avery, E. L. 1985. Sexual maturity and fecundity of brown trout in central and northern Wisconsin streams. Wis. Dep. Nat. Resour. Tech. Bull. No. 154. 13 pp.

►Very few female brown trout less than 8 inches long were sexually mature. Sexual maturity did not occur at age I, reached 70% at age II, and reached 95% at age III. A curvilinear relationship between egg number and total length is described. Average fecundity ranged from 229 eggs in females 7.0-7.9 inches long to 2,714 eggs in females 20.0-20.9 inches long.

**33** Avery, E. L. and R. L. Hunt. 1981. Population dynamics of wild brown trout and associated sport fisheries in four central Wisconsin streams. Wis. Dep. Nat. Resour. Tech. Bull. No. 121. 26 pp.

►Spring and fall population inventories were conducted on wild brown trout populations in 4 central Wisconsin streams for 3 years. Average spring density and biomass were 2,016 trout/mile and 96 lb/acre, respectively, while average fall density and biomass were significantly higher. Regulation changes to a minimum length limit of 7 inches and a season-long bag limit of 5 brown trout/day are recommended for the southern half of Wisconsin.

**34** Ayerst, J. D. 1977. The role of hatcheries in rebuilding steelhead runs of the Columbia River system. pp. 84-88 *in* E. Schwiebert, ed. Columbia River salmon and steelhead. Am. Fish. Soc. Spec. Publ. No. 10. 214 pp.

**35** Bachman, R. A. 1982. A growth model for drift-feeding salmonids: a selective pressure for migration. pp. 128-35 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**36** Bachman, R. A. 1984. Foraging behavior of free-ranging wild and hatchery brown trout in a stream. Trans. Am. Fish. Soc. 113:1-32.

►Wild brown trout in a fertile central Pennsylvania trout stream used the same discrete, energy-saving foraging sites year after year. The social structure was described as a cost-minimizing, size-dependent, linear dominance hierarchy of individuals having overlapping home ranges. Hatchery-reared brown trout fed less, moved more, and used cost-minimizing features of the substrate less than wild trout. This high energy cost may be a major cause of mortality among hatchery-reared trout. At high population densities, foraging sites may be limiting factors. Growth rate of drift-feeding salmonids was found to be density-independent.

**37** Bagliniere, J. L. and A. Champigneulle. 1986. Population estimates of juvenile Atlantic salmon, *Salmo salar*, as indices of smolt production in the R. Scorff, Brittany. J. Fish Biol. 29(4):467-82.

►A method is described for relating population estimates for juveniles occupying different habitat areas to estimates of smolt production. Riffles and rapids were the most productive habitats, providing 86% of the production from 28% of the water area.

**38** Bahnick, D. A., J. W. Horton, and R. K. Roubal. 1969. Chemical water quality survey of the surface waters of the Bois Brule River and its watershed, Wisconsin, tributary to Lake Superior. pp. 742-49 *in* Proceedings 12th conference on Great Lakes research. Int. Assoc. Great Lakes Res. 923 pp.

►Measurements of nitrogen, phosphorus, copper, dissolved oxygen, chemical oxygen demand, conductivity, pH, total solids, and water color were made during a 2-month period (1968) at 52 stations along the Brule River, Douglas County, and its tributaries.

**39** Bailey, J. E. 1969. Alaska's fishery resources: the pink salmon. U.S. Fish and Wildl. Serv., Bur. Commer. Fish. Fish. Leafl. 619. 8 pp.

**40** Bain, M. B. 1987. Structured decision making in fisheries management: trout fishing regulations on the Au Sable River, Michigan. North Am. J. Fish. Manage. 7:475-81.

**41** Bain, M. B., J. T. Finn, and H. E. Booke. 1985. A quantitative method for sampling riverine microhabitats by electrofishing. North Am. J. Fish. Manage. 5:489-93.

**42** Bain, M. B., J. T. Finn, and H. E. Booke. 1985. Quantifying stream substrate for habitat analysis studies. North Am. J. Fish. Manage. 5:499-506.

**43** Bakke, B. 1983. A historical perspective on the importance of wild salmonid management in the Northwest. pp. 10-17 *in* D. A. Kirkpatrick and T. Ameslav, eds. Proceedings of the wild salmon and trout conference. Seattle Univ., Seattle. 152 pp.

**44** Banks, J. W. 1969. A review of the literature on the upstream migration of adult salmonids. J. Fish Biol. 1:85-136.

►This literature review examines the upstream migration of all anadromous salmonids found in North America, except for coho salmon, in both natural (uncontrolled) and artificial (controlled) conditions. Topics of discussion include homing and the formation of local races; methods of observing migrations; the physiology of salmonids and the control of migration; and a variety of flow, fish passage, light intensity, and meteorological considerations.

**45** Barnhart, G. A. and R. Engstrom-Heg. 1984. A synopsis of some New York experiences with catch and release management of wild salmonids. pp. 91-101 *in* F. Richardson and R. H. Hamre, eds. Wild trout III. Proc. of a Symp. held at Yellowstone Natl. Park. 192 pp.

**46** Barnhart, R. A. 1975. Pacific slope steelhead trout management. pp. 7-11 *in* W. King, ed. Wild trout management. Proc. of a Symp. held at Yellowstone Natl. Park. 103 pp.

▶This report provides an interesting summary of the current status of steelhead fisheries throughout their native range and describes how management activities by the various states and the Province of British Columbia are affecting these fisheries. Includes a discussion of management problems and needs.

**47** Barton, D. R., W. D. Taylor, and R. M. Biette. 1985. Dimensions of riparian buffer strips required to maintain trout habitat in southern Ontario streams. North Am. J. Fish. Manage. 5:364-78.

**48** Bassett, C. E. 1978. Effect of cover and social structure on position choice by brown trout (*Salmo trutta*) in a stream. Mich. State Univ., East Lansing. M.S. Thesis. 181 pp.

**49** Bates, D. W. 1970. Diversion and collection of juvenile fish with traveling screens. U.S. Fish and Wildl. Serv., Bur. Commer. Fish. Fish. Leafl. 633. 5 pp.

**50** Bauer, W. B. A. J. 1984. Brethren of the Brule: forty years of steel heading. Arrowhead Print. Co., Superior, Wis. 171 pp.

**51** Bean, E. F. and J. W. Thomson. 1944. Topography and geology of the Brule River Basin. Trans. Wis. Acad. Sci., Arts and Lett. 36:7-17.

▶This paper presents a comprehensive physical description of the Brule River as part of a thorough interdisciplinary study done on the river in the early 1940s. All technical papers from this study were subsequently issued under one cover (see Wis. Cons. Dep. 1954).

**52** Becker, C. D. 1966. An annotated bibliography of the ecology of salmonids in Puget Sound estuaries. Wash. Univ. Fish. Res. Inst. Circ. 66-17. 69 pp.

**53** Becker, G. C. 1983. Fishes of Wisconsin. Univ. Wis. Press, Madison. 1052 pp.

**54** Beddington, J. R. and R. M. May. 1977. Harvesting natural populations in a randomly fluctuating environment. Science 197(4302):463-65.

**55** Behnke, R. J. 1972. The rationale of preserving genetic diversity: examples of the utilization of intraspecific races of salmonid fishes in fisheries management. Proc. of the 52nd Annu. Conf. West. States Assoc. of Fish and Game Comm. 52:559-61.

▶This paper gives a brief but insightful discussion of the potential management usefulness of preserving the genetic diversity of salmonids.

**56** Behnke, R. J. 1978. Use of native trout in special regulation fisheries. pp. 45-47 *in* K. Hashagen, ed. Wild trout management. Proc. of a Natl. Symp. Calif. Trout, Inc., San Francisco. 69 pp.

**57** Behrens Yamada, S. and T. J. Mulligan. 1982. Strontium marking of hatchery reared coho salmon, *Oncorhynchus kisutch* Walbaum, identification of adults. J. Fish Biol. 20:5-9.

**58** Bell, M. C. 1973. Fisheries handbook of engineering requirements and biological criteria. U.S. Army Corps Eng., Fish. Eng. Res. Program. 520 pp.

**59** Bell, W. H. and M. C. Armstrong. 1970. A photoelectric fish counter. Fish. Res. Board Can. Tech. Rep. No. 215. 23 pp.

**60** Berg, L. and T. G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment. Can. J. Fish. and Aquat. Sci. 42:1410-17.

▶Results from this study showed that at the higher turbidities tested (30 and 60 nephelometric turbidity units (NTU)), social behavior of coho salmon was negatively affected and gill flaring occurred more frequently.

**61** Berg, M. 1977. Tagging of migrating salmon smolts (*Salmo salar* L.) in the Vardnes River, Troms, northern Norway. Inst. Freshwater Res., Drottningholm, Sweden. Rep. No. 56:5-11.

**62** Bernatchez, L. and J. L. Dodson. 1987. Relationship between bioenergetics and behavior in anadromous fish migrations. Can. J. Fish. and Aquat. Sci. 44:399-407.

**63** Berst, A. H. and A. A. Wainio. 1967. Lamprey parasitism of rainbow trout in southern Georgian Bay. J. Fish. Res. Board Can. 24:2539-48.

**64** Best, E. A. and H. D. Boles. 1956. An evaluation of creel census methods. Calif. Fish and Game 42(2):109-15.

**65** Bidgood, B. F. 1980. Field surgical procedure for implantation of radio tags in fish. Alberta Fish and Wildl. Div. Fish. Res. Rep. No. 20. 9 pp.

**66** Bidgood, B. F. and A. H. Berst. 1967. Phenotypic characteristics of rainbow trout in the Great Lakes. J. Fish. Res. Board Can. 24:887-92.

**67** Biette, R. M., D. P. Dodge, R. L. Hassinger, and T. M. Stauffer. 1981. Life history and timing of migrations and spawning behavior of rainbow trout (*Salmo gairdneri*) populations of the Great Lakes. Can. J. Fish. and Aquat. Sci. 38:1759-71.

▶The major conclusion of this study was that

the innate ability of rainbow trout to adapt to different environmental conditions, together with their ability to "home," provides the potential for this exotic species to develop discrete stocks in the Great Lakes. The authors note that this process appeared to be occurring. Managers are urged to allow this species to develop its potential for producing discrete stocks.

**68** Bills, T. D. and L. L. Marking. 1976. Toxicity of TFM, Bayer 73, and a 98:2 mixture to fingerlings of seven fish species and to eggs and fry of coho salmon. U.S. Fish and Wildl. Serv. Invest. Fish Control No. 69. 9 pp.

►This laboratory study documented the toxicity of TFM, Bayer 73, and a 98:2 mixture of the 2 lampricides to fingerlings of 7 fish species including brook, brown, and rainbow trout and coho salmon. The mixture was slightly more toxic to sea lampreys than to other fish in comparable 24-hour toxicity tests; however, the margin of safety was small.

**69** Bills, T. D., L. L. Marking, and J. J. Rach. 1985. Toxicity of the lampricide 3-trifluoromethyl-4-nitrophenol (TFM) and 2′, 5-dichloro-4′-nitrosalicylanilide (Bayer 73) to eggs and nymphs of the mayfly (*Hexagenia* sp.). Great Lakes Fish. Comm. Tech. Rep. No. 47:13-23.

►Simulated stream treatments using exposure periods of 6-24 hours and concentrations of TFM or TFM plus Bayer 73 of 2.5-10.0 mg/L led to significant mortalities of mayfly nymphs at nearly all periods and concentrations.

**70** Bilton, H. T. and D. W. Jenkinson. 1968. Comparison of the otolith and scale methods for aging sockeye (*Oncorhynchus nerka*) and chum (*O. keta*) salmon. J. Fish. Res. Board Can. 25:1067-69.

**71** Binns, N. A. 1979. A habitat quality index for Wyoming trout streams. Wyo. Game and Fish Dep. Fish. Res. Rep. No. 2. 75 pp.

**72** Binns, N. A. and F. M. Eiserman. 1979. Quantification of fluvial trout habitat in Wyoming. Trans. Am. Fish. Soc. 108(3):215-28.

**73** Bjornn, T. C. 1969. Embryo survival and emergence studies. Ida. Fish and Game Dep. Completion Rep. Job No. 5. Dingell-Johnson Proj. F-49-R-7. 11 pp.

**74** Bjornn, T. C. 1971. Trout and salmon movements in two Idaho streams as related to temperature, food, streamflow, cover, and population density. Trans. Am. Fish. Soc. 100(3):423-38.

**75** Bjornn, T. C. 1977. Wild fish production and management. pp. 65-71 *in* E. Schwiebert, ed. Columbia River salmon and steelhead. Am. Fish. Soc. Spec. Publ. No. 10. 214 pp.

**76** Bjornn, T. C. 1978. Survival, production, and yield of trout and chinook salmon in the Lemhi River, Idaho. Univ. Ida., Coll. For., Wildl., and Range Sci. Bull. No. 27. 57 pp.

**77** Bjornn, T. C., R. R. Ringe, and P. Hiebert. 1978. Seaward migration of Dworshak Hatchery steelhead trout in 1976. Univ. Ida., For., Wildl., and Range Exp. Stn. Tech. Rep. No. 6. 45 pp.

**78** Black, G. A. and J. B. Dempson. 1986. A test of hypothesis of pheromone attraction in salmonid migration. Environ. Biol. Fishes 15(3):229-35.

**79** Bley, P. W. 1987. Age, growth, and mortality of juvenile Atlantic salmon in streams: a review. U.S. Fish and Wildl. Serv. Biol. Rep. 87(4). 25 pp.

**80** Bohlin, T. 1981. Methods of estimating total stock, smolt output and survival of salmonids using electrofishing. Inst. Freshwater Res. Drottningholm, Sweden. Rep. No. 59:5-14.

**81** Bonde, T. J. H. 1961. Determination of fishing success and satisfaction by means of a post card questionnaire. Minn. Dep. Nat. Resour. Invest. Rep. No. 231. 9 pp.

►This report describes the methods of operation and analysis of returns used in a successful postcard questionnaire survey to determine fishing success and satisfaction on the Whitefish Chain of Lakes in north central Minnesota.

**82** Booth, D. E. 1972. A model for optimal salmon management. Fish. Bull. 70(2):497-506.

**83** Boreman, J. 1974. Effects of stream improvement on juvenile rainbow trout in Cayuga Inlet, New York. Trans. Am. Fish. Soc. 103(3):637-41.

**84** Boreman, J. 1981. Characteristics of fall and spring migrant rainbow trout in Cayuga Inlet, New York. N.Y. Fish and Game J. 28(1):100-07.

**85** Borgeson, D. P. 1975. Anadromous trout management in the Great Lakes. pp. 12-17 *in* W. King, ed. Wild trout management. Proc. of a Symp. held at Yellowstone Natl. Park. 103 pp.

►This discussion presents an interesting review, with a balanced historical perspective, of regulations and species management for anadromous salmonids in the Great Lakes, particularly steelhead trout and Atlantic salmon. The author elaborates on his personal view that angling quality is inversely related to catch rate.

**86** Borgeson, D. P. 1978. The anatomy of wild trout fishing. pp. 61-66 *in* K. Hashagen, ed. Wild trout management. Proc. of a Natl. Symp. Calif. Trout, Inc., San Francisco. 69 pp.

**87** Borgeson, D. P. 1980. Salmonid stocking. pp. 34-38 *in* S. Gloss and B. Shupp, eds. Practical fisheries management: more with less in the 1980's. Proc. of the 1st Annu. Workshop N.Y. Chap. Am. Fish. Soc. 56 pp.

**88** Borgeson, D. P. 1981. Changing management of Great Lakes fish stocks. Can. J. Fish. and

Aquat. Sci. 38(12):1466-68.

►A brief rundown on the status of Michigan's Great Lakes management is presented from a species standpoint. Existing migratory steelhead populations in the Great Lakes have probably evolved from McCloud River strain (California) fish stocked in 1876. Borgeson observes that the migration timing of fall steelhead has changed since the introduction of Pacific salmon in the mid-1960s. Fall steelhead in many areas of the Great Lakes Basin now seem to delay entering parent streams until after the salmon run has ended (mid to late October).

**89** Bott, T. L., J. T. Brock, C. E. Cushing, S. V. Gregory, D. King, and R. C. Peterson. 1978. A comparison of methods for measuring primary productivity and community respiration in streams. Hydrobiologia 60:3-12.

**90** Bottom, D. L., P. J. Howell, and J. D. Rodgers. 1985. The effects of stream alterations on salmon and trout habitat in Oregon. Oreg. Dep. Fish and Wildl., Portland. 70 pp.

**91** Bouck, G. R. 1977. The importance of water quality to Columbia River salmon and steelhead. pp. 149-54 *in* E. Schwiebert, ed. Columbia River salmon and steelhead. Am. Fish. Soc. Spec. Publ. No. 10. 214 pp.

**92** Bouck, G. R. 1987. Improving hatchery effectiveness as related to smoltification. Proc. of a Workshop held at Warm Springs, Oreg. U.S. Dep. Energy, Bonneville Power Admin., Div. Fish and Wildl. 252 pp.

**93** Boussu, M. F. 1954. Relationship between trout populations and cover on a small stream. J. Wildl. Manage. 18:229-39.

**94** Bowlby, J. N. and J. C. Roff. 1986. Trout biomass and habitat relationships in southern Ontario streams. Trans. Am. Fish. Soc. 115(4):503-14.

**95** Boyce, R. R. 1986. A comprehensive plan for rehabilitation of anadromous fish stocks in the Umatilla River basin. U.S. Dep. Energy, Bonneville Power Adm., Div. Fish and Wildl. Final Rep. Proj. No. 84-10. 209 pp.

**96** Brannon, E. L. 1982. Orientation mechanisms of homing salmonids. pp. 219-27 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**97** Brannon, E. L., R. P. Whitman, and T. P. Quinn. 1984. Responses of returning adult coho salmon to home water and population-specific odors. Trans. Am. Fish. Soc. 113:374-77.

**98** Brasch, J. 1949. Notes on natural reproduction of the eastern brook trout (*S. fontinalis*) with a preliminary report of several experiments on the subject. Wis. Conserv. Dep., Sect. Fish. Biol. Invest. Rep. No. 653. 9 pp.

►Limited observations of brook trout spawning in northern Wisconsin spring ponds and creeks were made, including observations on spawning duration and timing, substrate requirements, behavior, and success. Limited brook trout fecundity data are presented for 2 creeks.

**99** Brasch, J. 1950. A creel census report of recent special trout seasons on certain streams of the Lake Superior south shore watershed. Wis. Conserv. Dep., Sect. Fish. Biol. Invest. Rep. No. 604. 11 pp.

►The Brule, Iron, Sioux, and Fish rivers in northern Wisconsin were open to angling during special fall seasons in 1948 and 1949. Random creel checks indicated that the Brule River supported the greatest number of anglers, but that the Brule, Sioux, and Fish rivers yielded trout at nearly equal rates. The sport catch was dominated by rainbow trout, which averaged 18 inches long.

**100** Brasch, J., J. McFadden, and S. Kmiotek. 1973. Brook trout: life history, ecology, and management. Wis. Dep. Nat. Resour. Publ. 26-3600. 15 pp.

**101** Brett, J. R. 1956. Some principles in the thermal requirements of fishes. Q. Rev. Biol. 31(2):75-87.

**102** Brett, J. R. 1965. The swimming energetics of salmon. Sci. Am. 213(2):80-85.

**103** Brett, J. R. and N. R. Glass. 1973. Metabolic rates and critical swimming speeds of sockeye salmon (*Oncorhynchus nerka*) in relation to size and temperature. J. Fish. Res. Board Can. 30(3):379-87.

►This paper is the product of 10 years of research on the metabolic rates and swimming speeds of an anadromous salmonid. Predictive graphic models are presented that depict metabolic rates and critical swimming speeds in relation to fish weight and length and water temperature.

**104** Briggs, J. C. 1953. The behavior and reproduction of salmonid fishes in a small coastal stream. Calif. Dep. Fish and Game. Fish Bull. No. 94. 62 pp.

**105** Brown, A. F. and M. Diamond. 1984. The consumption of rainbow trout (*Salmo gairdneri* Richardson) eggs by macroinvertebrates in the field. Freshwater Biol. 14:211-15.

**106** Brown, L. G. 1983. The future of trout stream management in Washington. pp. 125-33 *in* D. A. Kirkpatrick and T. Ameslav, eds. Proceedings of the wild salmon and trout conference. Seattle Univ., Seattle. 152 pp.

**107** Brown, T. L. 1976. The 1973-75 salmon runs: New York's Salmon River sport fishery, angler activity, and economic impact. N.Y. Sea Grant Inst. Rep. No. NYSSGP-RS-76-025. 25 pp.

**108** Brown, W. G., A. Singh, and E. N. Castle. 1965. Net economic value of the Oregon salmon-steelhead sport fishery. J. Wildl. Manage. 29(2):266-79.

**109** Bryant, M. D. 1983. The role and management of woody debris in west coast salmonid nursery streams. North Am. J. Fish. Manage. 3:322-30.

**110** Bryant, M. D. 1985. Changes 30 years after logging in large woody debris and its use by salmonids. U.S. For. Serv. Gen. Tech. Rep. RM-120:329-34.

**111** Bryant, M. D. and W. J. Walkotten. 1979. Carbon dioxide freeze-branding device for use on juvenile salmonids. Prog. Fish-Cult. 42(1):55-56.

**112** Brynildson, O. M. and C. L. Brynildson. 1967. The effect of pectoral and ventral fin removal on survival and growth of wild brown trout in a Wisconsin stream. Trans. Am. Fish. Soc. 96(3):353-55.

**113** Brynildson, O. M., V. A. Hacker, and T. A. Klick. 1963. Brown trout: life history, ecology, and management. Wis. Dep. Nat. Resour. Publ. No. 14-3600. 15 pp.

**114** Brynildson, O. M. and J. W. Mason. 1975. Influence of organic pollution on the density and production of trout in a Wisconsin stream. Wis. Dep. Nat. Resour. Tech. Bull. No. 81. 14 pp.

**115** Buck, R. J. G. and D. W. Hay. 1984. The relation between stock size and progeny of Atlantic salmon, *Salmo salar* L., in a Scottish stream. J. Fish Biol. 23:1-11.

**116** Bulkley, R. V. 1967. Fecundity of steelhead trout, *Salmo gairdneri*, from Alsea River, Oregon. J. Fish. Res. Board Can. 24(5):917-25.

**117** Bullock, G. L., G. Maestrone, C. Starliper, and B. Schill. 1983. Furunculosis: results of field trials for therapy with R05-0037, a potentiated sulfonamide. Prog. Fish-Cult. 45(1):51-53.

**118** Burger, C. V., K. Hepler, K. Roth, and K. Delaney. 1981. Radio tracking of adult coho salmon (*Oncorhynchus kisutch*) in the Deshka River, Alaska. pp. 151-58 *in* F. M. Long, ed. Proceedings third international conference on wildlife biotelemetry. Univ. Wyo., Laramie. 232 pp.

▶Adult coho salmon with low-frequency (40 MHz) radio transmitters inserted in their stomachs were successfully tracked via airplane. Tagged fish initially tended to remain in the area of release or move downstream for a brief period, but all fish subsequently moved upstream more than 30 km to apparent spawning areas. Average migration rates for different fish ranged from 1.9-5.9 km/day.

**119** Burger, C. V., M. Scott, M. Small, and W. Potterville. 1983. Overwintering and spawning areas of steelhead trout (*Salmo gairdneri*) in tributaries of the Upper Copper River, Alaska. Alsk. Dep. Fish and Game. Final Rep. 24 pp.

**120** Burger, C. V., R. L. Wilmot, and D. B. Wangaard. 1985. Comparison of spawning areas and times for two runs of chinook salmon (*Oncorhynchus tshawytscha*) in the Kenai River, Alaska. Can. J. Fish. and Aquat. Sci. 42:693-700.

▶Low-frequency (40 MHz) radio-tracking equipment was used to locate spawning areas of 2 runs of chinook salmon (transmitters inserted in stomachs). Fish did not move upstream for a period after tagging; however, 79% of the 188 tagged fish were more than 2 km upstream of the release site one week after tagging.

**121** Burnet, A. M. R. 1959. Some observations on natural fluctuations of trout population numbers. New Zealand J. Sci. 2:410-21.

**122** Burns, D. C. 1974. Feeding by mature steelhead (*Salmo gairdneri gairdneri*) in the spawning stream. Calif. Fish and Game 60(4):205-06.

**123** Burns, D. C. 1976. Theoretical aspects of bias associated with punchcard estimates of sports catch. U.S. Fish and Wildl. Serv. Prog. Rep. Coop. Contract No. 14-16-0001-5776-FS. 18 pp.

▶This report discusses a variety of models of angler responses to punch card systems of collecting sport fishing data. An asymtotic model is offered as a reasonable choice and is applied to punch card data supplied by the Washington Department of Fisheries.

**124** Burns, D. C. 1977. Catch-and-release fishing for steelhead in the state of Washington. pp. 161-65 *in* R. A. Barnhart and T. D. Roelofs, eds. Catch and release fishing. Proc. of a Natl. Symp. Humboldt State Univ., Arcata, Calif. 220 pp.

**125** Burns, J. W. 1971. The carrying capacity for juvenile salmonids in some northern California streams. Calif. Fish and Game 57(1):44-57.

**126** Burns, J. W. and A. Calhoun. 1966. Trout stream management. pp. 178-81 *in* A. Calhoun, ed. Inland fisheries management. Calif. Dep. Fish and Game, Sacramento. 546 pp.

**127** Burton, R. A. and T. A. Wesche. 1974. Relationship of duration of flows and selected watershed parameters to the standing crop estimates of trout populations. Univ. Wyo., Water Resour. Res. Inst. Water Resour. Ser. No. 52. 86 pp.

**128** Busack, C. 1983. Genetic variability in salmonids. pp. 53-57 *in* D. A. Kirkpatrick and T. Ameslav, eds. Proceedings of the wild salmon and trout conference. Seattle Univ., Seattle. 152 pp.

**129** Bustard, D. R. and D. W. Narver. 1975. Aspects of the winter ecology of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout

(*Salmo gairdneri*). J. Fish. Res. Board Can. 32:667-80.

**130** Bustard, D. R. and D. W. Narver. 1975. Preferences of juvenile coho salmon (*Oncorhynchus kisutch*) and cutthroat trout (*Salmo clarki*) relative to simulated alteration of winter habitat. J. Fish. Res. Board Can. 32:681-87.

▶The 2 preceding reports by Bustard and Narver describe the winter habitat requirements and behavior patterns for coho salmon, steelhead, and cutthroat trout and show the value of stable cover and pools for enhancing overwinter survival.

**131** Butler, R. L. 1975. Some thoughts on the effects of stocking hatchery trout on wild trout populations. pp. 83-87 *in* W. King, ed. Wild trout management. Proc. of a Symp. held at Yellowstone Natl. Park. 103 pp.

**132** Butler, R. L. and V. M. Hawthorne. 1968. The reactions of dominant trout to changes in overhead artificial cover. Trans. Am. Fish. Soc. 97:37-41.

**133** Calaprice, J. R. 1969. Production and genetic factors in managed salmonid populations. pp. 377-87 *in* T. G. Northcote, ed. Symposium on salmon and trout in streams. H. R. MacMillan Lect. in Fish., Univ. B.C., Vancouver. 388 pp.

**134** Callen, K. 1983. The genetic effect of stocking and population structure of brook trout (*Salvelinus fontinalis*) in the Beef River. Univ. Wis.-La Crosse. M.S. Thesis. 71 pp.

**135** Campana, S. E. 1983. Feeding periodicity and the production of daily growth increments in otoliths of steelhead trout (*Salmo gairdneri*) and starry flounder (*Platichthys stellatus*). Can. J. Zool. 61(7):1591-97.

**136** Campbell, K. P. 1973. Competition between brown trout and white suckers. Pa. State Univ., University Park. Ph.D. Thesis. 77 pp.

**137** Campton, D. E. and J. M. Johnston. 1985. Electrophoretic evidence for a genetic admixture of native and nonnative rainbow trout in the Yakima River, Washington. Trans. Am. Fish. Soc. 114:782-93.

**138** Carl, L. M. 1977. Attitudes and behavior of anglers fishing for salmon on Michigan streams. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1848. 49 pp.

**139** Carl, L. M. 1982. Natural reproduction of coho salmon and chinook salmon in some Michigan streams. North Am. J. Fish. Manage. 4:375-80.

▶This survey of 60 streams in lower Michigan revealed that most chinook salmon reproduction occurred in large, fast trout streams having coarse gravels. Coho salmon reproduced in a wider array of streams, using both large trout waters and small tributaries. A positive correlation existed between stream velocity and chinook salmon reproduction, with fry abundance increasing with increasing water velocity and no reproduction occurring where velocities were below 0.3 m/sec.

**140** Carl, L. M. 1983. Density, growth, and change in density of coho salmon and rainbow trout in three Lake Michigan tributaries. Can. J. Zool. 61:1120-27.

▶Changes in density (movement and mortality could not be accurately separated) of coho salmon were dramatic and dependent on initial coho density. Growth rates of coho salmon and rainbow trout were not dependent on initial density. Emergence times and timing of downstream migrations were documented for both species.

**141** Carlander, K. D., C. J. DiCostanzo, and R. J. Jessen. 1958. Sampling problems in creel census. Prog. Fish-Cult. 20(2):73-81.

**142** Carline, R. F. 1972. Biased harvest estimates from a postal survey of a sport fishery. Trans. Am. Fish. Soc. 101(2):262-66.

**143** Carline, R. F. 1975. Influence of recruitment rates on production by three populations of wild brook trout (*Salvelinus fontinalis* Mitchill). Univ. Wis.-Madison. Ph.D. Thesis. 128 pp.

**144** Carline, R. F. 1980. Features of successful spawning site development for brook trout in Wisconsin spring ponds. Trans. Am. Fish. Soc. 109:453-57.

▶A new method for developing spawning areas for brook trout in small spring-fed ponds is described. Spawning-site development contributed to increased recruitment of juvenile brook trout in 2 of 3 study ponds in northeastern Wisconsin.

**145** Carline, R. F. and O. M. Brynildson. 1972. Effects of the Floy anchor tag on the growth and survival of brook trout (*Salvelinus fontinalis*). J. Fish. Res. Board Can. 29:458-60.

**146** Carline, R. F. and O. M. Brynildson. 1977. Effects of hydraulic dredging on the ecology of native trout populations in Wisconsin spring ponds. Wis. Dep. Nat. Resour. Tech. Bull. No. 98. 40 pp.

