

Biological Services Program

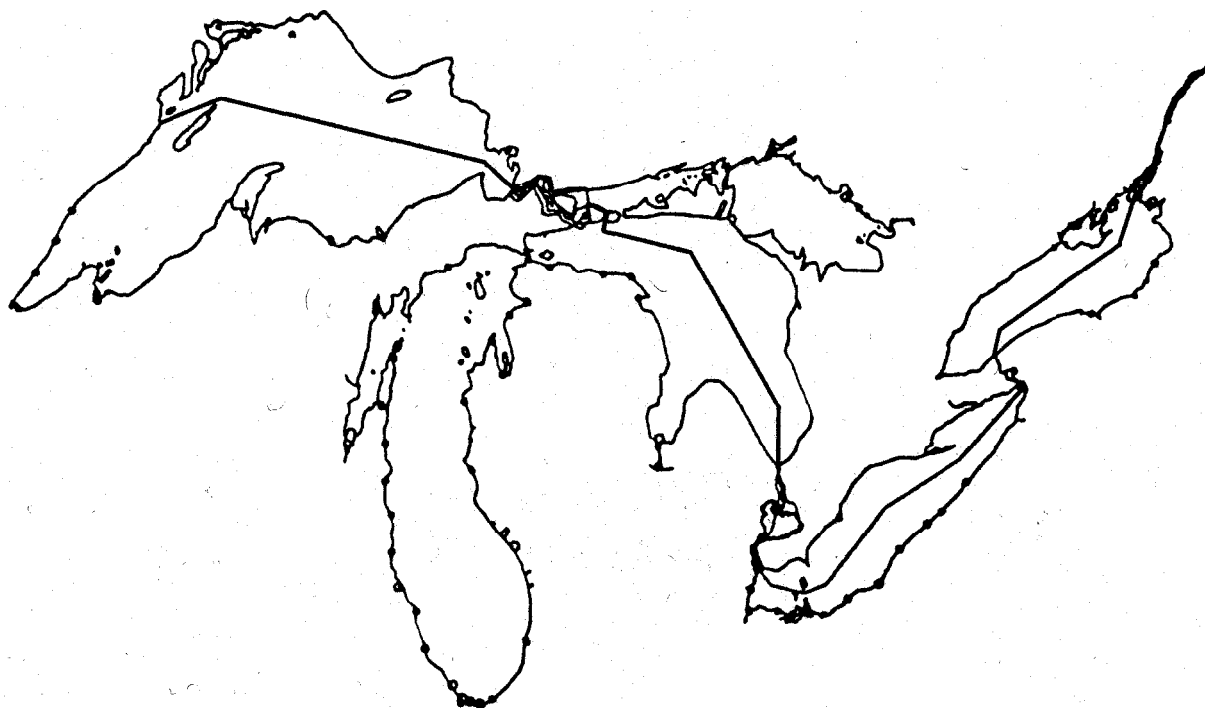
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SEPTEMBER 1982

ATLAS OF THE SPAWNING AND NURSERY AREAS OF GREAT LAKES FISHES

Volume XIII-Species Reproduction Characteristics

Great Lakes-St. Lawrence Seaway
Navigation Season Extension Program



Fish and Wildlife Service

Corps of Engineers

U.S. Department of the Interior

U.S. Department of the Army

The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues that impact fish and wildlife resources and their supporting ecosystems. The mission of the program is as follows:

- To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.
- To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major changes in land and water use.
- To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decisionmaking process to prevent or minimize the impact of development on fish and wildlife. Research activities and technical assistance services are based on an analysis of the issues, a determination of the decisionmakers involved and their information needs, and an evaluation of the state of the art to identify information gaps and to determine priorities. This is a strategy that will ensure that the products produced and disseminated are timely and useful.

Projects have been initiated in the following areas: coal extraction and conversion; power plants; geothermal, mineral and oil shale development; water resource analysis, including stream alterations and western water allocation; coastal ecosystems and Outer Continental Shelf development; and systems, inventory, including National Wetland Inventory, habitat classification and analysis, and information transfer.

The Biological Services Program consists of the Office of Biological Services in Washington, D.C., which is responsible for overall planning and management; National Teams, which provide the Program's central scientific and technical expertise and arrange for contracting biological services studies with states, universities, consulting firms, and others; Regional Staffs, who provide a link to problems at the operating level; and staffs at certain Fish and Wildlife Service research facilities, who conduct in-house research studies.