▶Thorough assessment was made of the physical, chemical, and biological aspects of 2 Wisconsin spring ponds before and after hydraulic dredging. Densities of benthic organisms were severely reduced by dredging. Trout biomass showed marked increase in one pond following dredging but showed little change in the other. Fishing pressure and catch increased dramatically in both ponds.

**147** Carline, R. F., O. M. Brynildson, and M. O. Johnson. 1976. Growth and survival of trout stocked in a northern Wisconsin spring pond. Wis. Dep. Nat. Resour. Res. Rep. No. 85. 21 pp.

**148** Carpenter, M. R., J. M. Deinstadt, and D. R. Bowlus. 1977. Attitudes of trout stream anglers

and their relation to trout stream management. pp. 19-25 *in* R. A. Barnhart and T. D. Roelofs, eds. Catch and release fishing. Proc. of a Natl. Symp. Humboldt State Univ., Arcata, Calif. 220 pp.

**149** Carrick, T. R. 1979. The effect of acid water on the hatching of salmonid eggs. J. Fish Biol. 14:165-72.

**150** Cauvin, D. M. 1980. The valuation of recreational fisheries. Can. J. Fish. and Aquat. Sci. 37:1321-27.

**151** Cederholm, C. J. 1983. Habitat requirements and life history of wild salmon and trout. pp. 88-96 *in* D. A. Kirkpatrick and T. Ameslav, eds. Proceedings of the wild salmon and trout conference. Seattle Univ., Seattle. 152 pp.

**152** Cederholm, C. J., G. Grette, and T. Terich. 1984. The importance of organic debris in salmonid habitat within the stream and marine continuum. Pap. presented at policies and appl. conf. Pac. Northwest Bioenergy Syst. 10 May 1984, Portland, Oreg. 16 pp.

**153** Cederholm, C. J. and W. J. Scarlett. 1982. Seasonal immigrations of juvenile salmonids into four small tributaries of the Clearwater River, Washington, 1977-1981. pp. 98-110 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**154** Chadwick, E. M. P. 1987. Causes of variable recruitment in a small Atlantic salmon stock. Am. Fish. Soc. Symp. 1:390-401.

**155** Chadwick, E. M. P. and R. G. Randall. 1986. A stock-recruitment relationship for Atlantic salmon in the Miramichi River, New Brunswick. North Am. J. Fish. Manage. 6:200-03.

**156** Chamberlain, T. K. 1942. Research in stream management in the Pisgah National Forest. Trans. Am. Fish. Soc. 72:1-27.
▶This classic study on trout steam management is still regarded as one of the most valuable contributions to the field.

**157** Chapman, D. W. 1958. Studies on the life history of Alsea River steelhead. J. Wildl. Manage. 22(2):123-34.

**158** Chapman, D. W. 1962. Aggressive behavior in juvenile coho salmon as a cause of emigration. J. Fish. Res. Board Can. 19(6):1047-80.

**159** Chapman, D. W. 1965. Net production of juvenile coho salmon in three Oregon streams. Trans. Am. Fish. Soc. 94:40-52.

**160** Chapman, D. W. 1966. Food and space as regulators of salmonid populations in streams. Am. Midl. Nat. 100:345-57.

**161** Chapman, D. W. 1966. The relative contributions of aquatic and terrestrial primary producers to the trophic relations of stream organisms. pp. 116-30 *in* K. W. Cummins, C. A. Tryon, and R. T. Hartman, eds. Organism-substrate relationships in streams. Univ. Pittsburgh, Pymatuning Lab. Ecol. Spec. Publ. No. 4. 145 pp.

**162** Chapman, D. W. and T. C. Bjornn. 1969. Distribution of salmonids in streams, with special reference to food and feeding. pp. 153-76 *in* T. G. Northcote, ed. Symposium on salmon and trout in streams. H. R. MacMillan Lect. in Fish. Univ. B.C., Vancouver. 388 pp.

**163** Chapman, D. W., D. E. Weitkamp, T. L. Welsh, M. B. Dell, and T. H. Schadt. 1986. Effects of river flow on the distribution of chinook salmon redds. Trans. Am. Fish. Soc. 115:537-47.

**164** Chaston, I. 1969. Seasonal activity and feeding pattern of brown trout (*Salmo trutta*) in a Dartmoor stream in relation to availability of food. J. Fish. Res. Board Can. 26:2165-71.

**165** Chilcote, M. W. 1983. The reproductive fitness of hatchery and wild steelhead. pp. 80-87 *in* D. A. Kirkpatrick and T. Ameslav, eds. Proceedings of the wild salmon and trout conference. Seattle Univ., Seattle. 152 pp.

**166** Chilcote, M. W., B. A. Crawford, and S. A. Leider. 1980. A genetic comparison of sympatric populations of summer and winter steelheads. Trans. Am. Fish. Soc. 109(2):203-06.
▶Findings from this study, in conjunction with field observations of known summer-winter steelhead spawning pairs, suggest that summer and winter steelheads in the Kalama River are not at present reproductively isolated. The authors suggest that the separate-stocks status typically given to summer and winter steelheads may need re-evaluation.

**167** Chilton D. E. and H. T. Bilton. 1986. New method for ageing chinook salmon (*Oncorhynchus tshawytscha*) using dorsal fin rays, and evidence of its validity. Can. J. Fish. and Aquat. Sci. 43:1588-94.

**168** Chisholm, I. M. and W. A. Hubert. 1985. Expulsion of dummy transmitters by rainbow trout. Trans. Am. Fish. Soc. 114:766-67.

**169** Chisholm, I. M., W. A. Hubert, and T. A. Wesche. 1987. Winter stream conditions and use of habitat by brook trout in high-elevation Wyoming streams. Trans. Am. Fish. Soc. 116:176-84.

**170** Chrisp, E. Y. and T. C. Bjornn. 1978. Parr-smolt transformation and seaward migration of wild and hatchery steelhead trout in Idaho. Ida. Dep. Fish and Game. Final Rep. Dingell-Johnson Proj. F-49-R-12. 118 pp.

**171** Churchill, W. S. 1945. The brook lamprey in the Brule River. Trans. Wis. Acad. Sci., Arts and

Lett. 37:337-46.

▶Prior to the time of TFM lampricide treatments in the Brule River to control sea lamprey ammocoetes, the northern brook lamprey was abundant throughout the lower part of the river. This report describes the general life history, distribution, and some population characteristics of this fish. This paper is one of 11 technical papers issued under one cover from an extensive interdisciplinary study conducted on the Brule River in the early 1940s (see Wis. Cons. Dep. 1954).

**172** Churikov, A. A. 1975. Features of the downstream migration of young salmon of the genus *Oncorhynchus* from the rivers of the northeast coast of Sakhalin. J. Ichthyol. 15(6):963-70.

**173** Cipriano, R. C. and S. W. Pyle. 1985. Adjuvant-dependent immunity and the agglutinin response of fishes against *Aeromonas salmonicida*, cause of furunculosis. Can. J. Fish. and Aquat. Sci. 42:1290-95.

**174** Cipriano, R. C. and C. E. Starliper. 1982. Immersion and injection vaccination of salmonids against furunculosis with an avirulent strain of *Aeromonas salmonicida*. Prog. Fish-Cult. 44(4):167-69.

**175** Claggett, L. E. and T. R. Dehring. 1984. Wisconsin salmonid strain catalog. Wis. Dep. Nat. Resour., Bur. Fish Manage. Adm. Rep. No. 19. 31 pp.

**176** Claggett, L. E., D. Ives, and K. Rollins. 1981. Age-growth data for Wisconsin stream trout. Wis. Dep. Nat. Resour., Bur. Fish Manage. 8 pp. (unpubl. rep.).

**177** Clark, J. and B. A. McCarl. 1983. An investigation of the relationship between Oregon coho salmon (*Oncorhynchus kisutch*) hatchery releases and adult production utilizing law of the minimum regression. Can. J. Fish. and Aquat. Sci. 40:516-23.

**178** Clark, R. D. 1981. Analysis of "quality fishing" regulations through mathematical simulation of a brown trout fishery. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1895. 33 pp.

**179** Clark, R. D. 1983. Potential effects of voluntary catch and release of fish on recreational fisheries. North Am. J. Fish. Manage. 3:306-14.

**180** Clark, R. D. 1984. The effects of fishing regulations on annual fluctuations in abundance and harvest. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1917. 37 pp.

▶A mathematical model was used to simulate fluctuating year-class strength in a brown trout fishery in order to estimate how the annual variability in population size and harvest would be affected by exploitation under different minimum size limits and fishing mortality rates. For fisheries with fluctuating year-class strength, variability in annual catch appeared to be minimized by maintaining the lowest practical size limit and managing the fishery by controlling fishing effort.

**181** Clark, R. D. and G. R. Alexander. 1984. Effects of a slotted size limit on the brown trout fishery of the Au Sable River, Michigan. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1927. 32 pp.

▶Changing a fishing regulation from a 12-inch minimum to a slotted limit allowing harvest of trout between 8 and 12 inches and over 16 inches resulted in decreased abundance of brown trout of all sizes but did not affect growth rates. Total harvest of brown trout increased nearly 5 times but consisted of smaller fish. The greatest effect of the slotted limit regulation was in reshaping angler use of the trout population. Biological effects were relatively unimportant.

**182** Clark, R. D. and G. R. Alexander. 1985. Effects of a slotted size limit on a multispecies trout fishery. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1926. 33 pp.

**183** Clark, R. D., G. R. Alexander, and H. Gowing. 1980. Mathematical description of trout stream fisheries. Trans. Am. Fish. Soc. 109(6):587-602.

**184** Clark, R. D., G. R. Alexander, and H. Gowing. 1981. A history and evaluation of regulations for brook trout and brown trout in Michigan streams. North Am. J. Fish. Manage. 1(1):1-14.

▶Mathematical modelling was used to predict brook and brown trout population responses to various minimum size limits and a no-kill regulation. Maximum harvest (both numbers and weight) was obtained at the lowest size limit tested (152 mm) for both species. Total yield (weight of trout caught and harvested plus weight of trout caught and released) increased as size limit increased and was maximum with a no-kill regulation.

**185** Clark, R. D. and R. T. Lackey. 1976. A technique for improving decision analysis in fisheries and wildlife management. Va. J. Sci. 27:199-201.

**186** Clay, C. H. 1961. Design of fishways and other fish facilities. Dep. Fish. Can., Ottawa. 301 pp.

**187** Cleaver, F. 1977. Role of hatcheries in the management of Columbia River salmon. pp. 89-92 *in* E. Schwiebert, ed. Columbia River salmon and steelhead. Am. Fish. Soc. Spec. Publ. No. 10. 214 pp.

**188** Close, T. L., S. E. Colvin, and R. L. Hassinger. 1984. Chinook salmon in the Minnesota sport fishery of Lake Superior. Minn. Dep. Nat. Resour., Div. Fish and Wildl. Invest. Rep. No. 380. 31 pp.

▶The Minnesota Department of Natural Resources stocked spring-strain chinook salmon into Minnesota waters of Lake Superior during 1974-78 and has stocked fall-strain fish since 1979. Annual harvest has ranged from 50-1,306 fish with an average length of 546 mm for

spring strain and 617 mm for fall strain. Spawners of both strains were predominantly age III+; however, natural reproduction was minimal. Straying to unstocked streams was also judged to be minimal.

**189** Close, T. L. and R. L. Hassinger. 1981. Evaluation of Madison, Donaldson and Kamloops strains of rainbow trout (*Salmo gairdneri*) in Lake Superior. Minn. Dep. Nat. Resour., Div. Fish and Wildl. Invest. Rep. No. 372. 17 pp.

**190** Close, T. L. and G. D. Siesennop. 1984. Angler census of the north shore spring stream fishery, 1981-1982. Minn. Dep. Nat. Resour. Fish Manage. Rep. No. 26. 21 pp.

**191** Coble, D. W. 1961. Influence of water exchange and dissolved oxygen in redds on survival of steelhead trout embryos. Trans. Am. Fish. Soc. 90(4):469-74.

**192** Colvin, S. E., T. L. Close, and R. L. Hassinger. 1985. Growth and fecundity of chinook salmon in western Lake Superior. Minn. Dep. Nat. Resour., Div. Fish and Wildl. Invest. Rep. No. 382. 7 pp.
►Spring- and fall-strain chinook fecundity averaged approximately 4,000 eggs/female. Growth rates of both strains were similar and were lower than growth rates of West Coast and Lake Michigan chinook but comparable to growth rates of chinook in eastern Lake Superior.

**193** Conlin, K. and B. D. Tutty. 1979. Juvenile salmonid field trapping manual. Can. Fish. and Mar. Serv. Manuscr. Rep. No. 1530. 136 pp.

**194** Cooper, C. O. and T. A. Wesche. 1976. Stream channel modification to enhance trout habitat under low flow conditions. Univ. Wyo., Water Resour. Res. Inst. Water Resour. Ser. No. 58. 107 pp.

**195** Cooper, E. L. 1952. Trout stocking as an aid to fish management. Pa. State Univ., Coll. Agric. Bull. 663:1-21.

**196** Cooper, E. L. 1953. Mortality rates of brook trout and brown trout in the Pigeon River, Otsego County, Michigan. Prog. Fish-Cult. 15:163-69.

**197** Cooper, E. L. 1970. Management of trout streams. pp. 153-62 *in* N. G. Benson, ed. A century of fisheries in North America. Am. Fish. Soc. Spec. Publ. No. 7. 330 pp.

**198** Cooper, E. L. 1974. Trout in streams. pp. 4-11 *in* A. R. Grove, Jr., ed. Salmonid management. Suppl. to Trout 15(1).

**199** Cooper, E. L. and R. C. Scherer. 1967. Annual production of brook trout (*Salvelinus fontinalis*) in fertile and infertile streams of Pennsylvania. Proc. Pa. Acad. Sci. 41:65-70.

**200** Copes, P. and J. L. Knetsch. 1981. Recreational fisheries analysis: management modes and benefit implications. Can. J. Fish. and Aquat. Sci. 38:559-70.

**201** Cordes, R. A. 1977. The fly fisherman's view of catch-and-release fishing. pp. 11-17 *in* R. A. Barnhart and T. D. Roelofs, eds. Catch and release fishing. Proc. of a Natl. Symp. Humboldt State Univ., Arcata, Calif. 220 pp.

**202** Cousens, N. B. F., G. A. Thomas, C. G. Swann, and M. C. Healey. 1982. A review of salmon escapement estimation techniques. Can. Tech. Rep. Fish. and Aquat. Sci. No. 1108. 122 pp.
►This report is subdivided according to techniques that have been used to estimate spawning salmon populations in the Pacific Northwest. Topics include discussions of methodology, locations of use, outlines of effective use and related problems, and summaries of available data on accuracy and precision.

**203** Couturier, C. Y., L. Clarke, and A. M. Sutterlin. 1986. Identification of spawning areas of two forms of Atlantic salmon (*Salmo salar* L.) inhabiting the same watershed. Fish. Res. 4:131-44.

**204** Crawford, B. A. 1983. Management of mixed stock salmonid fisheries in Washington: a continuing dilemma. pp. 118-22 *in* D. A. Kirkpatrick and T. Ameslav, eds. Proceedings of the wild salmon and trout conference. Seattle Univ., Seattle. 152 pp.

**205** Cresswell, R. C. 1986. Post-stocking movements and recapture of hatchery-reared trout released into flowing waters: a review. J. Fish Biol. 18:429-42.

**206** Crone, R. A. and C. E. Bond. 1976. Life history of coho salmon, *Oncorhynchus kisutch*, in Sashin Creek, south-eastern Alaska. Fish. Bull. 74:897-923.

**207** Crutchfield, J. A., S. Langdon, O. A. Mathisen, and P. H. Poe. 1982. The biological, economic, and social values of a sockeye salmon stream in Bristol Bay, Alaska. Univ. Wash., Fish. Res. Inst. Cir. No. 82-2. 39 pp.

**208** Cuinat, R. 1971. Ecology and repopulation of trout streams. Bulletin Francais de Pisciculture 242:5-32.

**209** Cummins, K. W., W. P. Coffman, and P. A. Roff. 1966. Trophic relationships in a small woodland stream. Verhandlungen Internationale Vereinigung fur theoretische und angewandte Limnologie 16:627-38.

**210** Cummins, K. W., W. G. Minshall, J. R. Sedell, C. E. Cushing, and R. C. Petersen. 1984. Stream ecosystem theory. Verhandlungen Internationale Vereinigung fur theoretische und angewandte Limnologie 22:1818-27.

**211** Cunjak, R. A., R. A. Curry, and G. Power. 1987. Seasonal energy budget of brook trout in streams: implications of a possible deficit in early winter. Trans. Am. Fish. Soc. 116:817-28.

**212** Cunjak, R. A. and J. M. Green. 1983. Habitat utilization by brook char (*Salvelinus fontinalis*) and rainbow trout (*Salmo gairdneri*) in Newfoundland streams. Can. J. Zool. 61(6):1214-19.

►Brook trout occupied positions with significantly lower water velocities and more cover than similarly sized rainbow trout in a Newfoundland stream where the 2 species coexisted. Brook trout showed similar microhabitat preferences in a nearby stream where they were allopatric; therefore the extent of species segregation appeared to be primarily influenced by local stream morphology.

**213** Cunjak, R. A. and J. M. Green. 1984. Species dominance by brook trout and rainbow trout in a simulated stream environment. Trans. Am. Fish. Soc. 113:737-43.

**214** Cunjak, R. A. and G. Power. 1986. Winter habitat utilization by stream resident brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*). Can. J. Fish. and Aquat. Sci. 43:1970-81.

**215** Cunjak, R. A. and G. Power. 1987. Cover use by stream-resident trout in winter: a field experiment. North Am. J. Fish. Manage. 7:539-44.

**216** Currens, K. P., C. B. Schreck, and H. W. Li. 1988. Reexamination of the use of otolith nuclear dimensions to identify juvenile anadromous and nonanadromous rainbow trout, *Salmo gairdneri*. Fish. Bull. 86:160-63.

**217** Cushing, D. H. 1968. Fisheries biology: a study in population dynamics. Univ. Wis. Press, Madison. 200 pp.

**218** Cushing, D. H. 1971. The dependence of recruitment on parent stock in different groups of fishes. Journal du Counseil International pour L'Exploration de la Mer 33(3):340-62.

**219** Cushing, D. H. and J. G. K. Harris. 1973. Stock and recruitment and the problem of density dependence. Rapports et Proces-Verbaux des Reunions Conseil Permanent International pour L'Exploration de la Mer 164:142-55.

**220** Dahl, F. H. and R. B. McDonald. 1980. Effects of control of the sea lamprey (*Petromyzon marinus*) on migratory and resident fish populations. Can. J. Fish. and Aquat. Sci. 37:1886-94.

►Fishkills have been, and will continue to be, unavoidable consequences of the sea lamprey control program. However, no large-scale detrimental effects have been demonstrated for migratory fish species. The only reliable instance of damage to a resident stream species has been the near loss of the stonecat (*Noturus flavus*) from tributaries to the southwest corner of Lake Superior.

**221** Dauble, D. D. and R. H. Gray. 1980. Comparison of a small seine and a backpack electroshocker to evaluate nearshore fish populations in rivers. Prog. Fish-Cult. 42(2):93-95.

**222** Davis, H. S. 1956. Culture and diseases of game fishes. Univ. Calif. Press, Berkeley. 332 pp.

**223** Davis, J. C. 1975. Minimal dissolved oxygen requirements of aquatic life with emphasis on Canadian species. J. Fish. Res. Board Can. 32:2295-332.

**224** Davis, R. A. 1985. The role of research in Minnesota fisheries management. Minn. Dep. Nat. Resour., Div. Fish and Wildl. Invest. Rep. No. 383. 15 pp.

**225** Davis, S. K., J. L. Congleton, and R. W. Tyler. 1980. Modified fyke net for the capture and retention of salmon smolts in large rivers. Prog. Fish-Cult. 42(4):235-37.

**226** Dawson, C. P. 1980. Evaluating angler demands and preferences. pp. 20-22 *in* S. Gloss and B. Shupp, eds. Practical fisheries management: more with less in the 1980's. Proc. of the 1st Annu. Workshop N.Y. Chap. Am. Fish. Soc. 56 pp.

**227** Decisional Business Analysts, Inc. 1981. Improving salmon-steelhead catch estimates: an analysis of alternatives. Decisional Business Analysts, Inc., Newburg, Oreg. 34 pp.

**228** Deinstadt, J. M. 1978. Management of California's designated wild trout streams. pp. 3-6 *in* K. Hashagen, ed. Wild trout management. Proc. Natl. Symp. Calif. Trout, Inc., San Francisco. 69 pp.

**229** Dermott, R. M. and H. J. Spence. 1984. Changes in populations and drift of stream invertebrates following lampricide treatment. Can. J. Fish. and Aquat. Sci. 41:1695-701.

►Increased drift rates rather than mortality appeared to be the major impact of TFM lampricide treatments on invertebrate communities in 3 Great Lakes tributaries. In 2 soft-water streams, philopotamid caddisflies and lumbriculid worms were significantly reduced. In a hard-water stream, TFM treatment resulted in a dramatic mortality of leeches. Abundance of oligochaetes and Turbellaria was also significantly reduced.

**230** DeVore, P. W., L. T. Brooke, and W. A. Swenson. 1978. The effects of red clay turbidity and sedimentation on aquatic life in the Nemadji River system. Univ. Wis.-Superior, Cent. Lake Superior Environ. Stud. Publ. No. 53. 134 pp.

►This study documents the impact of red clay turbidity on the aquatic community of the Nemadji River system (tributary to western Lake Superior). Major differences in community structure were identified between clear and turbid waters; however, in most cases it was

not proven that turbidity alone caused the differences. Many commonly held postulates concerning red clay turbidity (e.g., replacement of desirable fish species by less desirable ones, discouragement of spawning runs, decreased oxygen levels, increased nutrient levels) were shown not to be true. However, salmonid reproduction was adversely impacted by relatively low levels of red clay sedimentation.

**231** DeVore, P. W. and J. G. Eaton. 1983. An investigation of spinal deformity of trout (*Salmo* sp.) in the Brule River, Wisconsin. J. Great Lakes Res. 9(1):69-73.

►Convincing evidence is presented to support the hypothesis that the electric lamprey control weir operated on the Brule River, Douglas County, caused a high incidence of spinal deformities to out-migrating juvenile anadromous fish.

**232** DeVore, P. W. and R. J. White. 1978. Daytime responses of brown trout (*Salmo trutta*) to cover stimuli in stream channels. Trans. Am. Fish. Soc. 107:763-71.

**233** Dickas, A. B., ed. 1973. Wisconsin's Lake Superior basin water quality study. Univ. Wis.-Superior, Cent. Lake Superior Environ. Stud. Publ. No. 21. 116 pp.

►This report, along with its supplement (Whisnant 1974), presents 2 years of selected water quality data collected from the Brule River and 7 other river drainages along the Wisconsin shore of Lake Superior.

**234** Dickas, A. B. and P. C. Tychsen. 1969. Sediments and geology of the Bois Brule River, western Lake Superior. pp. 161-69 *in* Proceedings 12th conference on Great Lakes research. Int. Assoc. Great Lakes Res. 923 pp.

►This report presents the results of a sedimentary analysis of the bed load of the Brule River, Douglas County, Wisconsin. The mean size distribution of the clastic load, based on the phi scale, was 10% granules, 74% sand, 13% silt, and 3% clay.

**235** Dill L. M., R. C. Ydenberg, and A. H. G. Fraser. 1981. Food abundance and territory size in juvenile coho salmon (*Oncorhynchus kisutch*). Can. J. Zool. 59:1801-09.

**236** Dodge, D. P. 1967. Some biology and vital statistics of rainbow trout (*Salmo gairdneri* Richardson) of Bothwells Creek, Lake Huron. Univ. Guelph, Guelph, Ont. M.S. Thesis. 126 pp.

**237** Dodge, D. P. 1972. Comparative bio-ecology of rainbow trout (*Salmo gairdneri*, Richardson), of three tributaries to the Owen Sound, Lake Huron. Univ. Guelph, Guelph, Ont. Ph.D. Thesis. 111 pp.

**238** Dodge, D. P. and H. R. MacCrimmon. 1970. Vital statistics of a population of Great Lakes rainbow trout (*Salmo gairdneri*) characterized by an extended spawning season. J. Fish. Res. Board Can. 27:613-18.

►The timing and magnitude of spring and fall steelhead runs into Bothwell's Creek, Lake Huron, were examined for one year. Differences in fish size and age class structure occurred between the spring and fall runs.

**239** Dodge, D. P. and H. R. MacCrimmon. 1971. Environmental influences on extended spawning of rainbow trout (*Salmo gairdneri*). Trans. Am. Fish. Soc. 100(2):312-18.

►This report relates migration timing and spawning activity of Lake Huron steelhead to environmental factors. Variations in stream discharge and water temperature influenced spawning movements, while actual spawning was linked to rising water temperatures alone.

**240** Dolloff, C. A. 1986. Effects of stream cleaning or juvenile coho salmon and Dolly Varden in southeast Alaska. Trans. Am. Fish. Soc. 115:743-55.

**241** Dolloff, C. A. 1987. Seasonal population characteristics and habitat use by juvenile coho salmon in a small southeast Alaska stream. Trans. Am. Fish. Soc. 116:829-38.

**242** Donaldson, L. R. 1971. Development of select strains of salmonid fishes for use in management. Int. Atl. Salmon Found. Spec. Publ. Ser. 2(1):19-31.

**243** Donaldson, L. R. and T. Joyner. 1983. The salmonid fishes as a natural livestock. Sci. Am. 249(1):50-58.

**244** Dotson, T. 1982. Mortalities in trout caused by gear type and angler-induced stress. North Am. J. Fish. Manage. 2:60-65.

**245** Driver, B. L. and R. W. Cooksey. 1977. Preferred psychological outcomes of recreational fishing. pp. 27-40 *in* R. A. Barnhart and T. D. Roelofs, eds. Catch and release fishing. Proc. of a Natl. Symp. Humboldt State Univ., Arcata, Calif. 220 pp.

**246** Duke, R. 1986. Protection of wild adult steelhead in Idaho by adipose fin removal. U.S. Dep. Energy, Bonneville Power Adm., Div. Fish and Wildl. Annu. Rep. Proj. No. 84-2. 38 pp.

**247** Dwyer, W. P., F. L. Mayer, J. L. Allen, and D. R. Buckler. 1978. Chronic and simulated use-pattern exposures of brook trout (*Salvelinus fontinalis*) to 3-trifluoromethyl-4-nitrophenol (TFM). U.S. Fish and Wildl. Serv. Invest. Fish Control No. 84. 6 pp.

**248** Eames, M. J. and M. K. Hino. 1983. An evaluation of four tags suitable for marking juvenile chinook salmon. Trans. Am. Fish. Soc. 112:464-68.

**249** Ebel, W. J. 1974. Marking fishes and invertebrates. 3: Coded wire tags useful in auto-

matic recovery of chinook salmon and steelhead trout. Mar. Fish. Rev. 36(7):10-13.

**250** Ebel, W. J. 1980. Transportation of chinook salmon, *Oncorhynchus tshawytscha*, and steelhead, *Salmo gairdneri*, smolts in the Columbia River and effects on adult returns. Fish. Bull. 78(2):491-505.

**251** Edmundson, E., F. E. Everest, and D. W. Chapman. 1968. Permanence of station in juvenile chinook salmon and steelhead trout. J. Fish. Res. Board Can. 25(7):1453-64.

**252** Egglishaw, H. J. 1967. The food, growth, and population structure of salmon and trout in two streams in the Scottish Highlands. Dep. Agric. and Fish. Scotland. Freshwater and Salmon Fish. Res. Rep. 38. 32 pp.

**253** Ehlers, R. 1955. An evaluation of stream improvement devices constructed eighteen years ago. Calif. Fish and Game 42:203-17.

**254** Ehlinger, N. F. 1964. Selective breeding of trout for resistance to furunculosis. N.Y. Fish and Game J. 11(2):78-90.

►Strains of brook and brown trout were intensively exposed to *Aeromonas salmonicida*, the etiological agent of furunculosis disease, and survivors were retained as brood fish for the next generation, which was similarly exposed to disease. Results indicated that resistance to furunculosis can be achieved through this repetitive process.

**255** Eilers, J. M. 1980. Use of Hilsenhoff's biotic index as a measure of water quality in Wisconsin streams. Wis. Dep. Nat. Resour. Biol. Monit. Comm. Rep. 20 pp.

**256** Eilers, J. M., G. J. Lien, and R. G. Berg. 1984. Aquatic organisms in acidic environments: a literature review. Wis. Dep. Nat. Resour. Tech. Bull. No. 150. 18 pp.

►This literature review examines the distribution of aquatic organisms with respect to pH. Tolerance limits are defined for various species in acidified waters, and the impact of acidification on distributions is predicted.

**257** Elliott, J. M. 1966. Downstream movements of trout fry (*Salmo trutta*) in a Dartmoor stream. J. Fish. Res. Board Can. 23(1):157-59.

**258** Elliott, J. M. 1973. The food of brown and rainbow trout (*Salmo trutta* and *S. gairdneri*) in relation to the abundance of drifting invertebrates in a mountain stream. Oecologia (Berlin) 12:329-47.

**259** Elliott, J. M. 1984. Growth, size, biomass, and production of young migratory trout *Salmo trutta* in a Lake District stream, 1966-1983. J. Anim. Ecol. 53:979-94.

**260** Elliott, J. M. 1985. Population regulation for different life-stages of migratory trout *Salmo trutta* in a Lake District stream, 1966-83. J. Anim. Ecol. 54:617-38.

►This report describes the results of a 17-year fishery investigation of a lake-run brown trout population and addresses numerous questions about early life survival and density relationships. The "key factor" regulating populations was spring losses soon after the young trout started to feed. The problem of separating losses due to mortality from those due to migration is discussed but not completely resolved.

**261** Elliott, J. M. 1987. The distances travelled by downstream-moving trout fry, *Salmo trutta*, in a Lake District stream. Freshwater Biol. 17:491-99.

**262** Elliott, J. M., U. H. Humpesch, and M. A. Hurley. 1987. A comparative study of eight mathematical models for the relationship between water temperature and hatching time of eggs of freshwater fish. Arch. Hydro-biol. 109(2):257-77.

**263** Elson, P. F. 1975. Atlantic salmon rivers, smolt production and optimal spawning: an overview of natural production. Int. Atl. Salmon Found. Spec. Publ. Ser. No. 6:96-119.

**264** Elwood, J. W. and T. F. Waters. 1969. Effects of floods on food consumption and production rates of a stream brook trout population. Trans. Am. Fish. Soc. 98(2):253-62.

**265** Emery, L. 1985. A new look at marking fish with paper fasteners, jaw tags, and cold brands. Prog. Fish-Cult. 47(4):254-56.

**266** Emery, L. and R. Wydoski. 1987. Marking and tagging of aquatic animals: an indexed bibliography. U.S. Fish and Wildl. Serv. Resour. Publ. 165. 57 pp.

►This bibliography contains 1,436 references and a key word index. Emphasis is given to information on the different kinds of marks and tags available, techniques of application, retention and recovery, and effects on the organism.

**267** Engstrom-Heg, R. 1981. A philosophy of trout stream management in New York. Fisheries 6(3):11-16.

**268** Engstrom-Heg, R. 1986. Prediction of wild brown trout catch from estimated yearling population density and fishing intensity. North Am. J. Fish. Manage. 6:410-17.

**269** Enk, M. D. 1977. Instream overhead bank cover and trout abundance in two Michigan streams. Mich. State Univ., East Lansing. M.S. Thesis. 127 pp.

**270** Ensign, A. R. 1957. Foods eaten by brown trout (*Salmo trutta*) in two southern Wisconsin trout streams, Mount Vernon and Black Earth creeks, Dane County, Wisconsin. Wis. Conserv. Dep., Fish Manage. Div. South. Area Invest. Memo. No. 181. 2 pp.

**271** Erman, D. C. 1986. Long-term structure of fish populations in Sagehen Creek, California. Trans. Am. Fish. Soc. 115:682-92.

**272** Estes, R. D., ed. 1983. Bibliography of the eastern brook trout *Salvelinus fontinalis* (Mitchill). Trout Comm., South. Div., Am. Fish. Soc., Cookeville, Tenn. 33 pp.

▶This bibliography contains over 800 references on brook trout anatomy, physiology, ecology, and management.

**273** Evans, R. 1945. Bottom deposits of the Brule River. Trans. Wis. Acad. Sci., Arts and Lett. 37:325-35.

▶This technical paper represents the most complete description available on the nature and origin of bottom deposit material in the upper Brule River (Brule Bog). This paper is one of 11 technical papers subsequently issued under one cover (see Wis. Cons. Dep. 1954) from an extensive interdisciplinary study conducted on the Brule River in the early 1940s.

**274** Evenson, M. D. and R. D. Ewing. 1985. Long-term retention of fluorescent pigment marks by spring chinook salmon and summer steelhead. North Am. J. Fish. Manage. 5:26-32.

▶Approximately 60% of hatchery-released juvenile spring-run chinook salmon and steelhead marked with fluorescent polystyrene pigment were identifiable as returning adults after 54-56 months.

**275** Everest, F. H. 1973. Ecology and management of summer steelhead in the Rogue River. Oreg. State Game Comm. Fish. Res. Rep. No. 7. 48 pp.

▶This report explains how an effective management program for wild steelhead in the Rogue River, southwestern Oregon, was enhanced by a conservative stocking program using hatchery-reared summer steelhead smolts.

**276** Everest, F. H. and D. W. Chapman. 1972. Habitat selection and spatial interaction by juvenile chinook salmon and steelhead trout in two Idaho streams. J. Fish. Res. Board Can. 29:91-100.

**277** Everest, F. H. and E. H. Edmundson. 1967. Cold branding for field use in marking juvenile salmonids. Prog. Fish-Cult. 29:172-74.

**278** Everest, F. H., G. H. Reeves, J. R. Sedell, D. B. Hohler, and T. Cain. 1987. The effects of habitat enhancement on steelhead trout and coho salmon smolt production, habitat utilization, and habitat availability in Fish Creek, Oregon, 1983-86. U.S. Dep. Energy, Bonneville Power Adm., Div. Fish and Wildl. Annu. Rep. Proj. No. 84-11. 128 pp.

**279** Ewing, R. D., M. D. Evenson, and E. K. Birks. 1982. Infrared fish counter for measuring migration of juvenile salmonids. Prog. Fish-Cult. 45(1):53-55.

**280** Facchin, A. and P. A. Slaney. 1977. Management implications of substrate utilization during summer by juvenile steelhead trout (*Salmo gairdneri*) in the South Alouette River. B.C. Fish and Wildl. Branch. Fish. Tech. Rep. No. 32. 19 pp.

**281** Fallis, H. J. and W. E. Niemuth. 1962. Sucker removal operations and observations on trout movement through a two-way weir in the Brule River, Douglas County. Wis. Conserv. Dep., Fish Manage. Div. Invest. Memo. No. 4. 7 pp.

▶White suckers were removed from the Brule River over a 3-year period (1958-60) using a 2-way mechanical weir (Stone's Bridge) and supplemental fyke netting (Big and Lucius lakes). Fyke netting was the more effective removal method, but neither method appeared to greatly reduce sucker abundance. The weir provided valuable information on the movement of lake-run trout in the upper Brule River.

**282** Falter, C. M. and R. R. Ringe. 1974. Pollution effects on adult steelhead migration in the Snake River. U.S. Environ. Prot. Agency. Ecol. Res. Ser. EPA/660/3-73/017. 111 pp.

**283** Fassett, N. C. 1944. Vegetation of the Brule Basin, past and present. Trans. Wis. Acad. Sci., Arts and Lett. 36:33-56.

▶This thorough summary resulted from an interdisciplinary study done on the Brule River in the early 1940s. Eleven technical papers from this study were subsequently issued under one cover (see Wis. Cons. Dep. 1954).

**284** Fatora, J. R. 1970. Noontootla—a sixteen-year creel and use history of a southern Appalachian trout stream under changing management regulations. Proc. of the 24th Annu. Conf. Southeast. Assoc. of Game and Fish Comm. 24:622-37.

**285** Fausch, K. D. 1984. Profitable stream positions for salmonids: relating specific growth rate to net energy gain. Can. J. Zool. 62:441-51.

**286** Fausch, K. D., C. L. Hawkes, and M. G. Parsons. 1988. Models that predict standing crop of stream fish from habitat variables: 1950-1985. U.S. For. Serv., Pac. Northwest Res. Stn. Gen. Tech. Rep. PNW-GTR-213. 52 pp.

▶This report classifies models by the types of independent habitat variables found significant, by mathematical structure, and by model quality. The authors found 5 main ways that stream-fish-habitat models are used in fisheries management.

**287** Fausch, K. D. and R. J. White. 1981. Competition between brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) for positions in a Michigan stream. Can. J. Fish. and Aquat. Sci. 38:1220-27.

**288** Fausch, K. D. and R. J. White. 1986. Competition among juveniles of coho salmon, brook trout, and brown trout in a laboratory stream,

and implications for Great Lakes tributaries. Trans. Am. Fish. Soc. 115(3):363-81.

►In laboratory stream experiments coho dominated brook or brown trout of equal size, and brook trout dominated equally sized brown trout. Coho salmon emerged 2-3 weeks earlier than brook or brown trout in Lake Michigan tributaries and were 6-21 mm longer during the first summer of life. The authors speculate that the larger size and competitive superiority of coho salmon should give them an advantage over juvenile brook and brown trout in Great Lakes tributaries when resources become limiting.

**289** Favro, L. D., P. K. Kuo, and J. F. McDonald. 1979. Population-genetic study of the effects of selective fishing on the growth rate of trout. J. Fish. Res. Board Can. 36:552-61.

**290** Favro, L. D., P. K. Kuo, and J. F. McDonald. 1980. Effects of unconventional size limits on the growth rate of trout. Can. J. Fish. and Aquat. Sci. 37:873-76.

**291** Favro, L. D., P. K. Kuo, and J. F. McDonald. 1986. Capture-recapture experiment with fly-caught brown (*Salmo trutta*) and rainbow trout (*S. gairdneri*). Can. J. Fish. and Aquat. Sci. 43:896-99.

**292** Fay, C. W. and G. B. Pardue. 1985. Freeze brands and submandibular latex injections as identifying marks on rainbow trout. North Am. J. Fish. Manage. 5:248-51.

**293** Fessler, J. L. 1977. A case study in fish management—the Deschutes River: what we know and don't know. pp. 121-26 *in* E. Schweibert, ed. Columbia River salmon and steelhead. Am. Fish. Soc. Spec. Publ. No. 10. 214 pp.

**294** Fessler, J. L. and A. Lichens. 1978. Research studies of wild rainbow trout in the lower Deschutes River, Oregon. pp. 93-97 *in* J. R. Moring, ed. Proceedings of the wild trout-catchable trout symposium. Oreg. Dep. Fish and Wildl., Portland. 210 pp.

**295** Fessler, J. L. and H. H. Wagner. 1969. Some morphological and biochemical changes in steelhead trout during the parr-smolt transformation. J. Fish. Res. Board Can. 26(11):2823-41.

**296** Finnigan, R. J., D. E. Marshall, J. H. Mundie, P. A. Slaney, and G. D. Taylor. 1980. Stream enhancement guide. Can. Dep. Fish. and Oceans, Vancouver, B.C. 96 pp.

►This guide describes specific stream requirements for salmonids and methods for stream restoration and enhancement. Particular emphasis is given to anadromous salmonid nursery areas.

**297** Fischthal, J. H. 1945. Parasites of Brule River fishes. Trans. Wis. Acad. Sci., Arts and Lett. 37:275-78.

►This report provides a summary of the parasite loads of 8 of the more abundant fish species in the Brule River. In general, Brule River fish were lightly parasitized. This report is one of 11 reports subsequently issued under one cover (see Wis. Cons. Dep. 1954) from a large, interdisciplinary study conducted in the early 1940s.

**298** Flagg, T. A. and L. S. Smith. 1982. Changes in swimming behavior and stamina during smolting of coho salmon. pp. 191-95 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**299** Flick, W. A. and Webster, D. A. 1975. Movement, growth, and survival in a stream population of wild brook trout (*Salvelinus fontinalis*) during a period of removal of non-trout species. J. Fish. Res. Board Can. 32(8):1359-67.

►No well-defined changes in growth or survival rates of native brook trout were detected during 13 years of removing nontrout species from a small stream in the Adirondack Mountains. A virtual cessation of movement of both trout and nontrout species was noted after 7 years, suggesting that the removal program affected population behavior.

**300** Foerster, R. E. 1954. On the relation of adult sockeye salmon (*Oncorhynchus nerka*) returns to known smolt seaward migrations. J. Fish. Res. Board Can. 11(4):339-50.

**301** Folke, C. 1986. The Baltic salmon: ecological and economic evaluation of a natural resource. Inst. Freshwater Res., Drottningholm, Sweden. Rep. No. 63:36-46.

**302** Folmar, L. C. and W. W. Dickhoff. 1980. The parr-smolt transformation (smoltification) and seawater adaptation in salmonids: a review of selected literature. Aquaculture 21:1-37.

**303** Fraley, J. J., M. A. Gaub, and J. R. Cavigli. 1986. Emergence trap and holding bottle for the capture of salmonid fry in streams. North Am. J. Fish. Manage. 6:119-21.

►This report describes the construction and use of a salmonid fry emergence trap that is inexpensive to make, durable, and effective in a wide range of current velocities.

**304** Frankenberger, L. 1968. Effects of habitat management on trout in a portion of the Kinnickinnic River, St. Croix County, Wisconsin. Wis. Dep. Nat. Resour. Fish Manage. Rep. No. 22. 14 pp.

**305** Fraser, F. J. 1969. Population density effects on survival and growth of juvenile coho salmon and steelhead trout in experimental stream-channels. pp. 253-66 *in* T. G. Northcote, ed. Symposium on salmon and trout in streams. H. R. MacMillan Lect. in Fish., Univ. B.C., Vancouver. 388 pp.

**306** Gardiner, W. R. 1984. Estimating population densities of salmonids in deep water in streams. J. Fish Biol. 24:41-49.

▶Densities of salmonids in 2 fast-flowing Scottish streams were estimated by systematic counting by underwater observers where the water was greater than 1 m deep and by using electrofishing equipment in adjacent shallower areas. Tests of the efficiencies of the 2 methods are described and problems encountered are discussed.

**307** Garman, G. C. and T. F. Waters. 1983. Use of the size-frequency (Hynes) method to estimate annual production of a stream fish population. Can. J. Fish. and Aquat. Sci. 40:2030-34.

**308** Garside, E. T. 1966. Effects of oxygen in relation to temperature on the development of embryos of brook trout and rainbow trout. J. Fish. Res. Board Can. 23(8):1121-34.

**309** Gatz, A. J., J. M. Loar, and G. F. Cada. 1986. Effects of repeated electro-shocking on instantaneous growth of trout. North Am. J. Fish. Manage. 6:176-82.

▶Growth rates of wild and brown trout in 5 soft-water streams that had been electroshocked with pulsed dc current (2-7 times within a 12-month period) were lower than the average growth rates for trout of the same age and species at adjacent control sites. Growth rate decreases were most significant for age I and II trout and for trout that were shocked at intervals of less than 3 months. The authors suggest that fisheries management studies should be designed to avoid repeated electroshocking, particularly at intervals of less than 3 months.

**310** Gaufin, A. R. 1973. Use of aquatic invertebrates in the assessment of water quality. pp. 96-116 *in* J. Cairns and K. L. Dickson, eds. Biological methods for the assessment of water quality. Am. Soc. Test. and Mater., Philadelphia. Spec. Tech. Publ. No. 528. 256 pp.

**311** Gebert, W. A. 1979. Low-flow characteristics of streams in the Lake Superior basin, Wisconsin. U.S. Geol. Surv. Water Resour. Invest. 79-38. 74 pp.

▶This report provides low-flow data for numerous sites in the Lake Superior Basin including 10 locations in the Brule River watershed. The period of record varies by location.

**312** Gharrett, A. J. and M. A. Thomason. 1987. Genetic changes in pink salmon (*Oncorhynchus gorbuscha*) following their introduction into the Great Lakes. Can. J. Fish. and Aquat. Sci. 43:787-92.

**313** Gibbons, D. R. and E. O. Salo. 1973. An annotated bibliography of the effects of logging on fish of the western United States and Canada. U.S. For. Serv. Gen. Tech. Rep. PNW-10. 145 pp.

▶This report is probably the most complete reference for explaining the general effects of logging on fish populations. Although focusing primarily on western North America, this discussion clearly has relevance to all areas where logging activities may impact fisheries.

**314** Gibson, R. J. 1981. Behavioural interactions between coho salmon (*Oncorhynchus kisutch*), Atlantic salmon (*Salmo salar*), brook trout (*Salvelinus fontinalis*) and steelhead trout (*Salmo gairdneri*) at the juvenile fluviatile stages. Can. Tech. Rep. Fish. and Aquat. Sci. No. 1029. 74 pp.

▶Steelhead juveniles were found to be the most aggressive of the 4 species studied and were able to displace any of the other species of similar or slightly larger size from preferred locations in a stream tank. Brook trout and coho salmon were the least aggressive and least territorial. Severe competition might be expected between riffle-dwelling Atlantic salmon and steelhead and between predominantly pool-dwelling coho salmon and brook trout.

**315** Gilbert, J. C. 1978. Large scale experimental salmonid nursery area improvement in Big Tracadie River, New Brunswick. New Brunswick Dep. Nat. Resour., Fish and Wildl. Branch. Fish. Inf. Bull. No. 1. 27 pp.

**316** Gilderhus, P. A. and B. G. H. Johnson. 1980. Effects of sea lamprey (*Petromyzon marinus*) control in the Great Lakes on aquatic plants, invertebrates, and amphibians. Can. J. Fish. and Aquat. Sci. 37:1895-905.

▶No conclusive evidence was found that lampricide treatments have caused the catastrophic decline or disappearance of any species. The authors suggest that the overall impact of chemical lamprey control on aquatic communities has been minor compared with the benefits derived.

**317** Gillespie, D. C., T. P. T. Evelyn, C. Frantsi, R. M. MacKelvie, and N. Neufeld. 1974. Methods for the detection of certain pathogens of salmonid fishes. Fish. Res. Board Can. Misc. Spec. Publ. No. 23. 19 pp.

**318** Godin, J.-G. J. 1982. Migrations of salmonid fishes during early life history phases: daily and annual timing. pp. 22-50 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**319** Goldstein, R. M. 1978. Quantitative comparison of seining and underwater observation for stream fishery surveys. Prog. Fish-Cult. 40:108-11.

**320** Goodyear, C. P. and S. W. Christensen. 1984. On the ability to detect the influence of spawning stock on recruitment. North Am. J. Fish. Manage. 4:186-93.

**321** Gordon, D., D. W. Chapman, and T. C. Bjornn. 1973. Economic evaluation of sport fisheries—what do they mean? Trans. Am. Fish. Soc. 102:293-311.

**322** Gordon, D. J. 1978. Juvenile salmonid density, biomass and production in relation to season and the physical environment in a Lake Erie tributary. Univ. Guelph, Guelph, Ont. M.S. Thesis. 100 pp.

**323** Gordon, D. J. and H. R. MacCrimmon. 1982. Juvenile salmonid production in a Lake Erie nursery stream. J. Fish Biol. 21:455-73.

▶Normandale Creek was found to provide spawning and nursery areas for steelhead, lake-run brown trout, and coho salmon. The authors supply density, biomass, and annual production estimates for one year (April 1974-June 1975).

**324** Gould, R. W. 1982. Freshwater aspects of anadromous salmonid enhancement. U.S. Dep. Commerce. NOAA Tech. Rep. NMFS CIRC-447:21-22.

**325** Gowing, H. 1975. Population dynamics of wild brown trout in Gamble Creek, subject first to angling, then no angling. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1824. 20 pp.

**326** Gowing, H. and G. R. Alexander. 1980. Population dynamics of trout in some streams of the northern lower peninsula of Michigan. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1877. 45 pp.

**327** Gradall, K. S. and W. A. Swenson. 1982. Responses of brook trout and creek chubs to turbidity. Trans. Am. Fish. Soc. 111:392-95.

▶Creek chubs (*Semotilus atromaculatus*) preferred highly turbid water over moderately turbid water, but brook trout did not show a preference. The report suggests that turbidity may represent an important isolating mechanism that promotes production of creek chubs.

**328** Graff, D. R. and B. A. Hollender. 1977. Catch-and-release fishing—the Pennsylvania experience. pp. 137-49 *in* R. A. Barnhart and T. D. Roelofs, eds. Catch and release fishing. Proc. of a Natl. Symp. Humboldt State Univ., Arcata, Calif. 220 pp.

**329** Grande, M. 1965. Age determination from scales and otoliths in the brook trout (*Salvelinus fontinalis* Mitchill). Nytt Magasin for Zoologi (Oslo) 12:35-37.

**330** Grau, E. G. 1982. Is the lunar cycle a factor timing the onset of salmon migration? pp. 184-89 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**331** Gray, R. H. and J. M. Haynes. 1979. Spawning migration of adult chinook salmon (*Oncorhynchus tshawytscha*) carrying internal and external radio transmitters. J. Fish. Res. Board Can. 36:1060-64.

▶Migrating fish carried either externally mounted or internally placed (stomach insertion method) radio transmitters. Travel times and percent returns of chinook salmon that retained external transmitters did not differ significantly from those of control fish. Most internally tagged fish eventually swam downstream.

**332** Greeley, J. R. 1932. The spawning habits of brook, brown, and rainbow trout, and the problem of egg predators. Trans. Am. Fish. Soc. 62:239-47.

**333** Green, A. W., G. C. Matlock, and J. E. Weaver. 1983. A method for directly estimating the tag-reporting rate of anglers. Trans. Am. Fish. Soc. 112:412-15.

**334** Griffith, J. S. 1981. Estimation of the age-frequency distribution of stream-dwelling trout by underwater observation. Prog. Fish-Cult. 43(1):51-53.

**335** Gruber, J. C. 1978. Response of adult wild brown trout (*Salmo trutta*) to light and velocity under simulated bank cover in stream channels. Mich. State Univ., East Lansing. M.S. Thesis. 29 pp.

**336** Gulland, J. A. 1969. Manual of methods for fish stock assessment. Part 1: Fish population analysis. F.A.O. Man. Fish. Sci. No. 4. 154 pp.

**337** Gulland, J. A. 1978. Fishery management: new strategies for new conditions. Trans. Am. Fish. Soc. 107(1):1-11.

**338** Gulland, J. A. and M. A. Robinson. 1973. Economics of fishery management. J. Fish. Res. Board Can. 30:2042-50.

**339** Gunsolus, R. T. 1978. The status of Oregon coho and recommendations for managing the production, harvest, and escapement of wild and hatchery-reared stocks. Oreg. Dep. Fish and Wildl. Columbia Reg. Proc. Rep. 59 pp.

**340** Hahn, P. 1980. Methodology for estimated sport catches of steelhead in Washington using voluntarily returned punchcards. Wash. Dep. Game. 2 pp. (unpubl. rep.).

**341** Hahn, P. 1981. How the Game Department uses punchcards to estimate the sport catch of steelhead. Wash. Dep. Game. 4 pp. (unpubl. rep.).

▶The preceding 2 reports describe a successful methodology for estimating a sport catch of steelhead using voluntarily returned punch cards. The total catch is estimated by multiplying the returned cards by a projection factor (to account for cards not returned) that has been corrected for nonresponse bias.

**342** Haines, T. A. 1981. Acid precipitation and its consequences for aquatic ecosystems: a review. Trans. Am. Fish. Soc. 110(6):669-707.

**343** Hale, J. G. 1969. An evaluation of trout stream habitat improvement in a north shore tributary of Lake Superior. Minn. Dep. Conserv., Div. Game and Fish. Minn. Fish. Invest. No. 5:37-50.

▶The addition of artificial deflectors and shelters to the West Branch of the Split Rock River led to a greatly increased production of brook trout and a subsequent 362% increase in harvest. Harvest in a control stretch increased much less dramatically (51%). These habitat improvements proved to be cost effective as well.

**344** Hall, J. D. and C. O. Baker. 1982. Influence of forest and rangeland management on anadromous fish habitat in western North America. 12: Rehabilitating and enhancing stream habitat. 1: Review and evaluation. W. R. Meehan, tech. ed U.S. For. Serv. Gen. Tech. Rep. PNW-138. 29 pp.

**345** Hall, J. D. and R. L. Lantz. 1969. Effects of logging on the habitat of coho salmon and cutthroat trout in coastal streams. pp. 355-75 *in* T. G. Northcote, ed. Symposium on salmon and trout in streams. H. R. MacMillan Lect. in Fish., Univ. B.C., Vancouver. 388 pp.

**346** Hallock, R. J., W. F. Van Woert, and L. Shapovalov. 1961. An evaluation of stocking hatchery-reared steelhead rainbow trout (*Salmo gairdneri gairdneri*) in the Sacramento River system. Calif. Dep. Fish and Game. Fish Bull. No. 114. 74 pp.

**347** Hamilton, W. J. 1961. Late fall, winter and early spring foods of 141 otters from New York. N.Y. Fish and Game J. 8(2):106-09.

**348** Hampton, E. L. and R. T. Lackey. 1975. Analysis of angler preferences and fisheries management objectives with implications for management. Proc. of the 29th Annu. Conf. Southeast. Assoc. of Game and Fish Comm. 29:310-16.

**349** Hankin, D. G. 1982. Estimating escapement of Pacific salmon: marking practices to discriminate wild and hatchery fish. Trans. Am. Fish. Soc. 111:286-98.

**350** Hankin, D. G. 1984. Multistage sampling designs in fisheries research: applications in small streams. Can. J. Fish. and Aquat. Sci. 41:1575-91.

**351** Hannuksela, P. R. 1969. Food habits of brown trout in the Anna River, Alger County, Michigan. Mich. Dep. Nat. Resour. Res. and Dev. Rep. No. 186. (Fish. Res. Rep. No. 1759). 12 pp.

▶Small brown trout (< 12 inches) fed primarily on Trichoptera in a small Lake Superior tributary, whereas larger brown trout ate mostly fish. Stocked coho salmon smolts migrating downstream were apparently very vulnerable to brown trout predation.

**352** Hansen, E. A. 1971. Sediment in a Michigan trout stream, its source, movement and some effects on fish habitat. U.S. For. Serv. Res. Pap. NC-59. 14 pp.

**353** Hansen, M. J. and T. M. Stauffer. 1971. Comparative recovery to the creel, movement and growth of rainbow trout stocked in the Great Lakes. Trans. Am. Fish. Soc. 100(2):336-49.

**354** Hare, G. M. 1973. A modified stake net for collecting migrating smolts of Atlantic salmon (*Salmo salar*). J. Fish. Res. Board Can. 30:128-29.

▶The trap design described capitalizes on the known tendency of smolts to avoid trap entry by swimming upstream and is, consequently, very effective. In addition, problems with mortality of captured fish and accumulation of debris in the trap are nearly eliminated.

**355** Harris, C. C. and E. P. Bergersen. 1985. Survey on demand for sport fisheries: problems and potentialities for its use in fishery management planning. North Am. J. Fish. Manage. 5:400-10.

▶This report describes the results of a mail survey conducted in Colorado to determine angler demands and preferences for sport fishing in the state. A follow-up telephone survey of selected nonrespondents proved extremely useful in refining conclusions of the survey.

**356** Harshbarger, T. J. 1975. Factors affecting regional trout stream productivity. pp. 11-27 *in* Southeastern trout resource: ecology and management symposium proceedings. U.S. For. Serv., Southeast. For. Exp. Stn., Asheville, N.C. 145 pp.

**357** Hartman, G. F. 1965. The role of behavior in the ecology and interaction of underyearling coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo gairdneri*). J. Fish. Res. Board Can. 22(4):1035-81.

**358** Hartman, G. F. 1970. Nest-digging behavior of rainbow trout (*Salmo gairdneri*). Can. J. Zool. 48:1458-62.

**359** Hartman, W. L. 1958. Estimation of catch and related statistics of the stream rainbow trout fishery of the Finger Lakes region. N.Y. Fish and Game J. 5(2):205-12.

**360** Hartman, W. L. 1959. Biology and vital statistics of rainbow trout in the Finger Lakes region, New York. N.Y. Fish and Game J. 6(2):121-78.

**361** Hartzler, J. R. 1983. The effects of half-log covers on angler harvest and standing crop of brown trout in McMichaels Creek, Pennsylvania. North Am. J. Fish. Manage. 3:228-38.

**362** Hasler, A. D. 1971. Orientation and fish migration. pp. 429-510 *in* W. S. Hoar and D. J. Ran-

dall, eds. Fish physiology. Academic Press, New York. 559 pp.

**363** Hassinger, R. L., J. G. Hale, and D. E. Woods. 1974. Steelhead of the Minnesota north shore. Minn. Dep. Nat. Resour. Tech. Bull. No. 11. 38 pp.

►Investigations were conducted on 59 Minnesota streams tributary to Lake Superior to evaluate their spawning and rearing capacity for steelhead. Two streams (Kimball and Kadunce creeks) were studied in detail to obtain life history information and sport fishery statistics.

**364** Hassler, T. J. and R. R. Vankirk, eds. 1977. Proceedings of the genetic implications of steelhead management symposium. Calif. Coop. Fish. Res. Unit. Spec. Rep. No. 77-1. 57 pp.

**365** Hayes, J. W. 1987. Competition for spawning space between brown (*Salmo trutta*) and rainbow trout (*S. gairdneri*) in a lake inlet tributary, New Zealand. Can. J. Fish. and Aquat. Sci. 44:40-47.

**366** Haynes, J. M. and D. C. Nettles. 1983. Fall movements of brown trout in Lake Ontario and a tributary. N.Y. Fish and Game J. 30(1):39-56.

**367** Heacox, C. E. 1974. The complete brown trout. Winchester Press, New York. 182 pp.

**368** Healey, M. C. 1980. Utilization of the Nanaimo River estuary by juvenile chinook salmon, *Oncorhynchus tshawytscha*. Fish. Bull. 77(3):653-68.

►This report provides a detailed methodology for estimating numbers of salmonid smolt outmigrants using a fyke net and recovery box sampling system.

**369** Healey, M. C. 1986. Optimum size and age at maturity in Pacific salmon and effects of size-selective fisheries. pp. 39-52 *in* D. J. Meerburg, ed. Salmonid age at maturity. Can. Spec. Publ. Fish. and Aquat. Sci. No. 89. 118 pp.

**370** Healey, M. C. and W. R. Heard. 1984. Inter- and intra-population variation in the fecundity of chinook salmon (*Oncorhynchus tshawytscha*) and its relevance to life history theory. Can. J. Fish. and Aquat. Sci. 41:476-83.

**371** Healey, M. C., F. P. Jordan, and R. M. Hungar. 1976. Laboratory and field evaluating of fluorescent grit as a marking material for juvenile salmonids. Fish. Res. Board Can. Manuscr. Rep. No. 1392. 17 pp.

**372** Hearn, W. E. 1987. Interspecific competition and habitat segregation among stream-dwelling trout and salmon: a review. Fisheries 12(5):24-31.

►Stream-dwelling salmonid populations can be limited by competition, predation, or climatic events. Differences in habitat use resulting from differences in aggressiveness, habitat preference, timing of emergence, morphology, or a combination of these factors may facilitate long-term coexistence of sympatric species. Management considerations related to competition among salmonids are discussed.

**373** Hearn, W. E. and B. E. Kynard. 1986. Habitat utilization and behavioral interaction of juvenile Atlantic salmon (*Salmo salar*) and rainbow trout (*S. gairdneri*) in tributaries of the White River of Vermont. Can. J. Fish. and Aquat. Sci. 43:1988-98.

**374** Heberlein, T. A. and J. Vaske. 1977. Crowding and visitor conflict on the Bois Brule River. Univ. Wis.-Madison, Dep. Rural Sociol. and Water Resour. Cent. Tech. Rep. OWRT A-066-WIS. 109 pp.

►This report describes the results of a survey of nearly 3,000 canoers, tubers, and anglers on the upper Brule River, Douglas County, to record their perceptions of crowding, satisfaction, and contacts with other visitors.

**375** Heede, B. H. 1984. The evolution of salmonid stream systems. pp. 33-37 *in* F. Richardson and R. H. Hamre, eds. Wild trout III. Proc. of a Symp. held at Yellowstone Natl. Park. 192 pp.