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ATLAS OF THE SPAWNING AND NURSERY AREAS
OF GREAT LAKES FISHES

VOLUME XIII
Reproductive Characteristics
of Great Lakes Fishes

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PREFACE

The fish resources of the Great Lakes have changed markedly since the settlement of the Great Lakes Basin began in the late 1700s-early 1800s. Local declines in the abundance of some highly valued species that supported early fisheries were reported in the 1800s. By the late 1950s-early 1960s, a number of important native species had disappeared from the catch, most once-productive stocks were depleted, and the fisheries that persisted were supported mainly by species of low value and utility. These undesirable changes have been attributed to the overharvest of desirable species, the invasion and introduction of undesirable exotic species, lowered water quality, and the destruction of portions of the physical habitat, including spawning grounds, vital to the maintenance of the resource base.

Since the 1950s, intensive efforts have been mounted to reestablish stable, self-sustaining fish communities, mainly by reducing sea lamprey abundance, limiting the harvest of remnant native stocks, and stocking desirable native or exotic species to replace or supplement depleted populations. Many of the native species and some of the desirable, introduced species have responded favorably and are now supporting valuable, productive fisheries. These successes suggest that continued judicious exercise of established management strategies will result in further significant improvements in the fish resources and the fisheries. An emerging perspective suggests, however, that enduring, major improvements in the fish resources and the fisheries will require greater emphasis on rehabilitation efforts directed more specifically at safeguarding and improving the quality of the fish habitat in general, and on ensuring fuller utilization of the specialized habitat required by sensitive, embryonic-juvenile life stages of species that are to be included in any future, self-sustaining resource base. We prepared this atlas to provide a comprehensive information base against which past changes in the condition and use of spawning and nursery habitat of Great Lakes fishes could be viewed and evaluated and the needs of the future, self-sustaining resource base could be projected.

The atlas is composed of the following 14 volumes:

- | | |
|---|---|
| I. Spawning and Nursery Areas
of Great Lakes Fishes: A
Summary by Geographic Area | VIII. Detroit River |
| II. Lake Superior | IX. Lake Erie |
| III. St. Marys River | X. Niagara River |
| IV. Lake Michigan | XI. Lake Ontario |
| V. Lake Huron | XII. St. Lawrence River |
| VI. St. Clair River | XIII. Reproductive Characteristics
of Great Lakes Fishes |
| VII. Lake St. Clair | XIV. Literature Cited |

Volume I is designed to permit the reader to determine quickly whether a particular geographic area of interest contains fish spawning or nursery areas that are described in volumes II-XII. Volumes II-XII consolidate existing information describing spawning and nursery areas used by stocks of fish, including anadromous stocks, considered to be residents of the Great Lakes and their connecting waters. The information presented for each spawning or nursery area identified in volumes II-XII includes, when known, the area's precise location, history of use, season of use, water temperatures during the season of use, major substrate type, and water depth. Pre- and post-spawning migrations of mature fish and movements of young fish are also described, insofar as this information serves to better delineate spawning or nursery areas. Volume XIII contains concise descriptions of the reproductive characteristics of species included in volumes I-XII.

In the preparation of the atlas we found that considerable information was available for most of the species that support (or supported) major recreational or commercial fishes, or that are or were major components of the forage base; conversely, relatively little information was available for many other species not included in these general categories. For most species, spawning areas were more completely described than were nursery areas. The historical information in particular provided more extensive descriptions of spawning areas than of nursery areas, because much of this information was obtained from records of fisheries that had been conducted for spawning fish. Thus, although the information available to us for compilation was relatively extensive, it was nonetheless incomplete for the reasons given above. Users of the atlas are therefore cautioned not to view the lack of explicit reference to a given area as conclusive evidence that the area is or was not used as a spawning or nursery area by Great Lakes fishes.

Sources of the information incorporated in the atlas are described in volume I. Acknowledgements are also given in volume I.

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GREAT LAKES FISHES

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INTRODUCTION

This volume presents concise descriptions of the reproductive characteristics and related spawning and nursery habitat requirements of each of the species included in Volumes I-XII of the atlas. These descriptions were compiled mainly from the information for Great Lakes populations that is presented in Volumes I-XII. When we needed additional information to complete the descriptions in this volume, we included information for non-Great Lakes populations in the Province of Ontario and the eight states bordering the Great Lakes; in some instances we also included information for populations outside the Great Lakes region. When we presented information for non-Great Lakes populations, we identified by footnote the geographic location of the population from which the information was obtained.