**376** Heggenes, J. 1987. Random, stratified creel surveys in three Norwegian rivers with low fishing intensities. North Am. J. Fish. Manage. 7:363-68.

**377** Heifetz, J., M. L. Murphy and K. V. Koski. 1986. Effects of logging on winter habitat of juvenile salmonids in Alaskan streams. North Am. J. Fish. Manage. 6:52-58.

**378** Hellawell, J. M. 1973. Automatic methods of monitoring salmon populations. Int. Atl. Salmon Symp. 1973:317-37.

►This report provides a review and comparison of automatic counting equipment for upstream migrants and smolts as well as a discussion of the economic aspects of fish counting.

**379** Helle, J. H. 1981. Significance of the stock concept in artificial propagation of salmonids in Alaska. Can. J. Fish. and Aquat. Sci. 38:1664-71.

**380** Hendrickson, G. E., R. L. Knutilla, and C. J. Doonan. 1973. Hydrology and recreation of selected cold-water rivers of the St. Lawrence River Basin in Michigan, New York, and Wisconsin. U.S. Geol. Surv. Water Resour. Invest. 8-73. 73 pp.

►The recreational potential of 10 cold-water streams (including the Brule River, Douglas County, Wisconsin) is described in terms of aesthetic attractiveness, suitability for boating and camping, and fishing opportunity. Trout populations in these streams were found to be positively related to stream flow and hardness of water and negatively related to maximum water temperatures.

**381** Herbert, D. W. M. and J. C. Merkens. 1961. The effect of suspended mineral solids on the survival of trout. Int. J. Air and Water Pollut. 5:46-55.

**382** Herman, R. L. 1968. Fish furunculosis 1952-1966. Trans. Am. Fish. Soc. 97:221-30.

►This paper contains a comprehensive literature review on fish furunculosis covering the period 1952-66. The authors conclude that genetic resistance to furunculosis is a promising subject for investigation.

**383** Herrington, R. B. and D. K. Dunham. 1967. A technique for sampling general fish habitat characteristics of streams. U.S. For. Serv. Res. Pap. INT-41. 12 pp.

**384** Hicks, B. J. and N. R. N. Watson. 1985. Seasonal changes in abundance of brown trout (*Salmo trutta*) and rainbow trout (*S. gairdneri*) assessed by drift diving in the Rangitikei River, New Zealand. New Zealand J. Mar. and Freshwater Res. 19(1):1-10.

**385** Hilborn, R. 1985. Simplified calculation of optimum spawning stock size from Ricker's stock recruitment curve. Can. J. Fish. and Aquat. Sci. 42(11):1833-34.

**386** Hillman, T. W., J. S. Griffith, and W. S. Platts. 1987. Summer and winter habitat selection by juvenile chinook salmon in a highly sedimented Idaho stream. Trans. Am. Fish. Soc. 116:185-95.

**387** Hilsenhoff, W. L. 1982. Using a biotic index to evaluate water quality in streams. Wis. Dep. Nat. Resour. Tech. Bull. No. 132. 22 pp.

►A workable methodology, which has been used extensively in Wisconsin, is described for using a biotic index to evaluate stream water quality.

**388** Hilsenhoff, W. L., J. L. Longridge, R. P. Narf, K. J. Tennessen, and C. P. Walton. 1972. Aquatic insects of the Pine-Popple River, Wisconsin. Wis. Dep. Nat. Resour. Tech. Bull. No. 54. 42 pp.

►This study represents the most complete aquatic insect faunal survey of a trout stream in northern Wisconsin. Distribution and abundance were recorded, and notes were summarized on the identification, ecology, and life cycles of approximately 386 species of aquatic insects.

**389** Hoar, W. S. 1963. The endocrine regulation of migratory behavior in anadromous teleosts. Symp. Int. Congr. Zool. 16:14-20.

**390** Hoar, W. S. 1976. Smolt transformation: evolution, behavior, and physiology. J. Fish. Res. Board Can. 33:1234-52.

**391** Hobbs, D. F. 1948. Trout fisheries in New Zealand, their development and management. New Zealand Mar. Dep. Fish. Bull. 9:1-175.

►This important bulletin established the foundation for the management of New Zealand's trout fisheries for the last 40 years.

**392** Hoffman, G. L. and F. P. Meyer. 1974. Parasites of freshwater fishes. T. F. H. Publ., Inc., Ltd., Neptune City, N.J. 224 pp.

**393** Hollender, B. A. 1981. Embryo survival, substrate composition, and dissolved oxygen in redds of wild brook trout. Univ. Wis.-Stevens Point. M.S. Thesis. 87 pp.

**394** Holtby, L. B. and M. C. Healey. 1986. Selection for adult size in female coho salmon (*Oncorhynchus kisutch*). Can. J. Fish. and Aquat. Sci. 43:1946-59.

**395** Holton, G. D. 1953. A trout population study on a small creek in Gallatin County, Montana. J. Wildl. Manage. 17(1):62-82.

**396** Horrall, R. M. 1981. Behavioral stock-isolating mechanisms in Great Lakes fishes with special reference to homing and site imprinting. Can. J. Fish. and Aquat. Sci. 38:1481-96.

**397** House, R. A. and P. L. Boehne. 1985. Evaluation of instream enhancement structures for salmonid spawning and rearing in a coastal Oregon stream. North Am. J. Fish. Manage. 5:283-95.

**398** House, R. A. and P. L. Boehne. 1986. Effects of instream structures on salmonid habitat and populations in Tobe Creek, Oregon. North Am. J. Fish. Manage. 6:38-46.

►Stream enhancement techniques were successfully used to simulate large woody debris in an alder section of Tobe Creek that had been logged and cleared of debris 20 years before. These structures resulted in a significant increase in salmonid biomass (steelhead, cutthroat trout, coho salmon).

**399** Houston, A. H., J. A. Madden, R. J. Woods, and H. M. Miles. 1971. Some physiological effects of handling and tricaine methane sulphonate anesthetization upon the brook trout (*Salvelinus fontinalis*). J. Fish. Res. Board Can. 28(5):625-33.

**400** Howard Paish and Associates Ltd. 1986. A review of stocking juvenile resident trout in streams. B.C. Minist. Environ., Fish. Branch. Proj. Rep. No. RD9. 13 pp.

**401** Huang, C. C., I. B. Vertinsky, and N. J. Wilimovsky. 1976. Optimal controls for a single species fishery and the economic value of research. J. Fish. Res. Board Can. 33:793-809.

**402** Hubbs, C. L. and K. F. Lagler. 1964. Fishes of the Great Lakes region. Univ. Mich. Press, Ann Arbor. 213 pp.

**403** Hughes, B. D. 1978. The influence of factors other than pollution on the value of Shannon's diversity index for benthic macro-invertebrates in streams. Water Res. 12:359-64.

**404** Hulbert, P. J. and R. Engstrom-Heg. 1980. Hooking mortality of worm-caught hatchery brown trout. N.Y. Fish and Game J. 27(1):1-10.

**405** Hume, J. M. B. and E. A. Parkinson. 1987. Effect of stocking density on the survival, growth, and dispersal of steelhead trout fry (*Salmo gairdneri*). Can. J. Fish. and Aquat. Sci. 44:271-81.

**406** Hume, J. M. B. and E. A. Parkinson. 1988. Effects of size at and time of release on the survival and growth of steelhead fry stocked in streams. North Am. J. Fish. Manage. 8:50-57.

**407** Hunt, P. C. and K. O'Hara. 1973. Overwinter feeding in rainbow trout. J. Fish Biol. 5:277-80.

**408** Hunt, R. L. 1964. Evaluation of fly-fishing-only at Lawrence Creek (a three-year progress report). Wis. Conserv. Dep. Misc. Res. Rep. No. 10. 15 pp.

**409** Hunt, R. L. 1965. Food of northern pike in a Wisconsin trout stream. Trans. Am. Fish. Soc. 94(1):95-97.

**410** Hunt, R. L. 1965. Dispersal of wild brook trout during their first summer of life. Trans. Am. Fish. Soc. 94(2):186-88.

**411** Hunt, R. L. 1965. Surface-drift insects as trout food in the Brule River. Wis. Acad. Sci., Arts and Lett. 54:51-61.

▶A comparison of trout stomach contents with concurrent surface-drift collections of insects from the Brule River during a 10-week summer period showed that trout used surface food in direct relation to its abundance. Approximately 86% of the food present in all stomachs consisted of surface-drift insects, 31% of which were of terrestrial origin.

**412** Hunt, R. L. 1966. Production and angler harvest of wild brook trout in Lawrence Creek, Wisconsin. Wis. Conserv. Dep. Tech. Bull. No. 35. 52 pp.

**413** Hunt, R. L. 1969. Overwinter survival of wild fingerling brook trout in Lawrence Creek, Wisconsin. J. Fish. Res. Board Can. 26(6):1473-83.

▶Survival of brook trout through their first winter of life ranged from 35% to 73% during 11 successive winters and averaged 54%. Survival generally was independent of fingerling density. Factors positively affecting overwinter survival were mean length of fingerlings and winter water temperatures.

**414** Hunt, R. L. 1970. A compendium of research on angling regulations for brook trout conducted at Lawrence Creek, Wisconsin. Wis. Dep. Nat. Resour. Res. Rep. No. 54. 36 pp.

▶This report provides conclusions and management implications based on 13 years of testing and evaluating a variety of angling regulations. The size limit was found to be the best single regulation for preventing excessive angler harvest of brook trout populations. A "rule of thumb" procedure for setting size limits is offered. Anglers were attracted by "fly fishing only" regulations and enjoyed high quality fishing, but no detectable responses by the trout population to such a restriction were observed.

**415** Hunt, R. L. 1971. Responses of a brook trout population to habitat development in Lawrence Creek. Wis. Dep. Nat. Resour. Tech. Bull. No 48. 35 pp.

▶Habitat development in this central Wisconsin trout stream was followed by significant increases in standing crops of wild brook trout, angler use, and yield. Annual cost of development did not compare favorably with the annual cost of stocking legal-sized domestic trout, but pragmatic and philosophical reasons for rejecting the latter option are discussed.

**416** Hunt, R. L. 1974. Annual production by brook trout in Lawrence Creek during eleven successive years. Wis. Dep. Nat. Resour. Tech. Bull. No. 82. 29 pp.

▶Long-term fish population studies often provide important insights into fish population dynamics that would not have become apparent over a shorter period, as is the case with this study. Annual production averaged 11.7 g/m$^2$ over the 11-year period and did not vary greatly from year to year.

**417** Hunt, R. L. 1975. Species-specific size limits for trout. Wis. Conserv. Bull. 40(4):12-13.

**418** Hunt, R. L. 1975. Food relations and behavior of salmonid fishes. pp. 137-51 *in* A. D. Hasler, ed. Coupling of land and water systems. Springer-Verlag, New York. 336 pp.

**419** Hunt, R. L. 1975. Angling regulations in relation to wild trout management. pp. 66-74 *in* W. King, ed. Wild trout management. Proc. of a Symp. held at Yellowstone Natl. Park. 103 pp.

▶This report reviews the 1974 agency fishing regulations for all 43 states and 11 provinces that provide trout fishing. A useful summary of the results of numerous angling regulation studies is provided.

**420** Hunt, R. L. 1976. A long-term evaluation of trout habitat development and its relation to improving management-related research. Trans. Am. Fish. Soc. 105(3):361-64.

▶Significant increases in brook trout biomass, annual production, and density of fish > 15 cm were noted in Lawrence Creek (central Wisconsin) during the first 3 years following habitat development, but even more impressive responses were observed during the second 3 years. The deliberately delayed collection of post-treatment data may be a valid and less

costly way to conduct some long-term studies of aquatic systems.

**421** Hunt, R. L. 1977. An unsuccessful use of catch-and-release regulations for a wild brook trout fishery. pp. 125-36 *in* R. A. Barnhart and T. D. Roelofs, eds. Catch and release fishing. Proc. of a Natl. Symp. Humboldt State Univ., Arcata, Calif. 220 pp.

**422** Hunt, R. L. 1978. Instream enhancement of trout habitat. pp. 19-27 *in* K. Hashagen, ed. Wild trout management. Proc. of a Natl. Symp. Calif. Trout, Inc., San Francisco. 69 pp.

**423** Hunt, R. L. 1979. Removal of woody streambank vegetation to improve trout habitat. Wis. Dep. Nat. Resour. Tech. Bull. No. 115. 36 pp.

**424** Hunt, R. L. 1979. Exploitation, growth, and survival of three strains of domestic brook trout. Wis. Dep. Nat. Resour. Res. Rep. No. 99. 15 pp.

**425** Hunt, R. L. 1981. A successful application of catch and release regulations on a Wisconsin trout stream. Wis. Dep. Nat. Resour. Tech. Bull. No. 119. 30 pp.

►This report presents the first completed evaluation of catch and release regulations (artificial flies and lures only, 13-inch minimum size limit, daily bag limit of 1 trout) in Wisconsin. The regulations were judged highly successful for 5 reasons: (1) angler use remained high, (2) some trout were apparently released more than once per season, (3) distribution of angling effort over the course of the season was more even, (4) catch rates increased dramatically, and (5) abundance, biomass, and survival rate characteristics of trout all changed favorably. A much improved, "trophy" trout fishery was not realized, possibly due to lack of suitable habitat for such fish.

**426** Hunt, R. L. 1985. A follow-up assessment of removing woody streambank vegetation along two Wisconsin trout streams. Wis. Dep. Nat. Resour. Res. Rep. No. 137. 23 pp.

►This report provides a follow-up assessment of 10-11 years of research on 2 central Wisconsin trout streams to evaluate woody stream bank vegetation removal as a trout habitat development technique. Anticipated physical improvements to the stream channels occurred in both situations, but abundance of legal-sized and quality-sized trout increased significantly in only one stream.

**427** Hunt, R. L. 1986. An evaluation of brush bundles and half-logs to enhance carrying capacity of two brown trout streams. pp. 31-62 *in* J. G. Miller, J. A. Arway, and R. F. Carline, eds. Fifth trout stream habitat improvement workshop. Proc. of a Conf. Lock Haven Univ., Pa. 283 pp.

►Results of this 7-year study to evaluate the simultaneous applications of 2 trout habitat development techniques showed no evidence of synergistic benefits to the trout populations that received both applications. Trout habitat quality improved in both streams, but density and biomass of brown trout improved in only one.

**428** Hunt, R. L. and O. M. Brynildson. 1964. A five-year study of a headwaters trout refuge. Trans. Am. Fish. Soc. 93(2):194-97.

**429** Hunt, R. L., O. M. Brynildson, and J. T. McFadden. 1962. Effects of angling regulations on a wild brook trout fishery. Wis. Conserv. Dep. Tech. Bull. No. 26. 58 pp.

►Adoption of a restrictive regulation (9-inch size limit and bag limit of 10) dramatically reduced the catch and fishing pressure on a wild brook trout stream. A liberal regulation (6-inch limit and bag limit of 10) functioned similarly to the absence of regulations. In this productive fishery, enough mature brook trout usually survived the fishing season to provide adequate reproduction regardless of the angling regulations.

**430** Hunter, G. A., E. M. Donaldson, F. W. Goetz, and P. R. Edgell. 1982. Production of all-female and sterile coho salmon, and experimental evidence for male heterogamety. Trans. Am. Fish. Soc. 111:367-72.

►Groups of coho salmon were immersed in 17 β-estradiol or 17 α-methyltestosterone in eyed egg and alevin stages. The estradiol groups contained 96-100% females compared with 54% females in the control group. The methyltestosterone groups were comprised primarily of sterile fish that continued to grow during the one-year period following the spawning of the control group.

**431** Huppert, D. D., R. D. Fight, and F. H. Everest. 1985. Influence of forest and rangeland management on anadromous fish habitat in western North America. 14: Economic considerations. W. R. Meehan, tech. ed. U.S. For. Serv. Gen. Tech. Rep. PNW-181. 27 pp.

**432** Hutchings, J. A. and D. W. Morris. 1985. The influence of phylogeny, size and behaviour on patterns of covariation in salmonid life histories. Oikos 45(1):118-24.

**433** Hvidsten, N. A. and L. P. Hansen. 1988. Increased recapture rate of adult Atlantic salmon, *Salmo salar* L., stocked as smolts at high water discharge. J. Fish Biol. 32:153-54.

**434** Hynes, H. B. N. 1950. The food of fresh-water sticklebacks (*Gasterosteus aculeatus* and *Pygosteus pungitius*), with a review of methods used in studies of the food of fishes. J. Anim. Ecol. 19:36-58.

►Though somewhat dated, this paper provides a good general review of methods used to analyze the food of fishes.

**435** Hynes, H. B. N. 1970. The ecology of running waters. Univ. Toronto Press, Toronto. 555 pp.

**436** Hynes, H. B. N. and M. J. Coleman. 1968. A simple method of assessing the annual production of stream benthos. Limnol. Oceanogr. 13(4):569-73.

**437** Hyslop, E. J. 1980. Stomach contents analysis—a review of methods and their application. J. Fish Biol. 17:411-29.

▶This paper represents the most comprehensive critical assessment available on the variety of methods for analyzing fish stomach contents. The best measure of dietary importance is proposed as one where both the amount and bulk of a food category are recorded. The bibliography contains nearly 200 references.

**438** Irvine, J. R. and T. G. Northcote. 1982. Significance of sequential feeding patterns of juvenile rainbow trout in a large lake-fed river. Trans. Am. Fish. Soc. 111:446-52.

**439** Irving, J. S., F. S. Elle, and T. C. Bjornn. 1977. The fish populations and fishery in the Teton River prior to impoundment by Teton Dam. Univ. Ida., For., Wildl., and Range Exp. Stn. Contrib. No. 68. 97 pp.

**440** Ivlev, V. S. 1961. Experimental ecology of the feeding of fishes. Yale Univ. Press, New Haven, Conn. 302 pp.

**441** Jacobson, J. O., R. D. Cook, and R. Sopuck. 1983. An evaluation of alternative methods of collecting sportfishing statistics for the Northwest Territories. Can. Tech. Rep. Fish. and Aquat. Sci. No. 1180. 18 pp.

**442** James, P. W., S. C. Leon, A. V. Zale, and O. E. Maughan. 1987. Diver-operated electrofishing device. North Am. J. Fish. Manage. 7:597-98.

**443** Jameson, G. C. 1971. Michigan's mail creel census methodology. Mich. Dep. Nat. Resour. Res. and Dev. Rep. No. 252. 5 pp.

**444** Jeffrey, K. A., F. W. H. Beamish, S. C. Ferguson, R. J. Kolton, and P. D. MacMahon. 1986. Effects of the lampricide, 3-trifluoromethyl-4-nitrophenol (TFM) on the macroinvertebrates within the hyporheic region of a small stream. Hydrobiologia 134:43-51.

▶Of the 8 major taxa examined, only Tubificoidea exhibited a decrease in abundance attributable to TFM treatments. The authors suggest that the hyporheic region may act as a refuge zone for benthic macroinvertebrates during most of the TFM application season.

**445** Jenkins, T. M. 1969. Social structure, position choice and microdistribution of two trout species (*Salmo trutta* and *Salmo gairdneri*) resident in mountain streams. Anim. Behav. Monogr. 2:57-123.

**446** Jensen, A. L. 1971. Response of brook trout (*Salvelinus fontinalis*) populations to a fishery. J. Fish. Res. Board Can. 28:458-60.

**447** Jensen, A. L. 1981. Optimum size limits for trout fisheries. Can. J. Fish. and Aquat. Sci. 38:657-61.

▶This paper offers general support for the slot size limit concept. With a slot limit, the minimum size limit should be at the smallest size acceptable to anglers, unless trophy fish have a very high value. Slot limits produce a small increase in trophy catch and do not cause a large decrease in total catch.

**448** Jerrard, L. P. 1956. The Brule River of Wisconsin: a brief history and description with maps. Hall and Son, Chicago. 44 pp.

▶An interesting historical account of human activity in the Brule River Valley is presented with some scattered references to the early fishery. The history of the Cedar Island estate area is treated in particular detail.

**449** Johnsen, P. B. 1982. A behavioral control model for homestream selection in migratory salmonids. pp. 266-73 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**450** Johnson, J. H. 1980. Predation on the eggs of steelhead trout by stream salmonids in a tributary of Lake Ontario. Prog. Fish-Cult. 43(1):36-37.

**451** Johnson, J. H. 1980. Production and growth of subyearling coho salmon, *Oncorhynchus kisutch*, chinook salmon, *Oncorhynchus tshawytscha*, and steelhead, *Salmo gairdneri*, in Orwell Brook, tributary of Salmon River, New York. Fish. Bull. 78:549-54.

▶Comparative production values are presented for chinook and coho salmon and steelhead trout for the period 1 June-30 October 1978 in this Lake Ontario tributary. These are the first chinook salmon production data available for the Great Lakes region. The production figures are compared with other published Great Lakes and West Coast values.

**452** Johnson, J. H. 1981. Food interrelationships of coexisting brook trout, brown trout and yearling rainbow trout in tributaries of the Salmon River, New York. N.Y. Fish and Game. J. 28(1):88-99.

**453** Johnson, J. H. 1981. Comparative food selection by coexisting subyearling coho salmon, chinook salmon and rainbow trout in a tributary of Lake Ontario. N.Y. Fish and Game J. 28(2):150-61.

▶Subyearling chinook and coho salmon in Orwell Brook were similar in size and had similar habitat preferences. The diet of chinook salmon included mostly autochthonous prey items and was more similar to rainbow trout than to coho. The presence of chinook salmon in the same physical habitat as the coho may have caused the latter to shift to a more allochthonous diet.

**454** Johnson, J. H. and E. Z. Johnson. 1981. Feeding periodicity and diet variation in diet composition of subyearling coho salmon, *Oncorhynchus kisutch*, and steelhead, *Salmo gairdneri*, in a small stream during summer. Fish. Bull. 79(2):370-76.

**455** Johnson, J. H. and P. A. Kucera. 1985. Summer-autumn habitat utilization of subyearling steelhead trout in tributaries in Clearwater River, Idaho. Can. J. Zool. 63(10):2283-90.

**456** Johnson, J. H. and N. H. Ringler. 1980. Diets of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo gairdneri*) relative to prey availability. Can. J. Zool. 58:553-58.

►During summer, young-of-the-year coho in a tributary of Lake Ontario fed most heavily on terrestrial invertebrates, and their diet was most closely associated with the composition of the drift, whereas young-of-the-year steelhead fed primarily on benthic invertebrates. Diet overlap between coho and steelhead was not significant.

**457** Johnson, J. H. and N. H. Ringler. 1981. Natural reproduction and juvenile ecology of Pacific salmon and rainbow trout in tributaries of the Salmon River, New York. N.Y. Fish and Game J. 28(1):49-60.

**458** Jones, J. W. and J. N. Ball. 1954. The spawning behaviour of brown trout and salmon. Br. J. Anim. Behav. 2:103-14.

**459** Jones, R. D. 1984. Ten years of catch-and-release in Yellowstone Park. pp. 105-08 *in* F. Richardson and R. H. Hamre, eds. Wild trout III. Proc. of a Symp. held at Yellowstone Natl. Park. 192 pp.

**460** Jonsson, B. 1985. Life history patterns of freshwater resident and sea-run migrant brown trout in Norway. Trans. Am. Fish. Soc. 114:182-94.

**461** Jonsson, B. and F. R. Gravem. 1985. Use of space and food by resident and migrant brown trout, *Salmo trutta*. Environ. Biol. Fishes 14(4):281-93.

**462** Junge, C. O. and W. H. Bayliff. 1955. Estimating the contribution of a salmon production area by marked fish experiments. Wash. Dep. Fish. Fish. Res. Pap. 1(3):51-58.

**463** Junge, C. O. and A. L. Oakley. 1966. Trends in production rates for upper Columbia River runs of salmon and steelhead and possible effects of changes in turbidity. Oreg. Fish. Comm. Res. Briefs 12(1):22-43.

**464** Kaesler, R. L. and E. E. Herricks. 1976. Analysis of data from biological surveys of streams: diversity and sample size. Water Resour. Bull. 12(6):125-35.

**465** Kalleberg, H. 1958. Observations in a stream tank of territoriality and competition in juvenile salmon and trout (*Salmo salar* L. and *S. trutta* L.). Inst. Freshwater Res., Drottningholm, Sweden. Rep. No. 39:55-98.

**466** Keenleyside, M. H. A. 1962. Skin-diving observations of Atlantic salmon and brook trout in the Miramichi River, New Brunswick. J. Fish. Res. Board Can. 19:625-34.

**467** Keleher, C. J., J. M. Haynes, D. C. Nettles, R. A. Olson, and J. D. Winter. 1985. Fall movements of Pacific salmon in Lake Ontario and several tributaries. N.Y. Fish and Game J. 32(2):167-75.

**468** Keller, E. A. and F. J. Swanson. 1979. Effects of large organic material on channel form and fluvial processes. Earth Surf. Process. 4:361-80.

**469** Kelly-Quinn, M. and J. J. Bracken. 1988. Brown trout, *Salmo trutta* L., production in an Irish coastal stream. Aquacult. and Fish. Manage. 19:69-95.

**470** Kennedy, G. J. A. and C. D. Strange. 1986. The effects of intra- and inter-specific competition on the survival and growth of stocked juvenile Atlantic salmon, *Salmo salar* L., and resident trout, *Salmo trutta* L., in an upland stream. J. Fish Biol. 28:479-89.

**471** Kerr, S. J. 1984. Assessment of juvenile rainbow trout production in selected nursery streams within the Owen Sound District. Ont. Minist. Nat. Resour., Owen Sound Dist. 35 pp. (unpubl. rep.).

►Juvenile rainbow trout populations were assessed in 15 different streams and rivers in the Owen Sound District. Standing crop and growth rates are compared with similar data from other Great Lakes tributaries.

**472** Kerr, S. J. and D. A. Perron. 1984. The 1984 juvenile rainbow trout population assessment program, Owen Sound District. Ont. Minist. Nat. Resour., Owen Sound Dist. 32 pp. (unpubl. rep.).

**473** Kershner, J. L. and R. R. VanKirk. 1984. Characteristics and attitudes of some Klamath River anglers. Calif. Fish and Game 70(4):196-209.

**474** Klein, W. D. 1966. Mortality of trout caught on artificial lures and released by fishermen. Trans. Am. Fish. Soc. 95(3):326-28.

**475** Klein, W. D. 1974. Special regulations and elimination of stocking: influence on fishermen and the trout population at the Cache la Poudre River, Colorado. Colo. Dep. Nat. Resour. Tech. Publ. No. 30. 57 pp.

**476** Klontz, G. W., P. C. Downey, and R. L. Focht. 1979. A manual for trout and salmon production. Sterling H. Nelson and Sons, Inc., Murray, Utah. 21 pp.

**477** Knight, A. E., G. Marancik, and J. B. Layzer. 1977. Monitoring movements of juvenile anad-

romous fish by radiotelemetry. Prog. Fish-Cult. 39(30):148-50.

**478** Knopf, R. C., B. L. Driver, and J. R. Bassett. 1973. Motivations for fishing. Trans. of the 38th North Am. Wildl. and Nat. Resour. Conf. 38:191-204.

**479** Knudsen, E. E. and S. J. Dilley. 1987. Effects of riprap bank reinforcement on juvenile salmonids in four western Washington streams. North Am. J. Fish. Manage. 7:351-56.

**480** Knudsen, G. J. 1962. Relationship of beaver to forests, trout and wildlife in Wisconsin. Wis. Conserv. Dep. Tech. Bull. No. 25. 50 pp.

▶Based on one of the earliest intensive investigations on the relationship between beaver and trout in watersheds of low to moderate gradient, this report has provided the philosophical foundation for Wisconsin Department of Natural Resources policies regarding beaver and trout streams for 25 years. Beaver impoundments on low-gradient trout streams do much more harm than good to trout habitat.

**481** Kolton, R. J., P. D. MacMahon, K. A. Jeffrey, and F. W. H. Beamish. 1986. Effects of the lampricide, 3-trifluoromethyl-4-nitrophenol (TFM) on the macroinvertebrates of a hardwater river. Hydrobiologia 139:251-67.

▶Drift samples collected over a 7-month period documented the effects of TFM treatments on the aquatic macroinvertebrate community in a hard-water tributary to Lake Ontario. Five taxa showed significant decreases in relative abundance attributable to TFM treatment. Effects on several other taxa were observed but not statistically significant. Complete recolonization required 6.5 months.

**482** Krueger, C. C. and B. May. 1987. Stock identification of naturalized brown trout in Lake Superior tributaries: differentiation based on allozyme data. Trans. Am. Fish. Soc. 116(6):785-94.

▶Significant genetic differences were found among brown trout from the 4 drainages studied and among samples within drainages. Anadromous and resident brown trout appeared to be genetically distinct in 2 drainages. The authors concluded that brown trout from southwestern Lake Superior drainages seem to have a population structure organized by drainage system and life history.

**483** Krueger, C. C. and B. May. 1987. Genetic comparison of naturalized rainbow trout populations among Lake Superior tributaries: differentiation based on allozyme data. Trans. Am. Fish. Soc. 116(6):795-806.

▶Significant genetic differences were found among rainbow trout from different Lake Superior drainages and among 4 site-specific samples from Bois Brule River tributaries, but not between spring-run and fall-run adults. The authors recommended that the spatial units of management focus for Lake Superior tributaries should consist of groups of geographically proximate small streams and possibly individual large drainage systems.

**484** Krueger, C. C. and B. W. Menzel. 1979. Effects of stocking on genetics of wild brook trout populations. Trans. Am. Fish. Soc. 108:277-87.

**485** Kupka, K. H. 1966. A downstream migrant diversion screen. Can. Fish Cult. 37:27-34.

**486** Kutkuhn, J. H. 1981. Stock definition as necessary basis for cooperative management of Great Lakes fish resources. Can. J. Fish. and Aquat. Sci. 38(12):1476-78.

**487** Kwain, W. 1971. Life history of rainbow trout (*Salmo gairdneri*) in Batchawana Bay, eastern Lake Superior. J. Fish. Res. Board Can. 28:771-75.

▶The age structure (smolts and adult spawners), incidence of repeat spawners, and incidence of lamprey scarring are described for this steelhead population, based on a 2-year study.

**488** Kwain, W. 1981. Population dynamics and exploitation of rainbow trout in Stokely Creek, eastern Lake Superior. Trans. Am. Fish. Soc. 110:210-15.

▶The exploitation rate for this steelhead population averaged 19%/year. Estimated total mortality averaged 41%/year. Smolts that migrated at age II or III had higher survival rates than age I smolts.

**489** Kwain, W. 1983. Downstream migration, population size, and feeding of juvenile rainbow trout. J. Great Lakes Res. 9(1):52-59.

▶Downstream migration of steelhead smolts from a Lake Superior tributary was associated with receding water levels and rising water temperatures (peaking in mid-June). Smaller trout (<7 cm) fed more on benthic organisms than terrestrial insects, while larger trout (>14 cm) consumed more terrestrial insects than benthos.

**490** Kwain, W. 1987. Biology of pink salmon in the North American Great Lakes. Am. Fish. Soc. Symp. 1:57-65.

**491** Kwain, W. and J. A. Chappel. 1978. First evidence for even-year spawning pink salmon, *Oncorhynchus gorbuscha*, in Lake Superior. J. Fish. Res. Board Can. 35:1373-76.

**492** Kwain, W. and G. A. Rose. 1985. Growth of brook trout *Salvelinus fontinalis* subject to sudden reductions of pH during their early life history. Trans. Am. Fish. Soc. 114:564-70.

**493** Kwain, W. and E. Thomas. 1984. The first evidence of spring spawning by chinook salmon in Lake Superior. North Am. J. Fish. Manage. 4:227-29.

**494** Laarman, P. W. 1969. Effects of a limited food supply on growth rates of coho salmon and steelhead trout. Trans. Am. Fish. Soc. 98(3):393-97.

►Below a length of 84 mm, steelhead were dominant (significantly faster growth rate) over coho salmon in utilizing a limited supply of Oregon moist pellets in a laboratory raceway. For fish above 84 mm, steelhead growth rate was also greater than that of salmon, but the difference was not significant.

**495** Lackey, R. T. 1974. Priority research in fisheries management. Wildl. Soc. Bull. 2(2):63-66.

**496** Lackey, R. T. and W. A. Hubert. 1982. Analysis of exploited fish populations. Va. Polytech. Inst. and State Univ. VPI-SG-76-04. 97 pp.

**497** Laevastu, T. 1983. Quantitative relations between fishing mortality, spawning stress mortality and biomass growth rate. U.S. Dep. Commerce. NOAA Tech. Memo. NMFS F/NWC-38. 22 pp.

**498** Laird, L. M., R. J. Roberts, W. M. Shearer, and J. F. McArdle. 1975. Freeze branding of juvenile salmon. J. Fish Biol. 7:167-71.

►This report provides an in-depth description of a freeze-branding technique suitable for marking juvenile salmonids as small as 5 mm long. Marks are identifiable for at least one year.

**499** Lambou, V. W. 1961. Determination of fishing pressure from fisherman or party counts with a discussion of sampling problems. Proc. of the 15th Annu. Conf. Southeast Assoc. of Game and Fish Comm. 15:380-401.

**500** Lamsa, A. K. 1963. A study of rainbow trout in Silver Creek, Ontario. Univ. West. Ont., London. M.S. Thesis. 86 pp.

**501** Lanka, R. P., W. A. Hubert, and T. A. Wesche. 1987. Relations of geomorphology to stream habitat and trout standing stock in small Rocky Mountain streams. Trans. Am. Fish. Soc. 116:21-28.

**502** Lantiegne, E. 1974. Angler use of the "special regulation area" of the Batten Kill in 1973 and the effect of special regulations on the brown trout and brook trout populations. N.Y. Dep. Environ. Conserv., Albany. 27 pp.

**503** Larimore, R. W. 1974. Stream drift as an indication of water quality. Trans. Am. Fish. Soc. 103(3):507-17.

**504** Larkin, P. A. 1970. Management of Pacific salmon of North America. pp. 223-36 *in* N. G. Benson, ed. A century of fisheries in North America. Am. Fish. Soc. Spec. Publ. No. 7. 330 pp.

**505** Larkin, P. A. 1981. A perspective on population genetics and salmon management. Can. J. Fish. and Aquat. Sci. 38(12):1469-75.

►This relevant discussion covers a variety of management options and possibilities relating to population genetics theories.

**506** Larson, G. L. and S. E. Moore. 1985. Encroachment of exotic rainbow trout into stream populations of native brook trout in the southern Appalachian Mountains. Trans. Am. Fish. Soc. 114:195-203.

►In the southern Appalachian Mountains native brook trout retain their historical longitudinal distribution only in the few streams that lack rainbow trout. In other streams the typical pattern is for brook trout to occur in upper reaches, with rainbow trout in lower reaches and a zone of sympatry in between. The authors concluded that encroachment of rainbow trout is dynamic and continuing; brook trout may ultimately be reduced to a few inbreeding populations in headwater refugia unless bold management measures are taken.

**507** Larson, R. and J. Ward. 1955. Management of steelhead trout in the state of Washington. Trans. Am. Fish. Soc. 84:261-74.

**508** Larsson, P. O. 1985. Predation on migrating smolts as a regulating factor in Baltic salmon, *Salmo salar* L., populations. J. Fish Biol. 26:391-97.

**509** Latta, W. C. 1969. Some factors affecting survival of young-of-the-year brook trout (*Salvelinus fontinalis* Mitchill) in streams. pp. 229-40 *in* T. G. Northcote, ed. Symposium on salmon and trout in streams. H. R. MacMillan Lect. in Fish., Univ. B.C., Vancouver. 388 pp.

**510** Latta, W. C. 1972. The effects of stream improvement upon the anglers catch and standing crop of trout in the Pigeon River, Otsego County, Michigan. Mich. Dep. Nat. Resour. Res. and Dev. Rep. No. 265. 57 pp.

**511** Latta, W. C. 1973. The effects of a flies-only fishing regulation upon trout in the Pigeon River, Otsego County, Michigan. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1807. 28 pp.

►A flies-only fishing regulation caused a 44% decline in angling pressure on the stream and a decrease in harvest of brook trout, probably as a result of the decreased fishing pressure. There were no apparent effects of the regulation on the trout populations.

**512** Lawrie, A. H. and J. F. Rahrer. 1973. Lake Superior: a case history of the lake and its fisheries. Great Lakes Fish. Comm. Tech. Rep. No. 19. 69 pp.

►This report provides a general review of scientific knowledge about Lake Superior and its fish stocks, including history, physical and biological limnology, fisheries exploitation, and fish plantings.

**513** Leary, R. F., F. W. Allendorf, and K. L. Knudsen. 1985. Developmental instability as an indicator of reduced genetic variation in hatchery trout. Trans. Am. Fish. Soc. 114:230-35.

**514** Leclerc, J. and G. Power. 1980. Selectivity of fly-fishing, spinning and gillnet for brook charr and ouananiche in a large northern Quebec river. Environ. Biol. Fishes 5(2):181-84.

**515** Le Cren, E. D. 1973. The population dynamics of young trout *Salmo trutta* in relation to density and territorial behaviour. Rapports et Proces-Verbaux des Reunions Conseil Permanent International pour L'Exploration de la Mer 164:241-46.

**516** Leider, S. A. 1985. Precise timing of upstream migrations by repeat steelhead spawners. Trans. Am. Fish. Soc. 114:906-08.

**517** Leider, S. A., M. W. Chilcote, and J. J. Loch. 1984. Spawning characteristics of sympatric populations of steelhead trout (*Salmo gairdneri*): evidence for partial reproductive isolation. Can. J. Fish. and Aquat. Sci. 41:1454-62.

▶Significant temporal spawning differences were found between hatchery summer and wild winter steelhead, and between wild summer and wild winter steelhead in the Kalama River, Washington. Estimates of potential reproductive overlap between summer and winter spawner groups indicated that most reproductive activity involved members of the same spawner group. This high degree of restriction in gene flow provides a mechanism for the maintenance of racial identity.

**518** Leider, S. A., M. W. Chilcote, and J. J. Loch. 1986. Comparative life history characteristics of hatchery and wild steelhead trout (*Salmo gairdneri*) of summer and winter races in the Kalama River, Washington. Can. J. Fish. and Aquat. Sci. 43:1398-409.

**519** Leider, S. A., M. W. Chilcote, and J. J. Loch. 1986. Movement and survival of presmolt steelhead in a tributary and the main stem of a Washington river. North Am. J. Fish. Manage. 6:526-31.

**520** Les, B. 1975. Common parasites of freshwater fish. Wis. Dep. Nat. Resour. Publ. 10-3600(75). 22 pp.

**521** Lewis, A. E. and W. R. A. Muntz. 1984. The effects of external ultrasonic tagging on the swimming performance of rainbow trout, *Salmo gairdneri* Richardson. J. Fish Biol. 25:577-85.

▶Externally mounted ultrasonic tags caused an increase in both the tail beat frequency and opercular beat rate of 115-mm rainbow trout measured at different swimming speeds. Symmetrical tag attachment (2 packages mounted symmetrically on either side of the fish) affected behavior less than attachment of a single package on one side of the fish.

**522** Lewis, S. L. 1969. Physical factors influencing fish populations in pools of a trout stream. Trans. Am. Fish. Soc. 98:14-19.

**523** Li, H. 1975. Competition and coexistence in stream fish. pp. 19-30 *in* P. B. Moyle and D. L. Koch, eds. Symposium on trout/non-game relationships in streams. Univ. Nev., Cent. Water Resour. Res. Misc. Rep. No. 17. 81 pp.

**524** Liao, P. B. 1971. Water requirements of salmonids. Prog. Fish-Cult. 33:210-15.

**525** Libosvarsky, J. 1966. Successive removals with electrical fishing gear—a suitable method for making population estimates in small streams. Verhandlungen Internationale Vereinigung fur theoretische und angewandte Limnologie 16:1212-16.

**526** Libosvarsky, J. 1967. The effect of fish irritation by electrofishing on the population estimate. Ekologia Polska 15(4):91-106.

**527** Lichatowich, J. A. and J. D. McIntyre. 1987. Use of hatcheries in the management of Pacific anadromous salmonids. Am. Fish. Soc. Symp. 1:131-36.

**528** Lichens, A. B. 1977. A case study in fish management on the Deschutes River. pp. 115-20 *in* E. Schwiebert, ed. Columbia River salmon and steelhead. Am. Fish. Soc. Spec. Publ. No. 10. 214 pp.

**529** Lindroth, A. 1955. Distribution, territorial behaviour and movements of sea trout fry in the River Indalsälven. Inst. Freshwater Res., Drottningholm, Sweden. Rep. No. 36:104-19.

**530** Lisle, T. E. 1986. Effects of woody debris on anadromous salmonid habitat, Prince of Wales Island, southeast Alaska. North Am. J. Fish. Manage. 6:538-50.

**531** Lister, D. B. and H. S. Genoe. 1970. Stream habitat utilization by cohabiting underyearlings of chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon in the Big Qualicum River, British Columbia. J. Fish. Res. Board Can. 27:1215-24.

**532** Logan, S. M. 1963. Winter observations on bottom organisms and trout in Bridger Creek, Montana. Trans. Am. Fish. Soc. 92(2):140-45.

**533** Lorz, H. W. 1978. Brown trout ecology in Oregon, with management implications. pp. 135-50 *in* J. R. Moring, ed. Proceedings of the wild trout-catchable trout symposium. Oreg. Dep. Fish and Wildl., Portland. 210 pp.

**534** Lotspeich, F. B. and B. H. Reid. 1980. Tri-tube freeze-core procedure for sampling stream gravels. Prog. Fish-Cult. 42(2):96-99.

**535** Lowry, G. R. 1971. Effect of habitat alteration on brown trout in McKenzie Creek, Wisconsin. Wis. Dep. Nat. Resour. Res. Rep. No. 70. 27 pp.

**536** MacCrimmon, H. R. and D. J. Gordon. 1981. Salmonid spawning runs and estimated ova production in Normandale Creek of Lake Erie. J. Great Lakes Res. 7(2):155-61.

**537** MacCrimmon, H. R. and B. L. Gots. 1972. Rainbow trout in the Great Lakes. Ont. Minist. Nat. Resour., Toronto. 66 pp.

▶This treatise provides a complete historical account and present-day assessment of rainbow trout populations in the Great Lakes basin. Laws, regulations, and propagation activities are also described.

**538** MacCrimmon, H. R. and W. Kwain. 1966. Use of overhead cover by rainbow trout exposed to a series of light intensities. J. Fish. Res. Board Can. 23:983-90.

**539** Maciolek, J. A. and P. R. Needham. 1951. Ecological effects of winter conditions on trout and trout foods in Convict Creek, California, 1951. Trans. Am. Fish. Soc. 81:202-17.

**540** MacKenzie, W. C. 1974. Conceptual aspects of strategic planning for fishery management and development. J. Fish. Res. Board Can. 31:1705-12.

**541** MacLean, J. A. and D. O. Evans. 1981. The stock concept, discreteness of fish stocks, and fisheries management. Can. J. Fish. and Aquat. Sci. 38:1889-98.

**542** MacMahon, P. D., K. A. Jeffrey, F. W. H. Beamish, S. C. Ferguson, and J. R. Kolton. 1987. Effects of the lampricide 3-trifluoromethyl-4-nitrophenol (TFM) on the macroinvertebrates of Wilmot Creek. Hydrobiologia 148:25-34.

▶Drift and benthic sampling schemes were used to examine the effects of TFM treatments on the aquatic macroinvertebrate community in a soft-water tributary to Lake Ontario. Significant decreases in benthic abundance were exhibited by 4 taxa following treatment, but only the decreases of *Dolophilodes* sp. and Tubificoidea could conclusively be attributed to TFM treatment. The most severely affected taxa were not present in the benthos 350 days after treatment.

**543** MacPhee, C. 1966. Influence of differential angling mortality and stream gradient on fish abundance in a trout-sculpin biotope. Trans. Am. Fish. Soc. 95:381-87.

**544** Maher, F. P. and P. A. Larkin. 1954. Life history of the steelhead trout of the Chilliwack River, British Columbia. Trans. Am. Fish. Soc. 84:27-38.

**545** Mains, E. M. and J. M. Smith. 1955. Determination of the normal stream distribution, size, time and current preferences of downstream migrating salmon and steelhead trout in the Columbia and Snake rivers. Wash. Dep. Fish. Annu. Rep. Army Eng. Contract No. DA 35026-Eng-20571. 53 pp.

**546** Malvestuto, S. P. 1983. Sampling the recreational fishery. pp. 397-419 *in* L. A. Nielsen and D. L. Johnson, eds. Fisheries techniques. Am. Fish. Soc., Bethesda, Md. 468 pp.

**547** Malvestuto, S. P., W. D. Davies, and W. L. Shelton. 1978. An evaluation of the roving creel survey with nonuniform probability sampling. Trans. Am. Fish. Soc. 107(2):255-62.

**548** Malvestuto, S. P., W. D. Davies, and W. L. Shelton. 1979. Predicting the precision of creel survey estimates of fishing effort by use of climatic variables. Trans. Am. Fish. Soc. 108(1):43-45.

**549** Manion, P. J. 1977. Downstream movement of fish in a tributary of southern Lake Superior. Prog. Fish-Cult. 39(1):14-16.

**550** Mann, R. H. K. and T. Penczak. 1984. The efficiency of a new electrofishing technique in determining fish numbers in a large river in central Poland. J. Fish Biol. 24:173-85.

▶This report describes a highly efficient method of sampling fish populations in large rivers. The method involves electrofishing from boats downstream to an ac electrical barrier.

**551** Margolis, L. 1970. A bibliography of parasites and diseases of fishes of Canada: 1879-1969. Fish. Res. Board Can. Tech. Rep. No. 185. 38 pp.

▶This Canadian summary has relevance to the northern United States. The bibliography contains over 400 references.

**552** Marnell, L. F. and D. Hunsaker. 1970. Hooking mortality of lure-caught cutthroat trout (*Salmo clarki*) in relation to water temperature, fatigue, and reproductive maturity of released fish. Trans. Am. Fish. Soc. 99(4):684-88.

**553** Marshall, A. M. 1954. Brule country. North Cent. Publ. Co., St. Paul, Minn. 219 pp.

▶This book provides a detailed historical account of human activities in the Brule River Valley of northwestern Wisconsin. One chapter is devoted to fishing and its possible future trends.

**554** Marshall, T. L. and H. R. MacCrimmon. 1970. Exploitation of self-sustaining Ontario stream populations of brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*). J. Fish. Res. Board Can. 27:1087-102.

**555** Martin, L. 1965. The physical geography of Wisconsin. 3rd ed. Univ. Wis. Press, Madison. 608 pp.

**556** Martinez, A. M. 1984. Identification of brook, brown, rainbow, and cutthroat trout larvae. Trans. Am. Fish. Soc. 113:252-59.

**557** Mason, C. F. and S. M. Macdonald. 1982. The input of terrestrial invertebrates from tree canopies to a stream. Freshwater Biol. 12:305-11.

**558** Mason, J. C. 1976. Response of underyearling coho salmon to supplemental feeding in a natural stream. J. Wildl. Manage. 40(4):775-88.

▶Food limited the stream production of juvenile coho salmon during the summer in a small Vancouver Island stream. Summer carrying capacity was increased 6-7 fold above natural levels by augmenting the natural food supply with daily feeding. However, the potential increase in smolt yield was not realized because of the lower natural carrying capacity of the stream over winter.

**559** Mason, J. W. and R. L. Hunt. 1967. Mortality rates of deeply hooked rainbow trout. Prog. Fish-Cult. 29(1):87-91.

▶Nearly all deeply hooked trout died soon after release if hooks were removed; but if hooks were not removed, about two thirds of them survived and grew at least long enough to attain legal size.

**560** Mathews, S. B. and F. W. Olson. 1980. Factors affecting Puget Sound coho salmon (*Oncorhynchus kisutch*) runs. Can. J. Fish. and Aquat. Sci. 37:1373-78.

**561** Mathews, S. B. and H. O. Wendler. 1968. Economic criteria for division of catch between sport and commercial fisheries with special reference to Columbia River chinook salmon. Wash. Dep. Fish. Fish. Res. Pap. 3:93-105.

**562** McCarl, B. A. and R. B. Rettig. 1983. Influence of hatchery smolt releases on adult salmon production and its variability. Can. J. Fish. and Aquat. Sci. 40:1880-86.

**563** McCleave, J. D., J. H. Power, and S. A. Rommel. 1978. Use of radio telemetry for studying upriver migration of adult Atlantic salmon (*Salmo salar*). J. Fish Biol. 12:549-58.

▶This report gives a brief but useful evaluation and discussion of radio telemetry applied to the study of upstream-migrating Atlantic salmon. Salmon were tracked with partial success when transmitters were attached using a stomach insertion technique. Some salmon regurgitated transmitters.

**564** McCleave, J. D. and K. A. Stred. 1975. Effect of dummy telemetry transmitters on stamina of Atlantic salmon (*Salmo salar*) smolts. J. Fish. Res. Board Can. 32(4):559-63.

**565** McConnell, R. J. and G. R. Snyder. 1972. Key to field identification of anadromous juvenile salmonids in the Pacific Northwest. U.S. Dep. Commerce. NOAA Tech. Rep. NMFS CIRC-366. 6 pp.

**566** McDonald, P. D. M. and H. D. Smith. 1980. Mark-recapture estimation of salmon smolt runs. Biometrics 36:401-17.

**567** McDowall, R. M. 1984. Trout in New Zealand waters. The Wetland Press, Wellington, New Zealand. 120 pp.

**568** McFadden, J. T. 1961. A population study of brook trout, *Salvelinus fontinalis*. Wildl. Soc. Wildl. Monogr. No. 7. 73 pp.

**569** McFadden, J. T. 1969. Trends in freshwater sport fisheries of North America. Trans. Am. Fish. Soc. 98(1):136-50.

**570** McFadden, J. T. 1969. Dynamics and regulation of salmonid populations in streams. pp. 313-29 *in* T. G. Northcote, ed. Symposium on salmon and trout in streams. H. R. MacMillan Lect. in Fish., Univ. B.C., Vancouver. 388 pp.

▶Intense competition can occur among stream salmonids because of relatively high population densities, limited environmental resources, restricted opportunities for movements, and territoriality. Intrinsic regulation of populations is a highly flexible process, not dependent on any one environmental factor, but the specific mechanisms involved are poorly understood.

**571** McFadden, J. T., G. R. Alexander, and D. S. Shetter. 1967. Numerical changes and population regulation in brook trout, *Salvelinus fontinalis*. J. Fish. Res. Board Can. 24:1425-59.

**572** McFadden, J. T., E. L. Cooper, and J. K. Andersen. 1965. Some effects of environment on egg production in brown trout (*Salmo trutta*). Limnol. Oceanogr. 10:88-95.

**573** McGraw, B. M. 1952. Furunculosis of fish. U.S. Fish and Wildl. Serv. Spec. Sci. Rep.-Fish. No. 84. 87 pp.

▶Though dated, this paper presents a thorough review of furunculosis disease and includes a 15-page bibliography.

**574** McHugh, J. L. 1970. Trends in fishery research. pp. 25-56 *in* N. G. Benson, ed. A century of fisheries in North America. Am. Fish. Soc. Spec. Publ. No. 7. 330 pp.

**575** McIntyre, J. D. and R. R. Reisenbichler. 1977. An effect of interbreeding hatchery and wild anadromous salmonids. pp. 93-94 *in* E. Schwiebert, ed. Columbia River salmon and steelhead. Am. Fish. Soc. Spec. Publ. No. 10. 214 pp.

**576** McKeown, B. A. 1984. Fish migration. Timber Press, ISBS Inc., Beaverton, Oreg. 224 pp.

**577** McKern, J. L. and H. F. Horton. 1970. A punch to facilitate the removal of salmonid otoliths. Calif. Fish and Game 56(1):65-68.

**578** McKern, J. L., H. F. Horton, and K. V. Koski. 1974. Development of steelhead trout (*Salmo*

*gairdneri*) otoliths and their use for age analysis and for separating summer from winter races and wild from hatchery stocks. J. Fish. Res. Board Can. 31(8):1420-26.

►Otolith size and structure were found to contain diagnostic aspects that could be used to accurately separate summer from winter races and wild from hatchery stocks.

**579** McKim, J. M., D. A. Benoit, K. E. Biesinger, W. A. Brungs, and R. E. Siefert. 1975. Effects of pollution on freshwater fish. J. Water Pollut. Control Fed. 47(6):1711-68.

►This technical paper reviews the literature through 1974 on the effects of pollution on fresh-water fish and considers all salmonid species found in Wisconsin. The bibliography contains over 400 references.

**580** McLain, A. L., B. R. Smith, and H. H. Moore. 1965. Experimental control of sea lamprey with electricity on the south shore of Lake Superior, 1953-60. Great Lakes Fish. Comm. Tech. Rep. No. 10. 48 pp.

**581** McMillan, W. 1977. A sportman's view of wild fisheries. pp. 72-77 *in* E. Schwiebert, ed. Columbia River salmon and steelhead. Am. Fish. Soc. Spec. Publ. No. 10. 214 pp.

**582** McNeil, W. J. and J. E. Bailey. 1975. Salmon rancher's manual. Natl. Mar. Fish. Serv., Northwest Fish. Cent. Processed Rep. 95 pp.

**583** McNicol, R. E. and D. L. G. Noakes. 1984. Environmental influences on territoriality of juvenile brook charr, *Salvelinus fontinalis*, in a stream environment. Environ. Biol. Fishes 10:29-42.

**584** McNicol, R. E., E. Scherer, and E. J. Murkin. 1985. Quantitative field investigations of feeding and territorial behavior of young-of-the-year brook charr, *Salvelinus fontinalis*. Environ. Biol. Fishes 12(3):219-29.

**585** Mears, H. C. and R. W. Hatch. 1976. Overwinter survival of fingerling brook trout with single and multiple fin clips. Trans. Am. Fish. Soc. 105(6):669-74.

**586** Meehan, W. R. and R. A. Miller. 1978. Stomach flushing: effectiveness and influence on survival and condition of juvenile salmonids. J. Fish. Res. Board Can. 35:1359-63.

**587** Meehan, W. R., F. J. Swanson, and J. R. Sedell. 1977. Influences of riparian vegetation on aquatic ecosystems with particular reference to salmonid fishes and their food supply. pp. 137-45 *in* Importance, preservation and management of riparian habitat. U.S. For. Serv. Gen. Tech. Rep. No. RM43. 217 pp.

**588** Meigs, R. C. and C. F. Pautzke. 1941. Additional notes on the life history of the Puget Sound steelhead (*Salmo gairdneri*) with suggestions for management of the species. Wash. Dep. Game. Biol. Bull. No. 5. 13 pp.

**589** Mellas, E. J. and J. M. Haynes. 1985. Swimming performance and behavior of rainbow trout (*Salmo gairdneri*) and white perch (*Morone americana*): effects of attaching telemetry transmitters. Can. J. Fish. and Aquat. Sci. 42:488-93.

►This report compares the effects of external, surgical, and stomach tag attachment methods on the swimming performance and behavior of rainbow trout. Stomach tagging caused the least serious effects and appeared to be the best method of tag attachment for the species studied.

**590** Merna, J. W. 1985. Effects of TFM lampricide treatment of streams on trout populations and benthic communities. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1932. 23 pp.

►Sensitive species of benthos were significantly reduced by TFM lampricide treatments in one of 4 treated tributaries of Lake Michigan. The one tributary (Sturgeon River) where the trout population was monitored showed no grossly adverse effect on trout numbers following TFM treatment.

**591** Messersmith, J. D. 1958. Food habits of smolt steelhead trout, *Salmo gairdneri gairdneri* Richardson, in the Alsea River, Oregon. Oreg. State Univ., Corvallis. M.S. Thesis. 42 pp.

**592** Metcalfe, N. B. 1986. Intraspecific variation in competitive ability and food intake in salmonids: consequences for energy budgets and growth rates. J. Fish Biol. 28:525-31.

**593** Metzelaar, J. 1929. The food of the trout in Michigan. Trans. Am. Fish. Soc. 59:146-62.

**594** Metzger, R. J. and P. L. Shafland. 1986. Use of detonating cord for sampling fish. North Am. J. Fish. Manage. 6:113-18.

**595** Meyer, F. P. and R. A. Schnick. 1983. Sea lamprey control techniques: past, present, and future. J. Great Lakes Res. 9(3):354-58.

**596** Meyer, P. A. 1982. Net economic values for salmon and steelhead from the Columbia River system. U.S. Dep. Commerce. NOAA Tech. Memo. NMFS F/NWR-3. 26 pp.

**597** Mighell, J. L. 1969. Rapid cold branding of salmon and trout with liquid nitrogen. J. Fish. Res. Board Can. 26:2765-69.

**598** Mih, W. C. 1978. A review of restoration of stream gravel for spawning and rearing of salmon species. Fisheries 3:16-19.

**599** Millard, T. J. and H. R. MacCrimmon. 1972. Evaluation of the contributions of supplemental plantings of brown trout *Salmo trutta* (L.) to a self-sustaining fishery in the Sydenham River, Ontario, Canada. J. Fish Biol. 4:369-84.

**600** Millenbach, C. 1972. Genetic selection of steelhead trout for management purposes. pp. 253-58 *in* M. W. Smith and W. M. Carter, eds. Sym-

posium on Atlantic salmon. Int. Atl. Salmon Found. Spec. Publ. Ser. 4(1).

▶This report describes how new fish culture techniques led to development of the state of Washington's summer steelhead stocking program.

**601** Miller, B. 1974. The spawning migration and age and growth studies of steelhead in the Huron River, Baraga County, Michigan 1966-1970. Mich. Dep. Nat. Resour., Fish. Div. Tech. Rep. No. 74-10. 19 pp.

▶Fall-run steelhead comprised 15% and spring-run steelhead 85% of the run in this south shore tributary of central Lake Superior. Dominant age groups of migrant trout were 2/2 (2 stream years and 2 lake years) and 2/3 (2 stream and 3 lake years). Growth, length-weight relationship, sex ratio, and migration timing information are summarized.

**602** Miller, B. 1975. Results of transferring adult steelhead above migration barriers to spawn in the Huron River, Baraga County 1967-1970. Mich. Dep. Nat. Resour., Fish. Div. Tech. Rep. No. 75-2. 30 pp.

**603** Miller, D. D. 1987. A model of the population dynamics of stream salmonids. Colo. Div. Wildl. Prog. Rep. Suppl. to Stream Fish. Invest. Job 3: Special regulations evaluations. 29 pp.

**604** Miller, J. M. 1974. The food of brook trout *Salvelinus fontinalis* (Mitchill) fry from different subsections of Lawrence Creek, Wisconsin. Trans. Am. Fish. Soc. 103(1):130-34.

▶Diptera and Ephemeroptera were the dominant orders of insects consumed by trout fry during the first 6 months of life in a productive central Wisconsin trout stream. Simuliids (which are known to be vulnerable to mortality from lampricide TFM levels routinely used to control lamprey populations in the Great Lakes basin) were a major constituent of the diet during May, June, and July.

**605** Miller, R. B. 1957. Have the genetic patterns of fishes been altered by introductions or by selective fishing? J. Fish. Res. Board Can. 14:797-806.

**606** Mills, D. 1971. Salmon and trout: a resource, its ecology, conservation and management. Oliver and Boyd, Edinburgh, Scotland. 351 pp.

**607** Milner A. and L. Smith. 1985. Fyke nets used in a southeastern Alaskan stream for sampling salmon fry and smolts. North Am. J. Fish. Manage. 5:502-06.

**608** Minns, C. K., J. R. M. Kelso, and M. G. Johnson. 1986. Large-scale risk assessment of acid rain impacts on fisheries: models and lessons. Can. J. Fish. and Aquat. Sci. 43:900-21.

**609** Minshall, G. W. 1967. Role of allochthonous detritus in the trophic structure of a woodland springbrook community. Ecology 48:139-49.

**610** Minshall, G. W. 1978. Autotrophy in stream ecosystems. Bioscience 28:767-71.

**611** Moav, R., T. Brody, and G. Hulata. 1978. Genetic improvement of wild fish populations. Science 201:1090-94.

**612** Moeller, G. H. and J. H. Engelken. 1972. What fishermen look for in a fishing experience. J. Wildl. Manage. 36(4):1253-57.

**613** Moersfelder, E. M. 1978. The trout fisherman's legal rights and remedies. pp. 67-70 *in* E. L. Anderson, ed. Proceedings of the Upper Midwest trout symposiums I and II. Univ. Minn., St. Paul. 73 pp.