Information extracted from Volumes I-XII and presented in this volume is not specifically referenced in this volume. References listed in this volume represent only the information that does not appear in Volumes I-XII. Complete citations for the referenced information in Volumes I-XIII appear in Volume XIV.

SEA LAMPREY

MIGRATION OF ADULTS

Prespawning: Congregate in bays and river mouths in late winter; ascend streams, often more than 100 mi, beginning as early as late-January at 40°F; early migrants may be in streams several weeks prior to spawning.

Postspawning: Drift away from spawning grounds and die; males may remain on nests for up to 5 days after spawning.

SPAWNING

Season: March-September, usually May-July, at 50-82°F; peaks in late May-early June at 58-60°F.

Site: Clean, moderately swift water, with velocity of 2-5 fps, often just above rapids or riffles in streams.

Substrate: Eggs are deposited in nests excavated in sand, gravel, and rocks; sometimes also in nests excavated in substrate consisting mainly of clam shells or lumps of clay.

Water Depth: To 12 ft; usually to 3 ft.

INCUBATION AND BATCHING

Site: Adhesive eggs incubate in nest under a layer of sand and gravel.

Duration: Eggs hatch in 1-3 weeks; 14 days at 61°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain in nest 1-3 weeks; ammocoetes are carried downstream from nest to areas of quiet water and burrow into stream bed where they remain for 3-17 years; ammocoetes are also found along lake shores, in bays, and on alluvial fans as far as 2 mi, but usually less than 1/4 mi, from stream mouths.

Substrate: Gravel for prolarvae; soft substrate of detritus, mud, sand, or silt for ammocoetes; also found under objects on hard substrate.

Water Depth: To 75 ft.

REFERENCES

Applegate 1949, 1951b, 1961; Applegate and Brynildson 1952; Applegate and Moffett 1955; Barns 1959; Bean 1902, 1903; Brasch 1950; Eddy and Underhill 1974; Embody 1922; Fish. Res. Board Can. 1955; Fisherman 1952; Gage 1893, 1928; Greeley 1928; Guard 1953; Hubbs and Lagler 1958; Kennedy 1957; Lagler 1948; Lamsa 1961, 1963b; Lawrie 1955a; Lennon 1955; Loftus 1950; Manion 1968, 1972; Manion and Hansen 1980; Manion and Smith 1978; Moffett 1966b; Reed and Wright 1909; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Smith, B., and Elliott 1953; Smith, S. 1978c; Stauffer 1962; Surface 1897; Westerman 1946; Wigley 1953, 1959.

LAKE STURGEON

MIGRATION OF ADULTS

Prespawning: Move to spawning grounds in littoral waters and tributaries; enter tributaries in spring, usually after ice-out, but sometimes before ice-out; long upstream migrations recorded (125 mi in Wolf River, Wisconsin).

Postspawning: Leave tributaries after spawning.

SPAWNING

Season: April-July at 48-70°F, but usually May and June at 57-60°F; spawning may be inhibited at 70°F; duration of peak spawning usually 3-4 days.

Site: Rapids or other fast-water areas of streams or wave-swept lake shoals or ledges along shore; historically spawned in almost all Great Lakes tributaries.

Substrate: Eggs are broadcast over hard bottom, including rock, gravel, boulders, shale, hard clay and sand, and coal cinders.

Water depth: 1-30 ft; 3-4 ft is preferred depth range in lakes.

INCUBATION AND HATCHING

Site: Eggs adhere to substrate at spawning site.

Duration: Eggs hatch in 5-8 days at 60-57°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae drift with current; fry inhabit bays and eddies where current is not too swift.

Substrate: Exposed rock and rubble or mud.

Water Depth: Shallow; no detailed information.

REFERENCES

Becker 1976; Calhoun and Coon 1941; Coker 1930; Crossman 1976; Eddy and Underhill 1974; Evermann and Latimer 1910; Fogle 1975; Harkness 1923; Hubbs and Lagler 1958; Lagler 1948; MacKay 1959b, 1969; Meehan 1900; Mich. Cons. 1946; ODNR, undated; Price 1960, 1961; Priegel 1960, 1961; Priegel and Wirth 1971; Roussow 1957; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Smith 1972; Smith and Moe 1944; Stone 1900, 1901; Surber 1920; Van Oosten 1956; Williams 1951.

SPOTTED GAR

MIGRATION OF ADULTS

Prespawning: Congregate on spawning grounds in marshes.