**614** Montgomery, W. L., S. D. McCormick, R. J. Naiman, F. G. Whoriskey, and G. A. Black. 1983. Spring migratory synchrony of salmonid, catostomid, and cyprinid fishes in Riviere a la Truite, Quebec. Can. J. Zool. 61(11):2495-502.

**615** Moore, H. H. and R. A. Braem. 1965. Distribution of fishes in U.S. streams tributary to Lake Superior. U.S. Fish and Wildl. Serv. Spec. Sci. Rep.-Fish. No. 516. 61 pp.

**616** Moring, J. R. 1980. Nonreporting of recaptures of tagged rainbow trout from an Oregon stream. Prog. Fish-Cult. 42(2):113-15.

**617** Morse, M. N. and H. R. MacCrimmon. 1986. Characterization of post emergent behaviour, distribution, and growth, by young-of-the-year brook trout *Salvelinus fontinalis* and brown trout *Salmo trutta* in allopatry and sympatry. pp. 93-103 *in* J. G. Miller, J. A. Arway, and R. F. Carline, eds. Fifth trout stream habitat improvement workshop. Proc. of a Conf. Lock Haven Univ., Pa. 283 pp.

**618** Mortensen, E. 1977. Density-dependent mortality of trout fry (*Salmo trutta* L.) and its relationship to the management of small streams. J. Fish Biol. 11:613-17.

**619** Mortensen, E. 1978. The population dynamics and production of trout (*Salmo trutta* L.) in a small Danish stream. pp. 151-60 *in* J. R. Moring, ed. Proceedings of the wild trout-catchable trout symposium. Oreg. Dep. Fish and Wildl., Portland. 210 pp.

**620** Mottley, C. M. 1937. Loss of weight by rainbow trout at spawning time. Trans. Am. Fish. Soc. 67:207-10.

**621** Mullan, J. W. 1961. Trout stream management in Massachusetts. Mass. Div. Fish. and Game. Form FG-137. 94 pp.

**622** Mundie, J. H. 1969. Ecological implications of the diet of juvenile coho in streams. pp. 135-52 *in* T. G. Northcote, ed. Symposium on salmon and trout in streams. H. R. MacMillan Lect. in Fish., Univ. B.C., Vancouver. 388 pp.

**623** Mundie, J. H. 1974. Optimization of the salmonid nursery stream. J. Fish. Res. Board Can. 31:1827-37.

►Optimizing of the smolt-rearing potential of a stream depends on controlling discharge, food production, temperature, and cover. Economically feasible enhancement procedures are described which, when applied to channels made alongside streams, should combine some of the desirable features of natural streams with the productive capacities, but not the costs, of hatcheries.

**624** Mundie, J. H. and R. E. Traber. 1983. Movements of coho salmon (*Oncorhynchus kisutch*) fingerlings in a stream following marking with a vital stain. Can. J. Fish. and Aquat. Sci. 40:1318-19.

►A vital stain was used to mark fingerling coho salmon during a population estimation procedure. On only one of 9 occasions were fish evenly distributed throughout the study station 2 to 3 days after staining. On the other occasions, fish showed conspicuous upstream (3 occasions) or downstream (5 occasions) movements.

**625** Mundie, J. H. and R. E. Traber. 1983. The carrying capacity of an enhanced side channel for rearing salmonids. Can. J. Fish. and Aquat. Sci. 40:1320-22.

**626** Murphy, M. L., J. F. Thedinga, K. V. Koski, and G. B. Grette. 1984. A stream ecosystem in an old-growth forest in southeast Alaska. Part 5: Seasonal changes in habitat utilization by juvenile salmonids. pp. 89-98 *in* W. R. Meehan, T. R. Merrell, and T. A. Hanley, eds. Fish and wildlife relationships in old-growth forests. Proc. of the 1982 Symp. held in Juneau, Alsk. 425 pp.

**627** Naiman, R. J., J. M. Melillo, and J. E. Hobbie. 1986. Ecosystem alteration of boreal forest streams by beaver (*Castor canadensis*). Ecology 67(5):1254-69.

**628** Narf, R. P., E. L. Lange, and R. C. Wildman. 1984. Statistical procedures for applying Hilsenhoff's biotic index. J. Freshwater Ecol. 2(5):441-48.

**629** Narver, D. W. 1969. Age and size of steelhead trout in the Babine River, British Columbia. J. Fish. Res. Board Can. 26:2754-60.

**630** Narver, D. W. 1977. Benefits and future of wild steelhead—the British Columbia scene. pp. 51-58 *in* E. Schwiebert, ed. Columbia River salmon and steelhead. Am. Fish. Soc. Spec. Publ. No. 10. 214 pp.

**631** Narver, D. W. and G. D. Taylor. 1980. Wild trout management in British Columbia. pp. 94-100 *in* W. King, ed. Wild trout II. Proc. of a Symp. held at Yellowstone Natl. Park. 164 pp.

**632** Narver, D. W. and F. C. Withler. 1974. Steelhead of the Nanaimo River: aspects of their biology and the fishery from three years of angler's catches. Fish. Res. Board Can., Pacific Biol. Stn. Circ. No. 99. 25 pp.

**633** National Research Council of Canada. 1985. TFM and Bayer 73: lampricides in the aquatic environment. Environ. Secretariat Publ. No. NRCC 22488. 184 pp.

►This report presents a critical review of the use of TFM and Bayer 73 in aquatic systems, including sections on effects on nontarget organisms (mammals, herptiles, nontarget fishes, invertebrates, and aquatic macrophytes), chemistry, use patterns, methods of analysis, mode of action, and fate in the aquatic environment.

**634** Neave, F. 1958. Stream ecology and production of anadromous fish. pp. 43-48 *in* P. A. Larkin, ed. The investigations of fish-power problems. H. R. MacMillan Lect. in Fish., Univ. B.C., Vancouver. 111 pp.

**635** Needham, P. R. 1969. Trout streams. Rev. ed. Holden Day Publ., San Francisco. 241 pp.

**636** Needham, P. R. and A. C. Jones. 1959. Flow, temperature, solar radiation and ice in relation to activities of fishes in Sagehen Creek, California. Ecology 40(3):465-74.

**637** Needham, P. R. and A. C. Taft. 1934. Observations on the spawning of steelhead trout. Trans. Am. Fish. Soc. 64:332-38.

**638** Nehring, R. B. and R. Anderson. 1984. Catch and release management in Colorado—what works? How, when, where, why? pp. 109-12 *in* F. Richardson and R. H. Hamre, eds. Wild trout III. Proc. of a Symp. held at Yellowstone Natl. Park. 192 pp.

**639** Neilson, J. D. and G. H. Geen. 1981. Enumeration of spawning salmon from spawner residence time and aerial counts. Trans. Am. Fish. Soc. 110:554-56.

**640** Neilson, J. D. and G. H. Geen. 1986. First-year growth rate of Sixes River chinook salmon as inferred from otoliths: effects on mortality and age at maturity. Trans. Am. Fish. Soc. 115:28-33.

**641** Neilson, J. D., G. H. Geen, and B. Chan. 1985. Variability in dimensions of salmonid otolith nuclei: implications for stock identification and microstructure interpretation. Fish. Bull. 83(1):81-89.

**642** Nelson, J. E. 1979. A biotic index of the water quality of Chequamegon National Forest streams. U.S. For. Serv., Chequamegon Natl. For. Chequamegon Watershed Rep. 60 pp.

►Benthic macroinvertebrates were qualitatively collected from 41 sites on streams in the Chequamegon National Forest to determine biotic index (BI) values. The wide range of BI

values found was attributed to watershed characteristics and natural occurrences; only one site was affected by human disturbance.

**643** Neves, B. J., S. L. Brayton, and L. A. Helfrich. 1985. Abundance and production of a self-sustaining population of rainbow trout in the South Fork Holston River, Virginia. North Am. J. Fish. Manage. 5:584-89.

**644** Newbold, J. D., D. C. Erman, and K. B. Roby. 1980. Effects of logging on macroinvertebrates in streams with and without buffer strips. Can. J. Fish. and Aquat. Sci. 37(7):1076-85.

**645** Newman, M. A. 1956. Social behavior and interspecific competition in two trout species. Physiol. Zool. 29:64-81.

**646** Nicola, S. J. and A. J. Cordone. 1973. Effects of fin removal on survival and growth of rainbow trout (*Salmo gairdneri*) in a natural environment. Trans. Am. Fish. Soc. 102:753-58.

**647** Nicolette, J. P. and G. R. Spangler. 1986. Population characteristics of adult pink salmon in two Minnesota tributaries to Lake Superior. J. Great Lakes Res. 12(4):237-50.

**648** Niemuth, W. 1967. A study of migratory lake-run trout in the Brule River, Wisconsin. Part 1: brown trout. Wis. Dep. Nat. Resour. Fish Manage. Rep. No. 12. 81 pp.

**649** Niemuth, W. 1970. A study of migratory lake-run trout in the Brule River, Wisconsin. Part 2: rainbow trout. Wis. Dep. Nat. Resour. Fish Manage. Rep. No. 38. 70 pp.

▶The 2 preceding reports present the results of 4 years of intensive fishery investigation of the migratory brown and rainbow trout populations in the Brule River, Douglas County. Topics of investigation included fish movements and dispersal; age, size, growth, and mortality of trout; spawning behavior, spawning areas, and fecundity; incidence of lamprey scarring; creel census results; and attempted estimation of population sizes. Management considerations and recommendations are discussed.

**650** Nilsson, N. A. 1965. Food segregation between salmonid species in north Sweden. Inst. Freshwater Res., Drottningholm, Sweden. Rep. No. 46:58-78.

**651** Noakes, D. L. G. 1978. Social behaviour as it influences fish production. pp. 360-82 *in* S. D. Gerking, ed. Ecology of freshwater fish production. John Wiley and Sons, New York. 520 pp.

**652** Noakes, D. L. G. 1980. Social behavior of young charrs. pp. 683-701 *in* E. K. Balon, ed. Charrs, salmonid fishes of the genus *Salvelinus*. Dr. W. Junk Publ., The Hague, Netherlands. 928 pp.

**653** Nordeng, H. 1971. Is the local orientation of anadromous fishes determined by pheromones? Nature 233(5319):411-13.

**654** Northcote, T. G. 1962. Migratory behavior of juvenile rainbow trout, *Salmo gairdneri*, in outlet and inlet streams of Loon Lake, British Columbia. J. Fish. Res. Board Can. 19(2):201-70.

**655** Northcote, T. G. 1969. Patterns and mechanisms in the lakeward migratory behaviour of juvenile trout. pp. 183-203 *in* T. G. Northcote, ed. Symposium on salmon and trout in streams. H. R. MacMillan Lect. in Fish., Univ. B.C., Vancouver. 388 pp.

**656** Northcote, T. G. 1978. Migratory strategies and production in freshwater fishes. pp. 326-59 *in* S. D. Gerking, ed. Ecology of freshwater fish production. John Wiley and Sons, New York. 520 pp.

**657** Novitzki, R. P. 1973. Improvement of trout streams in Wisconsin by augmenting low flows with ground water. U.S. Geol. Surv. Water-Supply Pap. 2017. 52 pp.

**658** Nuhfer, A. J. 1979. Use of artificial instream trout shelters by trout in the Au Sable River, Michigan. Mich. State Univ., East Lansing. M.S. Thesis. 115 pp.

**659** O'Connor, J. F. and G. Power. 1976. Production of brook trout in the Matamek watershed, Quebec. J. Fish. Res. Board Can. 33(1):118-23.

**660** O'Donnell, D. J. 1944. A history of fishing in the Brule River. Trans. Wis. Acad. Sci., Arts and Lett. 36:19-31.

▶This report presents the best historical account available of early fishing trends on the Brule River up to the early 1940s.

**661** O'Donnell, D. J. 1945. Four-year creel census on the Brule River, Douglas County, Wisconsin. Trans. Wis. Acad. Sci., Arts and Lett. 37:279-303.

▶This report describes the results of the most complete series of creel surveys done on the Brule River up to the 1940s.

**662** O'Donnell, D. J. and W. S. Churchill. 1954. Certain physical, chemical and biological aspects of the Brule River, Douglas County, Wisconsin. Trans. Wis. Acad. Sci., Arts and Lett. 43:201-55.

▶This report summarizes the results of a thorough study of a variety of physical, chemical, and biological aspects of the Brule River ecosystem. Topics include anchor ice formation, fishes and fish populations, movement of fishes, spawning areas, food of fishes, and water chemistry. As with the 2 preceding papers, this paper was subsequently issued under one cover with a number of other works from a large interdisciplinary study done on the Brule River in the early 1940s (see Wis. Cons. Dep. 1954).

**663** Odum, H. T. 1956. Primary production in flowing waters. Limnol. Oceanogr. 1:102-17.

**664** Olsen, K. H. 1986. Chemo-attraction between juveniles of two sympatric stocks of Arctic charr, *Salvelinus alpinus* (L.), and their gene frequency of serum esterases. J. Fish Biol. 28:221-31.

**665** Onodera, K. 1962. Carrying capacity in a trout stream. Bull. Freshwater Fish. Res. Lab. 12(1):1-41.

**666** Onodera, K. and T. Ueno. 1961. On the survival of trout fingerlings stocked in a mountain brook. 2: Survival rate measured and scouring effect of flood as a cause of mortality. Bull. Jap. Soc. Sci. Fish. 27(6):530-57.

**667** Opdycke, J. D. and P. Zajac. 1981. Evaluation of half-length binary coded wire tag application in juvenile chum salmon. Prog. Fish-Cult. 43:48.

**668** Orcutt, D. R., B. R. Pulliam, and A. Arp. 1968. Characteristics of steelhead trout redds in Idaho streams. Trans. Am. Fish. Soc. 97:42-45.

**669** Ottaway, E. M., R. A. Carling, A. Clarke, and N. A. Reader. 1981. Observations on the structure of brown trout, *Salmo trutta* Linnaeus, redds. J. Fish Biol. 19:593-607.

**670** Ottaway, E. M. and A. Clarke. 1981. A preliminary investigation into the vulnerability of young trout (*Salmo trutta* L.) and Atlantic salmon (*S. salar* L.) to downstream displacement by high water velocities. J. Fish Biol. 19:135-45.

**671** Paloheimo, J. E. 1980. Estimation of mortality rates in fish populations. Trans. Am. Fish. Soc. 109(4):378-86.

**672** Parkinson, E. A. 1984. Genetic variation in populations of steelhead trout (*Salmo gairdneri*) in British Columbia. Can. J. Fish. and Aquat. Sci. 41:1412-20.

►This paper describes a pattern of biochemical genetic variation in steelhead that supports the hypothesis that this species is subdivided into a large number of semi-isolated populations, each having the potential to evolve adaptations to local environmental conditions.

**673** Parkinson, E. A. and P. A. Slaney. 1975. A review of enhancement techniques applicable to anadromous gamefishes. B.C. Fish and Wildl. Branch. Fish. Manage. Rep. No. 66. 100 pp.

►This report provides a wealth of information on the various techniques and considerations for enhancing natural populations of anadromous salmonids—particularly steelhead trout. The culture of anadromous game fish is also thoroughly addressed. A discussion of the life history characteristics and factors limiting the production of anadromous game fishes is included.

**674** Parry, G. 1979. Osmotic and ionic changes in blood and muscle of migrating salmonids. pp. 364-79 *in* M. S. Love and G. M. Cailliet, eds. Readings in ichthyology. Goodyear Publ. Co., Santa Monica, Calif. 525 pp.

**675** Patrick, R. 1951. A proposed biological measure of stream conditions. Proc. of the Int. Assoc. of Theor. and Appl. Limnol. 11:299-307.

**676** Pauley, G. B., B. M. Bortz, and M. F. Shepard. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest)—steelhead trout. U.S. Fish and Wildl. Serv. Biol. Rep. No. 82(11.62). 24 pp.

**677** Paulik, G. J. 1963. Detection of incomplete reporting of tags. Int. Comm. Northwest Atl. Fish. Spec. Publ. 4:238-47.

**678** Paulik, G. J. and A. C. Delacy. 1957. Swimming abilities of upstream migrant silver salmon, sockeye salmon, and steelhead at several water velocities. Univ. Wash., School Fish. Tech. Rep. No. 44.

**679** Pautzke, C. F. and R. C. Meigs. 1941. Studies on the life history of the Puget Sound steelhead trout (*Salmo gairdneri*). Trans. Am. Fish. Soc. 70:209-20.

**680** Pearlstone, D. S. M. 1976. Management implications of summer habitat characteristics of juvenile steelhead trout (*Salmo gairdneri*) in the Big Qualicum River. B.C. Fish and Wildl. Branch. Fish Manage. Rep. No. 67. 13 pp.

**681** Pearse Bowden Economics Consultants Ltd. 1970. The value of non-resident sport fishing in British Columbia. B.C. Dep. Rec. and Conserv. Econ. Wildl. and Recreat. Study Rep. No. 4. 65 pp.

**682** Pearse Bowden Economics Consultants Ltd. 1971. The value of fresh water sport fishing in British Columbia. B.C. Dep. Rec. and Conserv. Econ. Wildl. and Recreat. Study Rep. No. 5. 64 pp.

**683** Peck, J. W. 1970. Straying and reproduction of coho salmon, *Oncorhynchus kisutch*, planted in a Lake Superior tributary. Trans. Am. Fish. Soc. 99(3):591-95.

**684** Peck, J. W. 1974. Migration, food habits, and predation on yearling coho salmon in a Lake Michigan tributary and bay. Trans. Am. Fish. Soc. 103(2):10-14.

**685** Pennsylvania Fish Commission. 1986. Management of trout fisheries in Pennsylvania waters. Pa. Fish Comm., Div. Fish. 122 pp.

**686** Peterman, R. M. 1975. New techniques for policy evaluation in ecological systems: methodology for a case study of Pacific salmon fisheries. J. Fish. Res. Board Can. 32:2179-88.

►This paper presents "desk-top optimizer," a tool that permits decision-makers to perform fairly sophisticated "optimization" operations

at their desks instead of having to rely on decision theorists or operation researchers.

**687** Peterman, R. M. 1977. A simple mechanism that causes collapsing stability regions in exploited salmonid populations. J. Fish. Res. Board Can. 34:1130-42.

**688** Peterman, R. M. 1981. Form of random variation in salmon smolt-to-adult relations and its influence on production estimates. Can. J. Fish. and Aquat. Sci. 38:1113-19.

**689** Peterman, R. M. and R. D. Routledge. 1983. Experimental management of Oregon coho salmon (*Oncorhynchus kisutch*): designing for yield of information. Can. J. Fish. and Aquat. Sci. 40:1212-23.

**690** Peterson, D. A. 1972. Barometric pressure and its effect on spawning activities of rainbow trout. Prog. Fish-Cult. 24(2):110-12.

**691** Peterson, R. H., A. M. Sutterlin, and J. L. Metcalfe. 1979. Temperature preference of several species of *Salmo* and *Salvelinus* and some of their hybrids. J. Fish. Res. Board Can. 36:1137-40.

**692** Pettit, S. W. 1977. Comparative reproductive success of caught-and-released and unplayed hatchery female steelhead trout (*Salmo gairdneri*) from the Clearwater River, Idaho. Trans. Am. Fish. Soc. 106(5):431-35.

▶The "bloody egg syndrome" was not substantiated by the results of this study. No differences in reproductive success between caught-and-released and unplayed hatchery females were found.

**693** Pettit, S. W. 1977. Steelhead catch-and-release research and regulations on the Clearwater River, Idaho. pp. 169-75 *in* R. A. Barnhart and T. D. Roelofs, eds. Catch and release fishing. Proc. of a Natl. Symp. Humboldt State Univ., Arcata, Calif. 220 pp.

▶Although the catch-and-release regulation remains largely experimental and has not gained wide acceptance with steelhead managers, this report shows that it can be a useful tool in managing depressed steelhead stocks. In this Idaho study, angler attitudes played an important role in catch-and-release usefulness and popularity. Anglers were taught to recognize the differences between wild and hatchery-reared steelhead; then catch-and-release regulations were used to protect wild stocks, yet permit the harvest of hatchery fish.

**694** Phillips, R. W., L. L. Lantz, E. W. Claire, and J. R. Moring. 1975. Some effects of gravel mixtures on emergence of coho salmon and steelhead trout fry. Trans. Am. Fish. Soc. 105(3):461-65.

**695** Phinney, D. E. and S. B. Mathews. 1969. Field test of fluorescent pigment marking and finclipping of coho salmon. J. Fish. Res. Board Can. 26:1619-24.

**696** Phinney, D. E. and S. B. Mathews. 1973. Retention of fluorescent pigment by coho salmon after two years. Prog. Fish-Cult. 35:161-63.

**697** Pister, E. P. 1978. Wild trout concepts and the management of threatened fishes. pp. 49-59 *in* K. Hashagen, ed. Wild trout management. Proc. of a Natl. Symp. Calif. Trout, Inc., San Francisco. 69 pp.

**698** Pitman, D. R. and P. J. Wingate. 1986. Lake Superior tributary sampling guide. Minn. Dep. Nat. Resour., Div. Fish and Wildl., Sect. Fish. Spec. Publ. No. 141. 61 pp.

**699** Platts, W. S. 1974. Geomorphic and aquatic conditions influencing salmonids and stream classification with application to ecosystem classification. U.S. For. Serv. SEAM Publ. 199 pp.

**700** Platts, W. S. 1976. Validity of methodologies to document stream environments for evaluating fishery conditions. pp. 267-84 *in* J. F. Orsborn and C. H. Allman, eds. Instream flow needs. Vol. 2. Am. Fish. Soc., Bethesda, Md. 657 pp.

**701** Platts, W. S., W. F. Megahan, and G. W. Minshall. 1983. Methods for evaluating stream, riparian, and biotic conditions. U.S. For. Serv. Gen. Tech. Rep. INT-138. 70 pp.

**702** Platts, W. S. and V. E. Penton. 1980. A new freezing technique for sampling salmonid redds. U.S. For. Serv. Res. Pap. INT-248. 22 pp.

**703** Platts, W. S. and J. N. Rinne. 1985. Riparian and stream enhancement, management, and research in the Rocky Mountains. North Am. J. Fish. Manage. 5:115-25.

**704** Platts, W. S., M. A. Shirazi, and D. H. Lewis. 1979. Sediment particle sizes used by salmon for spawning with methods for evaluation. U.S. Environ. Prot. Agency. Rep. No. EPA/600/3-79/043. 39 pp.

**705** Pollard, H. A. and T. C. Bjornn. 1973. The effects of angling and hatchery trout on the abundance of juvenile steelhead trout. Trans. Am. Fish. Soc. 102(4):745-52.

**706** Pollard, J. E. and W. L. Kinney. 1979. Assessment of macroinvertebrate monitoring techniques in an energy development area: a test of the efficiency of three macrobenthic sampling methods in the White River. U.S. Environ. Prot. Agency. Rep. No. EPA/600/7-79/163. 26 pp.

▶Three methods of macroinvertebrate collection—Surber sampler, portable invertebrate box sampler (PIBS), and standardized traveling kick method (STKM)—were evaluated in riffle areas of a Colorado river for selectivity, reproducibility of results, capture effectiveness, and cost efficiency. The STKM collected the largest number and most taxa of animals per sample with equivalent or lower variability than the other 2 methods and was judged to be superior from a cost-efficiency standpoint as well.

**707** Potter, B. A., B. R. Zalewski, B. A. Barton, and N. C. Fraser. 1982. Summary and annotated bibliography of Salmoninae stocking investigations, stocking assessment methodology, and stocking policies in North America. Ont. Minist. Nat. Resour., Toronto. 183 pp.

**708** Power, G. 1973. Estimates of age, growth, standing crop and production of salmonids in some north Norwegian rivers and streams. Inst. Freshwater Res., Drottningholm, Sweden. Rep. No. 53:78-111.

**709** Power, G. 1979. The brook charr, *Salvelinus fontinalis*. pp. 141-230 *in* E. K. Balon, ed. Charrs, salmonid fishes of the genus *Salvelinus*. Dr. W. Junk Publ., The Hague, Netherlands. 928 pp.

**710** Power, G. 1981. Stock characteristics and catches of Atlantic salmon (*Salmo salar*) in Quebec, and Newfoundland and Labrador in relation to environmental variables. Can. J. Fish. and Aquat. Sci. 38:1601-11.

**711** Powers, J. E., R. T. Lackey, and J. R. Zuboy. 1975. Decision-making in recreational fisheries management: an analysis. Trans. Am. Fish. Soc. 104(3):630-34.

**712** Powers, P. D. and J. F. Orsborn. 1985. Analysis of barriers to upstream fish migration: an investigation of the physical and biological conditions affecting fish passage success at culverts and waterfalls. U.S. Dep. Energy, Bonneville Power Adm., Div. Fish and Wildl. Final Report Proj. No. 82-14. 120 pp.

**713** Quinn, T. P. and R. F. Tallman. 1987. Seasonal environmental predictability and homing in riverine fishes. Environ. Biol. Fishes 18(2):155-59.

**714** Radford, D. S. 1975. The harvest of fish from Dutch Creek, a mountain stream open to angling on alternate years. Alberta Recreat., Park and Wildl. Manage. Rep. No. 15. 54 pp.

**715** Radford, D. S. 1975. The harvest of sport fish from the Oldman River, a mountain stream open to angling on alternate years. Alberta Recreat., Park and Wildl. Manage. Rep. No. 16. 48 pp.

**716** Raleigh, R. F. 1982. Habitat suitability index models: brook trout. U.S. Fish and Wildl. Serv. Rep. No. FWS/OBS-82/10.24. 42 pp.

**717** Raleigh, R. F. and D. A. Duff. 1980. Trout stream habitat improvement: ecology and hydrology. pp. 67-77 *in* F. Richardson and R. H. Hamre, eds. Wild trout III. Proc. of a Symp. held at Yellowstone Natl. Park. 192 pp.

**718** Raleigh, R. F. and P. C. Nelson. 1985. Habitat suitability index models and instream flow suitability curves: pink salmon. U.S. Fish and Wildl. Serv. Rep. No. FWS/OBS-82/10.109. 36 pp.

**719** Raleigh, R. F., L. D. Zuckerman, and P. C. Nelson. 1984. Habitat suitability index models and instream flow suitability curves: brown trout. U.S. Fish and Wildl. Serv. Rep. No. FWS/OBS-82/10.71. 71 pp.

**720** Raymond, H. L. 1974. Marking fishes and invertebrates. 1: State of the art of fish branding. MFR Pap. 1067. Mar. Fish. Rev. 36(7):1-6.

►This paper presents a useful review of the advantages and disadvantages of a variety of fish marking methods with particular emphasis on anadromous salmonid species. Problems associated with the cold branding technique are discussed in particular detail.

**721** Raymond, H. L. 1979. Effects of dams and improvements on migrations of juvenile chinook salmon and steelhead from the Snake River, 1966 to 1975. Trans. Am. Fish. Soc. 108:505-29.

**722** Red Clay Interagency Committee. 1967. Erosion and sedimentation control on the red clay soils of northwestern Wisconsin. Wisconsin Soil Conserv. Board, Madison. 23 pp.

►A brief nontechnical summary of problems and committee recommendations concerning red clay erosion in northwestern Wisconsin is provided in this report.

**723** Redding, J. M. 1979. Chronic turbidity and stress in juvenile coho salmon and steelhead trout. Oreg. Coop. Fish. Res. Unit. Annu. Rep. 1978-79:16-36.

**724** Redding, J. M., C. B. Schreck, and F. H. Everest. 1987. Physiological effects on coho salmon and steelhead of exposure to suspended solids. Trans. Am. Fish. Soc. 116:737-44.

**725** Reeves, G. H. and T. D. Roelofs. 1982. Influence of forest and rangeland management on anadromous fish habitat in western North America. 13: Rehabilitating and enhancing stream habitat 2: Field application. W. R. Meehan, tech. ed. U.S. For. Serv. Gen. Tech. Rep. PNW-140. 38 pp.

**726** Reimers, N. 1956. Some aspects of the relation between stream foods and trout survival. Calif. Fish and Game 43(1):43-69.

**727** Reingold, M. 1965. Steelhead spawning study. Ida. Wildl. Rev. 17:8-10.

**728** Reingold, M. 1975. Effects of displacing, hooking, and releasing on migratory adult steelhead trout. Trans. Am. Fish. Soc. 104(3):458-60.

►Upstream migrating steelhead were collected, transported various distances back downstream, and hooked and played to exhaustion prior to marking and releasing them. Played and unplayed fish returned to their target spawning streams in equal numbers.

**729** Reisenbichler, R. R. and J. D. McIntyre. 1977. Genetic differences in growth and survival of juvenile hatchery and wild steelhead trout,

*Salmo gairdneri*. J. Fish. Res. Board Can. 34:123-28.

**730** Reiser, D. W. and T. C. Bjornn. 1979. Influence of forest and rangeland management on anadromous fish habitat in western North America. 1: Habitat requirements of anadromous salmonids. W. R. Meehan, tech. ed. U.S. For. Serv. Gen. Tech. Rep PNW-96. 54 pp.

▶This comprehensive summary of anadromous salmonid habitat requirements in streams details spawning, incubation, and juvenile rearing needs.

**731** Reiser, D. W. and T. A. Wesche. 1977. Determination of physical and hydraulic preferences of brown and brook trout in the selection of spawning locations. Univ. Wyo., Water Resour. Res. Inst. Water Res. Ser. 64. 100 pp.

**732** Renyard, T. S. and R. Hilborn. 1986. Sports angler preferences for alternative regulatory methods. Can. J. Fish. and Aquat. Sci. 43(1):240-42.

**733** Rettig, R. B. 1987. Bioeconomic models: do they really help fishery managers? Trans. Am. Fish. Soc. 116:405-11.

**734** Reynolds, D. B. 1947. Summary of twenty months investigation on the Platte River and adjacent waters, Benzie County, Michigan, with special reference to the rainbow trout (*Salmo gairdneri irideus*). Univ. Mich., Ann Arbor. M.S. Thesis. 74 pp.

**735** Richards, M. R. 1983. Wild salmon and trout: public acceptance and policy implementation. pp. 134-38 *in* D. A. Kirkpatrick and T. Ameslav, eds. Proceedings of the wild salmon and trout conference. Seattle Univ., Seattle. 152 pp.

**736** Ricker, W. E. 1973. Two mechanisms that make it impossible to maintain peak-period yields from stocks of Pacific salmon and other fishes. J. Fish. Res. Board Can. 30:1275-86.

**737** Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191. 382 pp.

**738** Riddell, B. E. and W. C. Leggett. 1981. Evidence of an adaptive basis for geographic variation in body morphology and time of downstream migration of juvenile Atlantic salmon (*Salmo salar*). Can. J. Fish. and Aquat. Sci. 38:308-20.

**739** Ringler, N. H. 1979. Selective predation by drift feeding brown trout (*Salmo trutta*). J. Fish. Res. Board Can. 36:392-403.

**740** Robson, D. S. 1960. An unbiased sampling and estimation procedure for creel censuses of fishermen. Biometrics 16(2):261-77.

**741** Robson, D. S. 1961. On the statistical theory of a roving creel census of fishermen. Biometrics 17(3):415-37.

**742** Roedel, P. M., ed. 1975. Optimum sustainable yield as a concept in fisheries management. Am. Fish. Soc. Spec. Publ. No. 9. 89 pp.

**743** Roelofs, T. D. 1984. Wild summer steelhead trout in California. pp. 41-46 *in* F. Richardson and R. H. Hamre, eds. Wild Trout III. Proc. of a Symp. held at Yellowstone Natl. Park. 192 pp.

**744** Rohrer, R. L. 1984. Subproject 4: river and stream investigations. Study 11: Henry's Fork fisheries investigations. Ida. Dep. Fish and Game. Perf. Rep. Dingell-Johnson Proj. F-73-R-5. 34 pp.

**745** Rombough, P. J. and J. O. T. Jensen. 1985. Reduced water uptake and resistance to deformation in acid-exposed eggs of steelhead *Salmo gairdneri*. Trans. Am. Fish. Soc. 114:571-76.

**746** Rose, G. A. 1986. Growth decline in subyearling brook trout (*Salvelinus fontinalis*) after emergence of rainbow trout (*Salmo gairdneri*). Can. J. Fish. and Aquat. Sci. 43(1):187-93.

**747** Rosentreter, N. 1977. Characteristics of hatchery fish: angling, biology, and genetics. pp. 79-83 *in* E. Schwiebert, ed. Columbia River salmon and steelhead. Am. Fish. Soc. Spec. Publ. No. 10. 214 pp.

**748** Rosgen, D. and B. L. Fittante. 1986. Fish habitat structures—a selection guide using stream classification. pp. 163-79 *in* J. G. Miller, J. A. Arway, and R. F. Carline, eds. Fifth trout stream habitat improvement workshop. Proc. of a Conf. Lock Haven Univ., Pa. 238 pp.

**749** Rounsefell, G. A. 1957. Fecundity of North American Salmonidae. Fish. Bull. 57:451-68.

**750** Rounsefell, G. A. 1958. Anadromy in North American Salmonidae. Fish. Bull. 58:171-85.

**751** Royal, L. A. 1972. An examination of the anadromous trout program of the Washington State Game Department. Wash. Game Dep. Spec. Rep. 176 pp.

▶This report provides complete review of all aspects of the anadromous trout program in Washington. Sections are included on statistics, natural ecology of salmonids, and fish culture programs. Emphasis is on steelhead, coho and chinook salmon, and species interrelationships.

**752** Ruggles, C. P. 1966. Depth and velocity as a factor in stream rearing and production of juvenile coho salmon. Can. Fish Cult. 38:35-53.

**753** Ruggles, C. P. 1980. A review of the downstream migration of Atlantic salmon. Can. Tech. Rep. Fish. and Aquat. Sci. No. 952. 39 pp.

**754** Russell, L. R. 1975. An annotated bibliography on steelhead trout and general salmonid ecology. B.C. Fish and Wildl. Branch. Fish. Tech.

Circ. No. 14. 178 pp.

▶This comprehensive bibliography should prove particularly helpful to steelhead managers because of the high quality and thoroughness of the annotations. The bibliography includes over 800 references; over 400 are annotated.

**755** Ryan, P. M. 1984. Fyke net catches as indices of the abundance of brook trout, *Salvelinus fontinalis*, and Atlantic salmon, *Salmo salar*. Can. J. Fish. and Aquat. Sci. 41:377-80.

**756** Ryan, P. M. 1986. Prediction of angler success in an Atlantic salmon, *Salmo salar*, fishery two fishing seasons in advance. Can. J. Fish. and Aquat. Sci. 43:2531-34.

**757** Salli, A. J. 1962. A study of the age and growth of the rainbow trout (*Salmo gairdneri* Richardson) of the Brule River, Douglas County, Wisconsin, prior to migration to Lake Superior. Univ. Wis.-Madison. M.S. Thesis. 79 pp.

▶Lengths-at-age were validated for juvenile rainbow trout in a mainstream reach of the Brule River. The body-length/scale-length relationship for rainbow trout was described by the equation $L = 18.13 + 1.495S$. Growth rates and length/weight relationships were determined for juvenile brook, brown, and rainbow trout.

**758** Salli, A. J. 1974. The distribution and behavior of young-of-the-year trout in the Brule River of northwestern Wisconsin. Univ. Wis.-Madison. Ph.D. Thesis. 278 pp.

▶A distinct segregation of young-of-the-year brook, brown, and rainbow trout occurred in the Brule River due to different times of emergence and use of different microhabitats. The detailed microhabitat preferences of these species are explained. A wealth of observations were recorded on territoriality and on feeding and social behavior.

**759** Salo, E. O. 1974. Anadromous fishes. pp. 12-21 A. R. Grove, Jr., ed. *in* Salmonid management. Suppl. to Trout 15(1).

**760** Sather, L. M. and S. I. Johannes. 1973. Surface water resources of Douglas County. Wis. Dep. Nat. Resour., Madison. 161 pp.

▶The document summarizes selected physical and chemical data for all surface water resources in Douglas County. Tributaries to the Brule River are treated individually.

**761** Saunders, J. W. and M. W. Smith. 1962. Physical alteration of stream habitat to improve trout production. Trans. Am. Fish. Soc. 91:185-88.

**762** Saunders, J. W. and M. W. Smith. 1964. Changes in a stream population of trout associated with increased silt. J. Fish. Res. Board Can. 22(2):395-404.

**763** Saunders, R. L. and K. R. Allen. 1967. Effects of tagging and of fin-clipping on the survival and growth of Atlantic salmon between smolt and adult stages. J. Fish. Res. Board Can. 24(12):2595-611.

**764** Saunders, R. L. and C. B. Schom. 1985. Importance of the variation in life history parameters of Atlantic salmon (*Salmo salar*). Can. J. Fish. and Aquat. Sci. 42:615-18.

**765** Scarnecchia, D. L. 1987. Rapid removal of otoliths from salmonids. North Am. J. Fish. Manage. 7:312-13.

**766** Scarnecchia, D. L. and E. P. Bergersen. 1987. Trout production and standing stock in Colorado's small streams, as related to environmental features. North Am. J. Fish. Manage. 7(3):315-30.

**767** Schaffer, W. M. and P. F. Elson. 1975. The adaptive significance of variation in life history among local populations of Atlantic salmon in North America. Ecology 56:577-90.

**768** Schill, D. J. and J. S. Griffith. 1984. Use of underwater observations to estimate cutthroat trout abundance in the Yellowstone River. North Am. J. Fish. Manage. 4:479-87.

**769** Schill, D. J., J. S. Griffith, and R. E. Gresswell. 1986. Hooking mortality of cutthroat trout in a catch-and-release segment of the Yellowstone River, Yellowstone National Park. North Am. J. Fish. Manage. 6:226-32.

**770** Schneberger, E. and A. D. Hasler. 1944. Brule River survey: introduction. Trans. Wis. Acad. Sci., Arts and Lett. 36:1-5.

**771** Schnick, R. A. 1972. A review of literature on TFM (3-trifluoromethyl-4-nitrophenol) as a lamprey larvicide. U.S. Fish and Wildl. Serv. Invest. Fish Control No. 44. 31 pp.

▶This review considers the history of lampricide development, physical and chemical properties of TFM, efficacy, toxicity on nontarget species, modes of action on sea lamprey, residues, application methods, and registration. The bibliography contains 150 references.

**772** Scholl, D. K., P. J. Peeters, and S. T. Schram. 1984. Migratory brown trout and rainbow trout populations of the Brule River, Wisconsin. Wis. Dep. Nat. Resour. Fish Manage. Rep. No. 123. 93 pp.

▶Methods used during this study largely replicated those of Niemuth (1967, 1970) in 1961-64, so that changes occurring to the migratory trout populations since the early 1960s could be documented. Few changes occurred in the migratory brown trout population either in numbers of fish or in size or age structure. Rainbow trout, however, increased in both numbers and average size over that time. Topics of investigation covered in this report include trout movement and catch, size structure, age and growth, injuries and abnormalities, mortality,

locations of angler-caught tagged trout, trout spawning areas and conditions, creel survey results, and significance of Pacific salmon in the Brule River.

**773** Scholz, A. T., R. M. Horrall, J. C. Cooper, A. D. Hasler, D. M. Madison, R. J. Poff, and R. I. Daly. 1975. Artificial imprinting of salmon and trout in Lake Michigan. Wis. Dep. Nat. Resour. Fish Manage. Rep. No. 80. 45 pp.

▶This study documented the ability of coho salmon and steelhead trout to learn and use artificial chemical cues for home stream detection. A summary of imprinting techniques details information about equipment, selection of chemicals, critical exposure periods, and stocking procedures.

**774** Schreck, C. B. 1980. Research perspectives for management of wild steelhead trout. pp. 26-32 *in* W. King, ed. Wild trout II. Proc. of a Symp. held at Yellowstone Natl. Park. 164 pp.

▶Wild steelhead stocks were found to differ genetically, and some of these differences were correlated with differences in performance of the populations. A model of performance of steelhead under various habitat elements is presented that has heuristic potential for understanding the interaction between the population and its environment.

**775** Schreck, C. B. 1982. Parr-smolt transformation and behavior. pp. 164-72 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**776** Schumacher, R. E. and J. G. Hale. 1962. Third generation pink salmon, *Oncorhynchus gorbuscha* (Walbaum), in Lake Superior. Trans. Am. Fish. Soc. 91(4):421-22.

**777** Scott, W. B. and E. J. Crossman. 1973. Freshwater fishes of Canada. Bull. Fish. Res. Board Can. 184. 966 pp.

**778** Seber, G. A. F. and E. D. Le Cren. 1967. Estimating population parameters from catches large relative to the population. J. Anim. Ecol. 36(3):631-43.

**779** Sedell, J. R. and K. J. Luchessa. 1982. Using the historical record as an aid to salmonid habitat enhancement. pp. 210-23 *in* N. B. Armantrout, ed. Aquisition and utilization of aquatic habitat inventory information. Proc. of a Symp. Am. Fish. Soc., Bethesda, Md. 376 pp.

**780** Seeb, J. E., L. W. Seeb, and F. M. Utter. 1986. Use of genetic marks to assess stock dynamics and management programs for chum salmon. Trans. Am. Fish. Soc. 115:448-54.

**781** Seegrist, D. W. and R. Gard. 1972. Effects of floods on trout in Sagehen Creek, California. Trans. Am. Fish. Soc. 101:478-82.

▶Winter floods caused high mortality of developing brook trout eggs. Survival of rainbow trout fry increased in years following winter floods, presumably due to reduced competition with young brook trout. Spring floods killed large numbers of rainbow trout eggs, which apparently contributed to increased survival of young brook trout during those years.

**782** Seelbach, P. W. 1985. Smolting success of hatchery-raised steelhead planted in a Michigan tributary of Lake Michigan. North Am. J. Fish. Manage. 7:223-31.

▶Four groups of hatchery-raised steelhead (spring yearlings, fall fingerlings, fall yearlings, and large spring yearlings) were released in the Little Manistee River, Michigan, and were assessed regarding survival from planting to smolting. Costs were calculated based on the number of fish surviving to smolting. Large spring yearlings exhibited 50% survival from planting to smolting and were the most economical and practical group for stocking.

**783** Seelbach, P. W. 1987. Effect of winter severity on steelhead smolt yield in Michigan: an example of the importance of environmental factors in determining smolt yield. Am. Fish. Soc. Symp. 1:441-50.

▶Annual steelhead smolt yield from the Little Manistee River, Michigan, varied from 10,000 to 72,000 during 1981-85 despite consistent age I+ parr production. Smolt yield varied with mortality during the presmolt winter. Overwinter mortality (range 13-90%) was highly correlated with an index of the intensity of cold temperatures.

**784** Seelbach, P. W. and G. B. Beyerle. 1984. Interpretation of the age and growth of anadromous salmonids using scale analysis. Mich. Dep. Nat. Resour. Fish. Tech. Rep. No. 84-5. 9 pp.

**785** Seelbach, P. W., R. N. Lockwood, and G. R. Alexander. 1985. A modified inclined-screen trap for catching salmonid smolts in large rivers. North Am. J. Fish. Manage. 5:494-98.

▶This report gives design specifications for a smolt trap featuring a hanging inclined screen, floating catch barge, and fish sorter to be used in conjunction with a low head dam. This design represents a successful system for sampling smolt out-migrations in rivers if a dam with the proper head is available.

**786** Seelbach, P. W. and G. E. Whelan. 1988. Identification and contribution of wild and hatchery steelhead stocks in Lake Michigan tributaries. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1950. 21 pp.

**787** Seifert, M. F. 1968. Distribution and downstream movement of under-yearling rainbow trout in Cayuga Inlet, New York. Cornell Univ., Ithaca, N.Y. M.S. Thesis. 62 pp.

**788** Sewell, W. R. D. and J. Rostron. 1970. Recreational fishing evaluation. Can. Dep. Fish. and For., Ottawa. 133 pp.

**789** Shannon, L. J. 1979. Dietary habits and food niche overlap among three trout species in a North Shore stream. Univ. Minn., Duluth. M.S. Thesis. 110 pp.

**790** Shapovalov, L. 1967. Biology and management of steelhead trout in California. Calif. Dep. Fish and Game. Inland Fish. Adm. Rep. No. 67-7. 6 pp.

**791** Shapovalov, L. and A. C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. Calif. Dep. Fish and Game. Fish Bull. No. 98. 375 pp.

▶Results are presented from an exhaustive investigation into all fresh-water aspects of the life history and population dynamics of steelhead rainbow trout and silver salmon in a small California river. This classic study provided much of the scientific knowledge for subsequent management plans for these species in their native range.

**792** Shardlow, T., R. Hilborn, and D. Lightly. 1987. Components analysis of instream escapement methods for Pacific salmon (*Oncorhynchus* spp.). Can. J. Fish. and Aquat. Sci. 44:1031-37.

**793** Sharpe, W. E. 1975. Timber management influences on aquatic ecosystems and recommendations for future research. Water Resour. Bull. 11(3):546-50.

**794** Shaul, L. D., P. L. Gray, and J. F. Koerner. 1984. Migratory patterns and timing of Stikine River coho salmon (*Oncorhynchus kisutch*) based on coded wire tagging studies, 1978-1982. Alsk. Dep. Fish and Game. Inf. Leafl. No. 232. 42 pp.

**795** Sheppard, J. D. and J. H. Johnson. 1985. Probability-of-use for depth, velocity, and substrate by subyearling coho salmon and steelhead in Lake Ontario tributary streams. North Am. J. Fish. Manage. 5:277-82.

**796** Shetter, D. S. 1965. Observations on the natural history of the rainbow trout and rainbow trout fishing in the East Branch of the AuGres River, Iosco County, Michigan. Mich. Dep. Nat. Resour. Res. and Dev. Rep. No. 23.

**797** Shetter, D. S. 1968. Observations on movements of wild trout in two Michigan stream drainages. Trans. Am. Fish. Soc. 97(4):472-80.

**798** Shetter, D. S. 1969. The effects of certain angling regulations on stream trout populations. pp. 333-53 *in* T. G. Northcote, ed. Symposium on salmon and trout in streams. H. R. MacMillan Lect. in Fish., Univ. B.C., Vancouver. 388 pp.

**799** Shetter, D. S. and G. R. Alexander. 1962. Effects of a flies-only restriction on angling and on fall trout populations in Hunt Creek, Montmorency County, Michigan. Trans. Am. Fish. Soc. 91(3):295-302.

**800** Shetter, D. S. and G. R. Alexander. 1965. Results of angling under special and normal trout fishing regulations in a Michigan trout stream. Trans. Am. Fish. Soc. 94(3):219-26.

**801** Shetter, D. S. and G. R. Alexander. 1966. Angling and trout populations on the North Branch of the Au Sable River, Crawford and Otsego counties, Michigan, under special and normal regulations, 1958-63. Trans. Am. Fish. Soc. 95(1):85-91.

**802** Shetter, D. S. and L. N. Allison. 1955. Comparison of mortality between fly-hooked and worm-hooked trout in Michigan streams. Mich. Dep. Conserv., Inst. Fish. Res. Misc. Publ. No. 9. 44 pp.

**803** Shetter, D. S. and L. N. Allison. 1958. Mortality of trout caused by hooking with artificial lures in Michigan waters 1956-57. Mich. Dep. Conserv., Inst. Fish. Res. Misc. Publ. No. 12.

**804** Shetter, D. S., M. J. Whalls, and O. M. Corbett. 1954. The effect of changed angling regulations on a trout population of the Au Sable River. Trans. of the 19th North Am. Wildl. Conf. 19:222-38.

**805** Shirazi, M. A. and W. K. Seim. 1979. A stream systems evaluation—an emphasis on spawning habitat for salmonids. U.S. Environ. Prot. Agency. Rep. No. EPA/600/3-79/109. 45 pp.

**806** Shirvell, C. S. and R. G. Dungey. 1983. Microhabitats chosen by brown trout for feeding and spawning in rivers. Trans. Am. Fish. Soc. 112:355-67.

**807** Sigler, J. W., T. C. Bjornn, and F. H. Everest. 1984. Effects of chronic turbidity on density and growth of steelheads and coho salmon. Trans. Am. Fish. Soc. 113:142-50.

▶Chronic turbidity in streams during emergence and rearing of young anadromous salmonids was shown to adversely affect the number and quality of fish produced. Fish subjected to continuous clay turbidities grew less well than those living in clear water, and more of them emigrated from the experimental stream channels.

**808** Silver, S. T., C. E. Warren, and P. Doudoroff. 1963. Dissolved oxygen requirements of developing steelhead trout and chinook salmon embryos at different water velocities. Trans. Am. Fish. Soc. 92(4):327-43.

**809** Simpson, J. C. and T. C. Bjornn. 1965. Methods used to estimate salmon and steelhead harvests in Idaho. Proc. of the 45th Annu. Conf. West. States Assoc. of Fish and Game Comm. 45:217-26.

**810** Skeesick, D. G. 1970. The fall immigration of juvenile coho salmon into a small tributary. Fish Comm. Oreg. Res. Rep. 2(1):1-6.

**811** Slaney, P. A. and T. G. Northcote. 1974. Effects of prey abundance on density and territorial behavior of young rainbow trout (*Salmo gairdneri*) in laboratory stream channels. J. Fish. Res. Board Can. 31:1201-09.

**812** Slaney, P. A., C. J. Perrin, and B. R. Ward. 1986. Nutrient concentration as a limitation to steelhead smolt production in the Keogh River. Proc. of the 66th Annu. Conf. West. Assoc. of Fish and Wildl. Agencies 66:146-58.

**813** Slatick, E., L. G. Gilbreath, and J. R. Harmon. 1982. Imprinting steelhead for homing. pp. 247-64 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**814** Smith, A. K. 1973. Development and application of spawning velocity and depth criteria for Oregon salmonids. Trans. Am. Fish. Soc. 102(2):312-16.

**815** Smith, C. L. 1980. Attitudes about the value of steelhead and salmon angling. Trans. Am. Fish. Soc. 109(3):272-81.

**816** Smith, G. E. and M. E. Aceituno. 1987. Habitat preference criteria for brown, brook, and rainbow trout in eastern Sierra Nevada streams. Calif. Dep. Fish and Game. Stream Eval. Rep. No. 87-2. 103 pp.

**817** Smith, L. L. and J. B. Moyle. 1944. A biological survey and fishery management plan for the streams of the Lake Superior north shore watershed. Minn. Dep. Conserv., Div. Game and Fish. Tech. Bull. No. 1. 228 pp.

▶A thorough biological survey was conducted on 30 major streams of the Lake Superior north shore watershed that included assessment of fish species, chemical quality, plant and animal plankton, bottom algae, aquatic macrophytes, and bottom fauna. Minnesota's subsequent management plan for the north shore watershed was based on the results of this survey.

**818** Smith, L. S. and G. R. Bell. 1975. A practical guide to the anatomy and physiology of pacific salmon. Can. Dep. Environ. Fish. and Mar. Serv. Misc. Spec. Publ. 27. 14 pp.

**819** Smith, S. 1974. Early life history of the steelhead in a North Shore stream. Univ. Minn., St. Paul. M.S. Thesis. 78 pp.

**820** Smith, S. B. 1960. A note on two stocks of steelhead trout (*Salmo gairdneri*) in Capilano River, British Columbia. J. Fish. Res. Board Can. 17(5):739-42.

**821** Smith, S. B. 1969. Reproductive isolation in summer and winter races of steelhead trout. pp. 21-38 *in* T. G. Northcote, ed. Symposium on salmon and trout in streams. H. R. MacMillan Lect. in Fish., Univ. B.C., Vancouver. 388 pp.

**822** Smith, S. H. 1972. The future of salmonid communities in the Laurentian Great Lakes. J. Fish. Res. Board Can. 29(6):951-57.

**823** Smith, S. H. 1973. Application of theory and research in fishery management of the Laurentian Great Lakes. Trans. Am. Fish. Soc. 102(1):156-63.

▶This review of the history of the Great Lakes indicates that extensive research and intensive management have failed to prevent deterioration of the fisheries either because research was not timely, did not provide necessary information, or was not interpreted to indicate a need for corrective action. Smith concludes that successful application of theory and research to fishery management has been impeded by lack of close coordination among some state, provincial, and federal government units that have various degrees of influence on fishery programs of the Great Lakes.

**824** Snieszko, S. F. 1973. Furunculosis of Salmonidae. pp. 157-62 *in* W. A. Dill, ed. Symposium on the major communicable fish diseases in Europe and their control. Eur. Inland Fish. Advis. Comm. Tech. Pap. No. 17, Suppl. 2.

▶Furunculosis is caused by the gram-negative, nonmotile pigment-producing bacterium *Aeromonas salmonicida*. It is transmitted by water, physical contact, contaminated ova, and equipment. Prevention can be achieved by sanitary measures, disinfection of ova and facilities, selective breeding, environmental control, and immunization.

**825** Solomon, D. J. 1982. Migration and dispersion of juvenile brown and sea trout. pp. 136-45 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**826** Solomon, D. J. 1982. Smolt migration in Atlantic salmon (*Salmo salar* L.) and the sea trout (*Salmo trutta* L.). pp. 196-203 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**827** Solomon, D. J. 1985. Salmon stock and recruitment, and stock enhancement. J. Fish Biol. 27 Suppl. A:45-57.

**828** Solomon, D. J. and T. J. Storeton-West. 1983. Radio tracking of migratory salmonids in rivers: development of an effective system. Minist. Agric., Fish., and Food, Lowestoft, England. Fish. Res. Tech. Rep. No. 75. 11 pp.

▶This paper documents the development of a strategy for monitoring upstream movements of adult salmonids (Atlantic salmon and brown trout) in rivers using both internally and externally placed radio transmitters. Migratory be-

havior of radio-tagged fish was similar to that of control fish.

**829** Sorg, C. F., D. M. Donnelly, J. B. Loomis, and G. L. Peterson. 1984. Implications of economics as applied to wild trout fisheries management in Idaho. pp. 187-91 *in* F. Richardson and R. H. Hamre, eds. Wild trout III. Proc. of a Symp. held at Yellowstone Natl. Park. 192 pp.

▶Monetary values associated with wild trout fishing are identified and explained in this report, and methods are given to derive these values.

**830** Sorhus, C. N., W. G. Brown, and K. C. Gibbs. 1981. Estimated expenditures by salmon and steelhead sport anglers for specified fisheries in the Pacific Northwest. Oreg. State Univ., Agric. Exp. Stn. Spec. Rep. 631. 86 pp.

**831** Southward, G. M. and J. Douglas. 1972. Evaluation of a winter steelhead fishery on a western Washington river. Trans. Am. Fish. Soc. 101:29-34.

▶This report provides an example of the use of a punch card system to evaluate the sport fishing harvest of a steelhead fishery.

**832** Sowden, T. K. and G. Power. 1985. Prediction of rainbow trout embryo survival in relation to groundwater seepage and particle size of spawning substrates. Trans. Am. Fish Soc. 114:804-12.

**833** Spiller, K. W., A. W. Green, and H. R. Osburn. 1988. Increasing the efficiency of angler surveys by canceling sampling during inclement weather. North Am. J. Fish. Manage. 8:132-38.

**834** Stabell, O. B. 1982. Homing of Atlantic salmon in relation to olfaction and genetics. pp. 238-46 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**835** Stabell, O. B. and T. Refstie. 1985. Influence of the olfactory sense upon smolt transformation in salmonid fishes. J. Chem. Ecol. 11(10):1427-38.

**836** Stauffer, T. M. 1955. Migration and growth of tagged, immature rainbow trout in the Black River, Mackinac County, and in Lake Michigan, 1951-1954. Mich. Dep. Conserv., Inst. Fish. Res. Rep. No. 1441. 18 pp.

**837** Stauffer, T. M. 1972. Age, growth, and downstream migration of juvenile rainbow trout in a Lake Michigan tributary. Trans. Am. Fish. Soc. 101:18-28.

▶Steelhead smolts in the downstream migration averaged 64% age I, 34% age II, and 2% age III. Growth averaged 76 mm/year. Most downstream migrants in Great Lakes tributaries were age II or less, while in Pacific Ocean tributaries, most were age II and III.

**838** Stauffer, T. M. 1975. Population characteristics and summer-to-autumn survival of juvenile rainbow trout and coho salmon in two Lake Superior tributaries, 1969-1972. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1825. 21 pp.

▶Numbers, biomass, production, survival, and growth were estimated for age 0 coho salmon and ages 0 and I rainbow trout by monthly sampling over a 3-year period.

**839** Stauffer, T. M. 1976. Fecundity of coho salmon (*Oncorhynchus kisutch*) from the Great Lakes and a comparison with ocean salmon. J. Fish. Res. Board Can. 33:1150-55.

▶Fecundity (range 1,600-3,500 eggs/female) of Great Lakes coho salmon was comparable to fecundity (range 1,500-3,300 eggs/female) of Pacific coho of similar size. Average egg diameters were similar for Lake Michigan (7.1-7.4 mm) and Pacific (6.1-7.4 mm) coho, but Lake Superior eggs were smaller (5.1-5.4 mm). Lake Michigan coho averaged more eggs (2,938) than did Lake Superior coho (2,150) of the same year class and early life history.

**840** Stauffer, T. M. 1977. Numbers of juvenile salmonids produced in five Lake Superior tributaries and the effect of juvenile coho salmon on their numbers and growth 1967-1974. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1846. 29 pp.

▶Newly established populations of juvenile coho salmon did not have a detectable effect on numbers or growth of rainbow trout. The data did suggest that coho salmon depressed brook and brown trout populations. Additional investigations are needed on interrelationships between coho salmon and brook and brown trout.

**841** Stauffer, T. M. 1979. Two-year cycles of abundance of age-0 rainbow trout in Lake Superior tributaries. Trans. Am. Fish. Soc. 108:542-47.

▶Two-year cycles of abundance of age 0 rainbow trout occurred in 2 of 5 tributaries on the south shore of central Lake Superior from 1967-74. The cause(s) of the cycles could not be determined but were not obviously related to density of juvenile salmonids, spawner abundance, weather conditions, or abiotic stream characteristics.

**842** Stauffer, T. M. and M. J. Hansen. 1969. Mark retention, survival, and growth of jaw-tagged and fin-clipped rainbow trout. Trans. Am. Fish. Soc. 98(2):225-29.

**843** Stern, D. H. and M. S. Stern. 1980. Effects of bank stabilization on the physical and chemical characteristics of streams and small rivers: a synthesis. U.S. Fish and Wildl. Serv. Rep. No. FWS/OBS-80/11. 43 pp.

**844** Sternberg, R. B. 1978. Minnesota stream survey manual. Minn. Dep. Nat. Resour., Div. Fish and Wildl. Spec. Publ. No. 120. 82 pp.

**845** Steven, J. C. and G. Z. Jacobi. 1978. Macroinvertebrates in ten streams in northern Wiscon-

sin. U.S. For. Serv., Chequamegon Natl. For. Chequamegon Watershed Rep. 74 pp.

▶Quantitative and qualitative benthic macroinvertebrate collections were made at 14 locations on Chequamegon National Forest streams. Biotic index values ranged from 1.80-4.64.

**846** Stewart, P. A. 1970. Physical factors influencing trout density in a small stream. Colo. State Univ., Fort Collins. Ph.D. Thesis. 78 pp.

**847** Strogen, J. W. 1979. A comparison of the diet and growth of the trout from the upper Au Sable and upper Manistee rivers, Michigan. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1867. 56 pp.

▶*Hexagenia limbata* accounted for about 35% of the total annual food consumption by brook trout in the upper Au Sable River. Trichopterans made up about 45% of the total diet of brown trout in the upper Manistee River.

**848** Stuart, T. A. 1962. The leaping behaviour of salmon and trout at falls and obstructions. Dep. Agric. and Fish. Scotland. Freshwater and Salmon Fish. Res. Rep. No. 28. 46 pp.

**849** Stuber, R. J. 1986. Stream habitat improvement evaluation: an alternative approach. pp. 153-61 *in* J. G. Miller, J. A. Arway, and R. F. Carline, eds. Fifth trout stream habitat improvement workshop. Proc. of a Conf. Lock Haven Univ., Pa. 238 pp.

**850** Swales, S., R. B. Lauzier, and C. D. Levings. 1986. Winter preferences of juvenile salmonids in two interior rivers in British Columbia. Can. J. Zool. 64:1506-14.

**851** Swales, S. and K. O'Hara. 1980. Instream habitat improvement devices and their use in freshwater fisheries management. J. Environ. Manage. 10:167-79.

**852** Swanson, B. L. 1974. Brule River creel census. Wis. Dep. Nat. Resour., Bayfield. 4 pp. (unpubl. rep.).

▶This unpublished memo reports the results of a creel survey conducted on the Brule River during the early, late, and regular seasons. A brief comparison is provided of the characteristics of spring and fall migratory rainbow trout runs and their sport fisheries.