Postspawning: Remain on spawning grounds for extended period.

SPANNING

Season: May and June at 70-78°F; usually completed by early June.

Site: Quiet marshes and grassy sloughs.

Substrate: Eggs are deposited over vegetation, mud, and silt.

Water Depth: Usually 3 ft or less.

INCUBATION AND HATCHING

Site: Eggs adhere to plants and debris at spawning site.

Duration: Eggs hatch in 6-8 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain attached by cement gland to submerged objects for 9-10 days; fry remain in vegetated spawning **areas^{1/}**; young-of-the-year (YOY), 0.8-2.5 in. long, inhabit shallow littoral water.

Substrate: Vegetation, mud, silt, sand.

Water Depth: 2-3 ft; YOY are often seen just beneath the surface.

REFERENCES

Echelle **1967^{1/}**; Echelle and Riggs **1967^{1/}**; Eddy and Underhill 1974; Garman 1889; Mich. Cons. 1932b; ODNR, undated; Richardson 1913; Scott 1967; Slastenenko 1958.

^{1/} Oklahoma and Texas

LONGNOSE GAR

MIGRATION OF ADULTS

Prespawning: Move to spawning grounds in littoral areas and tributaries beginning in April; historically entered tributaries at the same time as lake sturgeon.

Postspawning: Lake spawners move offshore; tributary spawners return to lake^{1/} or move downstream to larger river pools after spawning^{2/}.

SPAWNING

Season: May and June at 66-84°F; may peak at 66°F.

Site: Nearshore weed beds of lakes; open sloughs and backwaters of tributaries.

Substrate: Eggs are scattered over aquatic plants, sand, silt, gravel, rock, mud, decaying vegetation, or deposited in a loosely constructed nest.

Water depth: 6 in. - 2 ft; usually less than 1 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to vegetation, roots, debris, or stones at spawning site.

Duration: Eggs hatch in 5-9 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Newly hatched larvae attach to objects by means of adhesive disk; larvae begin to swim when about 3 weeks old. Young-of-the year (YOY) remain in weed beds along shore throughout the summer.

Substrate: Vegetation, mud, silt, sand.

Water Depth: No detailed information; YOY move from shallows to deeper water as they grow; they are often seen just beneath the surface, above submerged vegetation.

REFERENCES

Agassiz 1878; Bean 1903; Cady 1945^{1/}; Cahn 1927; Coker 1930; Dean 1895; Eddy and Underhill 1974; Evermann and Clark 1920; Eycleshymer 1903; Faber 1963; Forbes and Richardson 1920; Frisby 1942; Hay 1894; Hubbs and Lagler 1958; Lagler 1948; MacKay 1957e, 1969; Mark 1890; Meek and Hildebrand 1910; Mich. Cons. 1932b; Netsch and Witt 1962^{2/}; ODNr, undated; Price and Kelly 1976; Scott 1967; Slastenenko 1958; Surber 1920; Williamson 1951; Wright 1879.

1/ Tennessee

2/ Missouri

BOWFIN

MIGRATION OF ADULTS

Prespawning: Move to spawning grounds in littoral waters or tributaries.

Postspawning: Male remains on spawning ground for several weeks to guard nest and fry before returning to deeper water.

SPAWNING

Season: Late March-late July, but usually April-June; spawning peaks at 61-66°F and usually ceases at 68°F, but has been observed at 79°F.

Site: Protected, weedy shallows, embayments, marshes and tri'outary mouths; also in streams and flooded bottomlands.

Substrate: Eggs are scattered over bottom of large nest scooped out in cleared area or under a log or bush on soft bottom, including submerged vegetation, mud, silt, sand, muck, and organic debris; occasionally nest built on gravel.

Water Depth: 8 in. - 6 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to exposed roots, leaves, stems, or gravel in the nest.

Duration: Eggs hatch in 4-14 days, usually 8-10 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain attached to rootlets and debris in the nest for about 9 days; after leaving nest, fry remain in weedy shallows and are seen in open water accompanied by male; older young-of-the-year usually seek protection under bushes or vegetation.

Substrate : Soft bottom, as described for spawning site.

Water Depth: Fry up to about 1.5 in. long are found in 1-1/2 to 2 ft of water; those 2-4 in. long are found in water as shallow as 6 in.