**853** Swanson, B. L. 1985. Pikes Creek/Lake Superior steelhead population: population dynamics, fishery, and management alternatives. Wis. Dep. Nat. Resour. Fish Manage. Rep. No. 125. 29 pp.

▶The population dynamics of a naturally reproducing steelhead population were determined via tagging, scale analysis, and creel survey for a 4-year period (1977-81) on a small Wisconsin tributary to Lake Superior. The mean annual spawning population was 989 fish. Annual fishing mortality rates were 23% and 20% for males and females, respectively. Changes in the population structure were estimated for various fishing mortality rates, and a rate of 20% was recommended to maintain a quality fishery.

**854** Symons, P. E. K. 1971. Behavioral adjustment of population density to available food by juvenile Atlantic salmon. J. Anim. Ecol. 40:569-87.

**855** Symons, P. E. K. 1979. Estimated escapement of Atlantic salmon (*Salmo salar*) for maximum smolt production in rivers of different productivity. J. Fish. Res. Board Can. 36:132-40.

**856** Tappel, P. D. and T. C. Bjornn. 1983. A new method of relating size of spawning gravel to salmonid embryo survival. North Am. J. Fish. Manage. 3(2):123-35.

**857** Taube, C. M. 1974. Transfer releases of coho salmon and trout into an upper part of Platte River and observations on salmonid spawning. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1815. 28 pp.

**858** Taube, C. M. 1975. Abundance, growth, biomass, and interrelationship of trout and coho salmon in the Platte River. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1830. 8 pp.

▶Juvenile coho salmon exerted no detectable effect on growth or numbers of brown or rainbow trout in sections of a Lake Michigan tributary except for one section heavily used by spawning coho. However, a reduction in numbers of young brown trout in this section was compensated for by better survival to the older ages.

**859** Tautz, A. F. and C. Groot. 1975. Spawning behavior of chum salmon (*Oncorhynchus keta*) and rainbow trout (*Salmo gairdneri*). J. Fish. Res. Board Can. 32(5):633-42.

**860** Tautz, A., P. A. Larkin, and W. E. Ricker. 1969. Some effects of simulated long-term environmental fluctuations on maximum sustained yield. J. Fish. Res. Board Can. 26:2715-26.

**861** Taylor, E. B. and J. D. McPhail. 1985. Variation in burst and prolonged swimming performance among British Columbia populations of coho salmon, *Oncorhynchus kisutch*. Can. J. Fish. and Aquat. Sci. 42:2029-33.

**862** Taylor, G. D. 1978. Enhanced stream production for kokanee, rainbow and cutthroat trout in British Columbia. pp. 29-30 *in* K. Hashagen, ed. Wild trout management. Proc. of a Natl. Symp. Calif. Trout, Inc., San Francisco. 69 pp.

**863** Theurer, F. D., I. Lines, and T. Nelson. 1985. Interaction between riparian vegetation, water temperature, and salmonid habitat in the Tucannon River. Water Resour. Bull. 21(1):53-64.

**864** Thompson, D. 1985. Genetic identification of trout strains. Aquaculture 46:341-51.

**865** Thomson, J. W. 1944. A survey of the larger aquatic plants and bank flora of the Brule River. Trans. Wis. Acad. Sci., Arts and Lett. 36:57-76.

▶This report describes the results of a thorough reconnaissance of the aquatic and riparian floral association of the Brule River during 1943. This survey was part of a larger interdisciplinary study done on the Brule River. Eleven technical papers from this study were subsequently published under one cover (see Wis. Cons. Dep. 1954).

**866** Thomson, J. W. 1945. An analysis of the vegetative cover of the Brule River (Wisconsin) watershed. Trans. Wis. Acad. Sci., Arts and Lett. 37:305-23.

▶An extension of Thomson's previous work on Brule River aquatic and bank flora, this descriptive report of the vegetative cover of the entire watershed was issued under the same cover (see Wis. Cons. Dep. 1954).

**867** Thorpe, J. E. 1982. Migration in salmonids, with special reference to juvenile movements in freshwater. pp. 86-97 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**868** Thorpe, J. E. 1987. Smolting versus residency: developmental conflict in salmonids. Am. Fish. Soc. Symp. 1:244-52.

**869** Thorpe, J. E. and J. F. Koonce (with D. Borgeson, B. Henderson, A. Lamsa, P. S. Maitland, M. A. Ross, R. C. Simon, and C. Walters). 1981. Assessing and managing man's impact on fish genetic resources. Can. J. Fish. and Aquat. Sci. 38:1899-907.

**870** Thorpe, J. E., L. G. Ross, G. Struthers, and W. Watts. 1981. Tracking Atlantic salmon smolts *Salmo salar* through Loch Voil Scotland, United Kingdom. J. Fish Biol. 19(5):519-38.

**871** Threinen, C. W. and R. Poff. 1964. The geography of Wisconsin's trout streams. Wis. Acad. Sci., Arts and Lett. 52:57-75.

**872** Thurow, R. F. and T. C. Bjornn. 1978. Response of cutthroat trout populations to the cessation of fishing in St. Joe River. Ida. Coop. Fish. Res. Unit. Proj. No. F-6-R. 40 pp.

**873** Tiegs, C. 1982. State of Wisconsin surface water quality monitoring data 1980. Wis. Dep. Nat. Resour., Madison. 93 pp.

**874** Tiegs, C. and J. St. Amant. 1983. State of Wisconsin surface water quality monitoring data 1981. Wis. Dep. Nat. Resour., Madison. 106 pp.

**875** Tiegs, C. and R. Wallace. 1980. State of Wisconsin surface water quality monitoring data 1973-1976. Wis. Dep. Nat. Resour., Madison. 213 pp.

**876** Tiegs, C. and R. Wallace. 1980. State of Wisconsin surface water quality monitoring data 1977. Wis. Dep. Nat. Resour., Madison. 130 pp.

**877** Tiegs, C. and R. Wallace. 1980. State of Wisconsin surface water quality monitoring data 1978. Wis. Dep. Nat. Resour., Madison. 133 pp.

▶The 5 preceding reports, covering 1973-81, provide monthly print-outs of selected chemical surface water data for 44 river locations in Wisconsin, including the Brule River at the Hwy. 13 bridge area.

**878** Toews, D. A. A. and M. J. Brownlee. 1981. A handbook for fish habitat protection on forest lands in British Columbia. Dep. Fish. and Oceans, Vancouver, B.C. 166 pp.

**879** Torblaa, R. L. 1968. Effects of lamprey larvicides on invertebrates in streams. U.S. Fish and Wildl. Serv. Spec. Sci. Rep.-Fish. No. 572. 13 pp.

**880** Tschaplinski, P. J. and G. F. Hartman. 1983. Winter distribution of juvenile coho salmon (*Oncorhynchus kisutch*) before and after logging in Carnation Creek, British Columbia, and some implications for overwinter survival. Can. J. Fish. and Aquat. Sci. 40:452-61.

▶Sections of a British Columbia coastal stream containing adequate winter habitat in the form of deep pools, log jams, and undercut banks with tree roots and debris lost fewer juvenile coho salmon during freshets and maintained higher numbers of fish in winter than sections without these habitat characteristics.

**881** Tsumura, K. and J. M. B. Hume. 1986. Two variations of a salmonid smolt trap for small rivers. North Am. J. Fish. Manage. 6:272-76.

**882** Turner, S. E. 1972. Rainbow trout literature review. Mo. Dep. Conserv. Final Rep. Study S-9. Dingell-Johnson Proj. F-1-R-21. 9 pp.

**883** Turner, S. E. 1984. Missouri trout: wise use of a limited resource. pp. 85-89 *in* F. Richardson and R. H. Hamre, eds. Wild trout III. Proc. of a Symp. held at Yellowstone Natl. Park. 192 pp.

**884** Turner, S. E. 1986. The effects of restrictive fishing methods upon catch, harvest and survival of trout in Meramec River. Mo. Dep. Conserv. Final Rep. Study S-31. Dingell-Johnson Proj. F-1-R-35. 30 pp.

**885** Tyler, R. W. 1979. Method of sampling seaward migration of juvenile salmon. Prog. Fish-Cult. 41(2):78-81.

**886** Tyus, H. M., B. D. Burdick, and C. W. McAda. 1984. Use of radio-telemetry for obtaining habitat preference data on Colorado squawfish. North Am. J. Fish. Manage. 4:177-80.

▶Habitat use observations made using radiotelemetry appeared to avoid some of the bias associated with conventional collection tech-

niques and therefore provided a better understanding of habitat requirements (depth, velocity, substrate preferences) of Colorado squawfish (*Ptychocheilus lucius*) in a turbid river.

**887** Van Hyning, J. M. 1973. Factors affecting the abundance of fall chinook salmon in the Columbia River. Fish Comm. Oreg. Res. Rep. 4(1). 87 pp.

**888** Vannote, R. L., G. W. Minshall, K. W. Cummins, J. R. Sedell, and C. E. Cushing. 1980. The river continuum concept. Can. J. Fish. and Aquat. Sci. 37:130-37.

▶This concept has provided a valuable framework for interpreting and predicting progressive shifts in biological community structure and function over a river's length.

**889** Van Velson, R. C. 1978. The McConaughy rainbow: life history and a management plan for the North Platte River Valley. Nebr. Game and Parks Comm. Nebr. Tech. Ser. No. 2. 83 pp.

**890** Vaux, W. G. 1968. Intragravel flow and interchange of water in a streambed. Fish. Bull. 66(3):479-89.

**891** Vetrano, D. M. 1988. Unit construction of trout habitat improvement structures for Wisconsin coulee streams. Wis. Dep. Nat. Resour., Bur. Fish. Manage. Adm. Rep. No. 27. 35 pp.

**892** Vetter, E. F. 1988. Estimation of natural mortality in fish stocks: a review. Fish. Bull. 86(1):25-43.

**893** Vincent, E. R. 1984. Effect of stocking hatchery rainbow trout on wild stream-dwelling trout. pp. 48-52 *in* F. Richardson and R. H. Hamre, eds. Wild trout III. Proc. of a Symp. held at Yellowstone Natl. Park. 192 pp.

▶When stocking of catchable-size hatchery rainbow trout was discontinued on a section of the Madison River, Montana, the wild trout population increased in numbers and biomass by over 180%. A previously unstocked section of a nearby creek showed a 45% decrease in wild trout numbers and biomass immediately following planting of hatchery catchables. At the same time, an unplanted creek section (control) showed no significant change in its trout population.

**894** Wagner, H. H. 1967. A summary of investigations of the use of hatchery-reared steelhead in the management of a sport fishery. Oreg. State Game Comm., Res. Div. Fish. Rep. No. 5. 62 pp.

**895** Wagner, H. H. 1968. Effect of stocking time on survival of steelhead trout, *Salmo gairdneri*, in Oregon. Trans. Am. Fish. Soc. 97(4):374-79.

**896** Wagner, H. H. 1974. Photoperiod and temperature regulation of smolting in steelhead trout (*Salmo gairdneri*). Can. J. Zool. 52:219-34.

**897** Wagner, H. H. 1977. Options for managing the anadromous fisheries of lower Deschutes River. pp. 127-32 *in* E. Schwiebert, ed. Columbia River salmon and steelhead. Am. Fish. Soc. Spec. Publ. No. 10. 214 pp.

**898** Wagner, H. H., R. J. Wallace, and H. J. Campbell. 1963. The seaward migration and return of hatchery-reared steelhead trout, *Salmo gairdneri* Richardson, in the Alsea River, Oregon. Trans. Am. Fish. Soc. 92:202-10.

**899** Wagner, W. C. 1975. Food habits of coexisting juvenile coho salmon, brown trout and rainbow trout in the Platte River, 1967 and 1972. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1831. 14 pp.

▶The diet composition of 3 salmonid species was found to be similar in a tributary to Lake Michigan. The author judged that a significant degree of competition for food did not occur, since growth of trout was unaffected and coho salmon and rainbow trout appeared to be spatially segregated.

**900** Wagner, W. C. 1985. Size, age, and fecundity of pink salmon in Michigan. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1933. 13 pp.

▶Data on size, age, and fecundity of mature pink salmon were collected from 1973-84 in Lakes Superior, Michigan, and Huron. Lake Superior pink salmon mean lengths were 387 mm and 379 mm for males and females, respectively, and mean fecundity was 1,030 eggs.

**901** Wagner, W. C. and T. M. Stauffer. 1978. Survival of rainbow trout stocked in a Lake Superior tributary, 1971-73. Mich. Dep. Nat. Resour. Fish. Res. Rep. No. 1859. 18 pp.

**902** Wagner, W. C. and T. M. Stauffer. 1980. Three-year-old pink salmon in Lake Superior tributaries. Trans. Am. Fish. Soc. 109:458-60.

**903** Wainio, A. A. 1962. Rainbow trout in the Nottawasaga River—with special reference to Nicolston Dam. Ont. Fish and Wildl. Rev. 1(4):19-24.

**904** Wainio, A. A., R. I. Toth, and R. A. Hester. 1972. Rainbow trout and the Nicolston Dam fishway. Ont. Minist. Nat. Resour., Toronto. 100 pp.

**905** Walsh, G., R. Morin, and R. J. Naiman. 1988. Daily rations, diel feeding activity and distribution of age-O brook charr, *Salvelinus fontinalis*, in two subarctic streams. Environ. Biol. Fishes. 21(3):195-205.

**906** Walters, C. J. 1975. Optimal harvest strategies for salmon in relation to environmental variability and uncertain production parameters. J. Fish. Res. Board Can. 32:1777-84.

**907** Ward, B. R. and P. A. Slaney. 1979. Evaluation of instream enhancement structures for the production of juvenile steelhead trout and coho salmon in the Keogh River: progress 1977 and

1978. B.C. Fish and Wildl. Branch. Fish. Tech. Circ. No. 45. 47 pp.

▶This report provides a thorough discussion of 7 designs for instream structures used to increase the production of steelhead and coho salmon smolts in a Vancouver Island coastal tributary. Parr densities and standing crops were greatest where boulder groupings were installed (optimal rock size was 60 cm in diameter).

**908** Warner, K. and P. R. Johnson. 1978. Mortality of landlocked Atlantic salmon (*Salmo salar*) hooked on flies and worms in a river nursery area. Trans. Am. Fish. Soc. 107(6):772-75.

**909** Warren, C. E., J. H. Wales, G. E. Davis, and P. Doudoroff. 1964. Trout production in an experimental stream enriched with sucrose. J. Wildl. Manage. 28(4):617-60.

**910** Washington, P. 1982. The influence of the size of juvenile coho salmon (*Oncorhynchus kisutch*) on seaward migration and survival. pp. 146-52 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**911** Washington State Department of Game. 1984. A basic fishery management strategy for resident and anadromous trout in stream habitats of the state of Washington. Wash. State Dep. Game, Clarkston. 60 pp.

**912** Waters, T. F. 1969. Invertebrate drift-ecology and significance to stream fishes. pp. 121-34 *in* T. G. Northcote, ed. Symposium on salmon and trout in streams. H. R. MacMillan Lect. in Fish., Univ. B.C., Vancouver. 388 pp.

**913** Waters, T. F. 1977. Secondary production in inland waters. Adv. Ecol. Res. 10:91-164.

**914** Waters, T. F. 1983. Replacement of brook trout by brown trout over 15 years in a Minnesota stream: production and abundance. Trans. Am. Fish. Soc. 112:137-46.

▶The trout population in a Minnesota stream changed—during a 15-year period of erratic hydrologic conditions that included floods and siltation—from virtually 100% brook trout in 1965 to predominantly brown trout in 1980 with some rainbow and brook trout. Speculative explanations for the species changes are given.

**915** Weaver, C. R. 1963. Influence of water velocity upon orientation and performance of adult migrating salmonids. Fish. Bull. 63(1):97-121.

**916** Webster, D. A. and W. A. Flick. 1975. Species management. pp. 40-47 *in* W. King, ed. Wild trout management. Proc. of a Symp. held at Yellowstone Natl. Park. 103 pp.

**917** Wedemeyer, G. A. 1972. Some physiological consequences of handling stress in the juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo gairdneri*). J. Fish. Res. Board Can. 29:1780-83.

**918** Wedemeyer, G. A. 1973. Some physiological aspects of sublethal heat stress in the juvenile steelhead trout (*Salmo gairdneri*) and coho salmon (*Oncorhynchus kisutch*). J. Fish. Res. Board Can. 30:831-34.

**919** Wedemeyer, G. A., R. L. Saunders, and W. C. Clarke. 1980. Environmental factors affecting smoltification and early marine survival of anadromous salmonids. North Am. Salmon Res. Cent. Rep. No. 5. 14 pp.

▶This useful paper presents physiological criteria for identifying fully functional smolts, identifies environmental factors that influence smoltification, and describes methods for optimizing time, age, and size at release. In addition, information is presented on methods of environmental manipulation to alter smoltification to fit specific resource management needs, and guidelines are provided for management strategies to improve survival of Pacific salmon, Atlantic salmon, and steelhead trout.

**920** Weiner, G. S., C. B. Schreck, and H. W. Li. 1986. Effects of low pH on reproduction of rainbow trout. Trans. Am. Fish. Soc. 115:75-82.

**921** Weiss, D. M. 1972. A simple electronic smolt counter. J. Fish Biol. 4:257-60.

**922** Wenger, M. N., R. M. Lichorat, and J. D. Winter. 1984. Pre-spawning and spawning behavior of coho salmon and chinook salmon in eastern Lake Erie. N.Y. Fish and Game J. 31(2):146-64.

**923** Wesche, T. A. 1980. The WRRI trout cover rating method: development and application. Water Resour. Res. Inst. Water Resour. Ser. 78. 46 pp.

▶This report gives the results of continued testing of the WRRI cover rating method and adapts it to different streams. Trout cover, although a vitally important habitat component, has often been overlooked in the course of instream flow studies, primarily because its measurement has been considered subjective, and standard procedures have not existed.

**924** Wesche, T. A., C. M. Goertler, and C. B. Frye. 1985. Importance and evaluation of instream and riparian cover in smaller trout streams. U.S. For. Serv. Gen. Tech. Rep. RM-120:325-28.

**925** Wesche, T. A., C. M. Goertler, and W. A. Hubert. 1987. Modified habitat suitability index model for brown trout in southeastern Wyoming. North Am. J. Fish. Manage. 7:232-37.

▶This report identifies 9 habitat variables (from 39 examined) found to be significantly correlated with brown trout standing stocks in southeastern Wyoming streams. The best model for predicting standing stocks of brown trout included measures of cover availability and flow regime. An index of fishing pressure

was also found to be significantly related to standing stock.

**926** Whisnant, D. M., ed. 1974. Wisconsin's Lake Superior basin water quality study—supplement. Univ. Wis.-Superior, Cent. Lake Superior Environ. Stud. Publ. No. 35. 49 pp.

▶This supplement, along with its companion volume (Dickas 1973), presents selected water quality data collected during 2 years for the Brule River and 7 other river drainages along the Wisconsin shore of Lake Superior.

**927** White, R. J. 1975. Trout population responses to stream flow fluctuation and habitat management in Big Roche-a-Cri Creek, Wisconsin. Verhandlungen Internationale Vereinigung fur theoretische und angewandte Limnologie 19:2469-77.

▶The author's conclusions include the following: (1) in a given stream reach, the more water, the more trout; (2) year-to-year changes in stream flow regime may often govern trout abundance; (3) narrowing the stream and providing overhead hiding cover can help to ameliorate unfavorable effects of a low flow; and (4) the greatest benefits of such management accrue to large size classes of trout.

**928** White, R. J. 1978. Limitations of trout stream management: capability, constraint, and consequence. pp. 7-18 *in* K. Hashagen, ed. Wild trout management. Proc. of a Natl. Symp. Calif. Trout, Inc., San Francisco. 69 pp.

**929** White, R. J. 1983. Stream habitat improvement. pp. 103-17 *in* D. A. Kirkpatrick and T. Ameslav, eds. Proceedings of the wild salmon and trout conference. Seattle Univ., Seattle. 152 pp.

**930** White, R. J. 1986. Physical and biological aspects of stream habitat management for fish: the primacy of hiding/security cover. pp. 241-65 *in* J. G. Miller, J. A. Arway, and R. F. Carline, eds. Fifth trout stream habitat improvement workshop. Proc. of a Conf. Lock Haven Univ., Pa. 283 pp.

▶White states that the most beneficial stream habitat management approach is to simulate and accentuate natural channel characteristics that favor fish: meandering in low-gradient streams, abrupt stair-stepping and lateral scour pools in steep streams, and vegetation-bound undercut banks and woody debris accumulations at proper locations in all streams. For drift-feeding salmonids, providing hiding/security cover swept by major current, especially along banks, is most effective.

**931** White, R. J. and O. M. Brynildson. 1967. Guidelines for management of trout stream habitat in Wisconsin. Wis. Dep. Nat. Resour. Tech. Bull. No. 39. 64 pp.

▶This nationally recognized guide to trout stream habitat management provides instruction on techniques to protect and improve trout habitat. A summary of the main principles in managing trout stream habitat is included.

**932** White, R. J. and R. L. Hunt. 1969. Regularly occurring fluctuations in year-class strength of two brook trout populations. Trans. Wis. Acad. Sci., Arts and Lett. 57:135-53.

**933** Whitworth, W. E. and R. J. Strange. 1983. Growth and production of sympatric brook and rainbow trout in an Appalachian stream. Trans. Am. Fish. Soc. 112:469-75.

**934** Wickett, W. P. 1958. Review of certain environmental factors affecting the production of pink and chum salmon. J. Fish. Res. Board Can. 15:1103-26.

**935** Willers, W. B. 1981. Trout biology—an anglers guide. Univ. Wis. Press, Madison. 206 pp.

**936** Williams, D. D. 1980. Some relationships between stream benthos and substrate heterogeneity. Limnol. Oceanogr. 25(1):166-72.

**937** Williams, D. D. 1981. The first diets of post-emergent brook trout (*Salvelinus fontinalis*) and Atlantic salmon (*Salmo salar*) alevins in a Quebec river. Can. J. Fish. and Aquat. Sci. 38:765-71.

▶Simuliid larvae, zooplankton, and emerging adults of orthocladine chironomids were the most common food items of post-emergent brook trout in a large Quebec river. Simuliid larvae of the genus *Prosimulium* were the single most important food item by volume of post-emergent brook trout.

**938** Windell, J. T. and S. H. Bowen. 1968. Methods for study of fish diets based on analysis of stomach contents. pp. 219-26 *in* T. Bagenal, ed. Methods for assessment of fish production in fresh waters. Blackwell Sci. Publ., Oxford. 365 pp.

▶This chapter discusses collection and preservation of fish stomachs, reviews 3 methods of analyzing contents, and provides a general discussion on data analysis.

**939** Wingate, P. J., R. J. Brown, J. H. Davies, J. H. Mickey, W. R. Bonner, and H. M. Ratledge. 1979. Effects of fishing regulation changes on lotic wild trout populations. Proc. of the Annu. Conf. Southeast. Assoc. of Fish and Wildl. Agencies 35:654-60.

**940** Winget, R. N. and F. A. Mangum. 1979. Biotic condition index: integrated biological, physical and chemical stream parameters for management. U.S. For. Serv., Intermountain Reg. 51 pp.

**941** Winter, B. D. 1986. A method for the efficient removal of juvenile salmonid otoliths. Calif. Fish and Game 72:63-64.

**942** Winter, J. D. 1976. Movements and behavior of largemouth bass (*Micropterus salmoides*) and steelhead (*Salmo gairdneri*) determined by radio telemetry. Univ. Minn., St. Paul. Ph.D. Thesis. 195 pp.

▶This thesis contains a wealth of information

on homing, migration timing, and reproduction of steelhead in north shore streams of western Lake Superior. Numerous additional life history observations were recorded. A technique for externally mounting radio transmitters was successfully used on adult steelhead and brown trout.

**943** Winter, J. D. 1983. Underwater biotelemetry. pp. 371-95 *in* L. A. Nielsen and D. L. Johnson, eds. Fisheries techniques. Am. Fish. Soc., Bethesda, Md. 468 pp.

**944** Winter, J. D., V. B. Kuechle, D. B. Siniff, and J. R. Tester. 1978. Equipment and methods for radio tracking freshwater fish. Univ. Minn., Agric. Exp. Stn. Misc. Rep. 152-1978. 18 pp.

**945** Wisconsin Conservation Department. 1954. The Brule River, Douglas County. Wis. Cons. Dep., Madison. 201 pp.

**946** Withler, F. C. 1972. Research needs for intensive management of British Columbia steelhead. Fish. Res. Board Can., Pacific Biol. Stn. Circ. No. 92. 41 pp.

▶This document describes the decision-making process for steelhead management objectives in British Columbia. The author states that research can supply answers to management information needs so that management objectives can be attained. Five areas needing management information are highlighted: (1) determining what anglers really want, (2) conducting inventories of and describing steelhead stocks, (3) developing methods to improve steelhead production in natural streams, (4) finding effective and economical means of artificial production, and (5) mitigating threats of disease and "genetic pollution" to wild stocks from hatchery plants.

**947** Withler, I. L. 1966. Variability in life history characteristics of steelhead trout (*Salmo gairdneri*) along the Pacific coast of North America. J. Fish. Res. Board Can. 23(3):365-93.

**948** Witzel, L. D. and H. R. MacCrimmon. 1981. Role of gravel substrate on ova survival and alevin emergence of rainbow trout, *Salmo gairdneri*. Can. J. Zool. 59:629-36.

**949** Witzel, L. D. and H. R. MacCrimmon. 1983. Redd-site selection by brook trout and brown trout in southwestern Ontario streams. Trans. Am. Fish. Soc. 112:760-71.

▶This paper presents a detailed examination of redd-substrate composition, water velocity, depth, and other variables associated with redd-site selection and spawning by brook trout and brown trout in southwestern Ontario streams. Redd-site preference by brook trout for slow velocity areas of ground water seepage and by brown trout for faster water velocities and coarser substrate particles minimized species interaction during the spawning season.

**950** Wood, C. C. 1987. Predation of juvenile Pacific salmon by the common merganser (*Mergus merganser*) on eastern Vancouver Island. 1: Predation during the seaward migration. Can. J. Fish. and Aquat. Sci. 44:941-49.

**951** Wright, S. 1981. Contemporary Pacific salmon fisheries management. North Am. J. Fish. Manage. 1:29-40.

**952** Wydoski, R. S. 1977. Relation of hooking mortality and sublethal hooking stress to quality fishery management. pp. 43-87 *in* R. A. Barnhart and T. D. Roelofs, eds. Catch and release fishing. Proc. of a Natl. Symp. Humboldt State Univ., Arcata, Calif. 220 pp.

▶This report provides an in-depth, well-referenced discussion on the relation between fish losses caused by hooking stress and "quality" angling regulations such as catch-and-release. Such losses could be very important to management of quality fisheries in less productive waters such as can be found in the northern United States.

**953** Wydoski, R. S. 1978. Responses of trout populations to alterations in aquatic environments: a review. pp. 57-92 *in* J. R. Moring, ed. Proceedings of the wild trout-catchable trout symposium. Oreg. Dep. Fish and Wildl., Portland. 210 pp.

**954** Wydoski, R. S. and E. L. Cooper. 1966. Maturation and fecundity of brook trout from infertile streams. J. Fish. Res. Board Can. 23(5):623-49.

**955** Wydoski, R. S. and D. A. Duff. 1978. Indexed bibliography on stream habitat improvement. U.S. Bur. Land Manage. Tech. Note 322. 35 pp.

**956** Wydoski, R. S. and L. Emery. 1983. Tagging and marking. pp. 215-37 *in* L. A. Nielsen and D. L. Johnson, eds. Fisheries techniques. Am. Fish. Soc., Bethesda, Md. 468 pp.

**957** Wydoski, R. S., G. A. Wedemeyer, and N. O. Nelson. 1976. Physiological response to hooking stress in hatchery and wild rainbow trout (*Salmo gairdneri*). Trans. Am. Fish. Soc. 105(5):601-06.

**958** Youngs, W. D. 1974. Estimation of the fraction of anglers returning tags. Trans. Am. Fish. Soc. 103(3):616-18.

**959** Youngs, W. D. and D. S. Robson. 1975. Estimating survival rate from tag returns: model tests and sample size determination. J. Fish. Res. Board Can. 32:2365-71.

**960** Youngson, A. F., R. J. G. Buck, T. H. Simpson, and D. W. Hay. 1983. The autumn and spring emigrations of juvenile Atlantic salmon, *Salmo salar* L., from the Girnock Burn, Aberdeenshire, Scotland: environmental release of migration. J. Fish Biol. 23:625-39.

**961** Zaugg, W. S. 1982. Relationships between smolt indices and migration in controlled and natural environments. pp. 173-83 *in* E. L. Brannon and E. O. Salo, eds. Proceedings of the salmon and trout migratory behavior symposium. Univ. Wash., Seattle. 309 pp.

**962** Zaugg, W. S., J. E. Bodle, J. E. Manning, and E. Wold. 1986. Smolt transformation and seaward migration in O-age progeny of adult spring chinook salmon (*Oncorhynchus tshawytscha*) matured early with photoperiod control. Can. J. Fish. and Aquat. Sci. 43:885-88.

**963** Zimmerman, J. W. 1986. Water quality of streams tributary to Lake Superior and Michigan. U.S. Fish and Wildl. Serv. Spec. Sci. Rep.-Fish. No. 559. 41 pp.

**964** Zippin, C. 1958. The removal method of population estimation. J. Wildl. Manage. 22:82-90.

**965** Zubik, R. J. and J. J. Fraley. 1988. Comparison of snorkel and mark-recapture estimates for trout populations in large streams. North Am. J. Fish. Manage. 8:58-62.

►A snorkel-expansion estimate of cutthroat trout abundance in the South Fork of the Flathead River was similar to 2 Petersen estimates (hook-and-line Petersen and snorkel Petersen). The authors concluded that in large clear streams with little cover, the snorkel-expansion method provides a quick, reliable density estimate at relatively low cost.

**966** Zuboy, J. R., R. T. Lackey, N. S. Prosser, and R. V. Corning. 1973. Computerized creel census system for use in fisheries management. Proc. of the 27th Annu. Conf. Southeast. Assoc. of Game and Fish Comm. 27:570-74.

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