REFERENCES

Allen 1914; Bean 1903; Cahn 1927; Coker 1930; Dean 1896, 1899; Eaton 1928; Eddy and Underhill 1974; Evermann and Clark 1920; Forbes and Richardson 1920; Garman 1899; Goode 1884; Greeley 1928; Hubbs and Lagler 1958; Kramer and Smith 1960; Lagler 1948; MacKay 1958b, 1969; Meek and Hildebrand 1910; Mich. Cons. 1932b; Pearse 1918a; Price and Kelly 1976; Raphael and Jaworski 1979; Reighard 1900a,b, 1902, 1903; Richardson 1913a; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Surber 1920; Whitman and Eycleshymer 1897.

AMERICAN EEL

MIGRATION OF ADULTS

Prespawning: Only catadromous resident of the Great Lakes; adults migrate from fresh water to spawning grounds in the Atlantic Ocean in July-January; in the Great Lakes migration usually occurs in September and October.

Postspawning: None; both sexes die after spawning.

SPAWNING

Season: Probably late winter to summer at about 60°F.

Site: Sargasso Sea, northeast and east of the West Indies, approximately between latitudes 20° and 30° and longitudes 60° and 78°.

Substrate: No information; eggs broadcast in open water.

Water Depth: Greater than 3,000 ft.

INCUBATION AND HATCHING

Site: Eggs incubate at surface of open sea.

Duration: Eggs hatch in 2 days or less.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae (leptocephali) drift in open ocean; after about one Year, they reach the Atlantic coast and transform to elvers, which ascend rivers along the east coast of the U.S and Canada usually in April-June.

Substrate: No information.

Water Depth: Leptocephali drift from deep oceanic spawning ground to littoral coastal areas; after reaching lakes, elvers are found in littoral zone in water 6-15 ft deep.

REFERENCES

Adams and Hankinson 1916, 1928; Balon 1975; Bean 1902, 1913; Breder 1962; Eaton 1928; Eigenmann 1902; Gill 1908; Goode 1881; Greeley 1929; Lauer et al. 1974; Nash 1913; Radforth 1944; Raney 1959; Schmidt 1925, 1928; Smith 1913; Smith and Saunders 1955; Wickliff 1957.

ALEWIFE

MIGRATION OF ADULTS

Prespawning: Move from overwintering areas in deep water to spawning grounds in littoral waters and tributaries; movement occurs in March-July, usually April-June, beginning at 43-50°F.

Postspawning: Disperse offshore to deep water in late July or August.

SPAWNING

Season: March-September at 44-72°F, but usually May-August at 55-70°F; peak spawning occurs in June and July; spawning occurs earlier in tributaries than along lake shores.

Site: Shorelines, tributaries, and protected nearshore areas, including beaches, river mouths, marshes, canals, bays, and harbors, especially near breakwalls.

Substrate: Eggs are broadcast over a wide variety of substrate, including sand, clay, mud, silt, gravel, rock, rubble, detritus, and submersed vegetation.

Water Depth: 1-60 ft; usually less than 30 ft.

INCUBATION AND HATCHING

Site: Initially eggs adhere to plants, stones, and debris; but subsequently eggs become demersal.

Duration: Eggs hatch in 2-6 days at 72-60°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Remain in warm water in tributaries and in nearshore areas; move offshore when nearshore waters cool in September and October.

substrate: Varied, including sand, clay, silt, gravel, scattered rock, and submerged vegetation.

water Depth: To 70 ft but are usually most abundant within 6-10 ft of the surface in water less than 30 ft deep.

REFERENCES

Allen 1914; Bean 1902, 1903; Eddy and Underhill 1974; Green 1880; Odell 1934; Price and Kelly 1976; Rothschild 1966; Scott and Crossman 1973; Smith 1969; USDI 1969b.

GIZZARD SHAD

MIGRATION OF ADULTS

Prespawning: Move to spawning grounds in littoral waters and tributaries in April and May, when water temperature increases to 59°F.

Postspawning: Return to lake after spawning, usually in August.

SPAWNING

Season: Early May-late August at 60-77°F; peak spawning occurs in late May-late June at water temperatures above 67°F; also reported to spawn on falling temperatures.

Site: Quiet, protected areas with some current, including harbors, bays, marshes, sloughs, river mouths, beaches, backwaters, and low gradient streams and ditches.

Substrate: Eggs are broadcast over mud, sand, and gravel with detritus and emergent and submergent vegetation; also over rock; eggs sink slowly.

water Depth: 6 in. - 16 ft; usually 1-4 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to any submersed object, including plants and rocks, at spawning site,

Duration: Eggs hatch in 2-4 days at 80-62°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae are buoyant, move with current, and concentrate in the lower reaches of rivers and streams, around breakwalls in harbors, and in bays and along beaches; young-of-the-year (YOY) remain in nearshore areas throughout summer.

Substrate: Mud and muck with submerged vegetation; occasionally sand and rock with no vegetation.

Water Depth: To 10 ft, but usually less than 4 ft; YOY swim just below surface.

REFERENCES

Balon 1975; Eddy and Underhill 1974; Garman 1889; Hartley 1975; Kirsch 1895; Miller 1960; Momot et al. 1977; Storck et al. 1978; Trautman 1957; Tucker 1968; Warner 1940; Wickliff 1936, 1957.

MOONEYE

MIGRATION OF ADULTS

Prespawning: Move into tributaries to spawn.

Postspawning: No information.

SPAWNING

Season: April-early July at approximately 67°F.

Site: Fast-water areas of large, clear streams.

Substrate: Eggs are broadcast over rock.

Water Depth: Usually less than 2 ft.

INCUBATION AND HATCHING

Site: Eggs incubate among rocks at spawning site.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae are planktonic and are carried from spawning ground by current.

Substrate: No information.

Water Depth: No information.

REFERENCES

Crossman 1976; Eddy and Underhill 1974; Faber 1963; Gammon 1976;
Trautman 1957.

LONGJAW **cisco**^{1/}

MIGRATION OF ADULTS

Prespawning: Move to shallower water to spawn; reported to enter bays and tributaries.

Postspawning: No information.

SPAWNING

Season: November, but sometimes beginning in October.

Site: Open water.

Substrate: Eggs are scattered over mud, clay, rock, or gravel.

Water depth: 60-150 ft.

INCUBATION AND HATCHING

Site: Eggs incubate in open lake.

Duration: Eggs hatch in spring.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Pelagic in open lake.

Substrate: No information.

Water Depth: Deep, open lake.

REFERENCES

Balon 1975; Lagler 1948; Smith 1969, 1978.

^{1/} Now considered to be synonymous with shortjaw cisco.

LAKE HERRING

MIGRATION OF ADULTS

Prespawning: Shoreward movement to spawning grounds usually begins in late September-October when the water temperature reaches 43-41°F.

Postspawning: Movement away from spawning grounds occurs in December-January soon after spawning.

SPAWNING

Season: Late October-early January, but usually a 2-week period during late November-early December, when temperature is falling from 41-36°F; peak spawning occurs at 39-37°F.

Site: Shallow inshore areas, including shoals, beaches, bays, and tributaries; but also deep water adjacent to shoreline or farther offshore.

Substrate: Eggs are broadcast over clean, hard bottom, including rock, gravel, boulders, rubble, sand, clay, and marl; also reported to spawn over mud and vegetation.

Water Depth: 3-60 ft; but also to depths as great as 930 ft in Lake Superior.

INCUBATION AND HATCHING

Site: Eggs are demersal; incubate at spawning site.

Duration: Eggs hatch in 10-14 weeks at 40-43°F; hatching occurs just before ice breakup in late March-May.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae swim to surface immediately after hatching; during the first month of life they are found in protected bays; thereafter they move to deep water where they assume a pelagic existence.

Substrate: Larvae are found among rocks and vegetation.

Water Depth: Young-of-the-year are generally distributed from the surface to mid-depths in open water.

REFERENCES

Adams and Hankinson 1916, 1928; Bean 1903; Brooke and Colby 1980; Brown and Moffett 1942; Cahn 1927; Clady 1966; Colby and Brooke 1969, 1970, 1973; Crossman 1976; Eaton 1928; Edsall and Colby 1970; Engel and Magnuson 1971; Hay 1894; Bile 1936; Hinrichs and Brooke 1975;

Hubbs and Lagler 1958; John 1954, 1956; John and Hasler 1956;
Johnson, J., 1956; Lagler 1948; Langlois 1941; MacKay 1959d, 1969;
McCormick, Jones, and Syrett 1971; McCrimmon 1956; Ont. Game Fish
1934; Pearse 1921a; Price and Kelly 1976; Scott 1967; Slastenenko
1958; Smith 1969; Stockwell 1876; U.S. Army Engin. Dist., Detroit,
1978, 1979; U.S. Comm. Fish Fish. 1900; Van Oosten 1927b, 1929;
Wagner 1911; Washburn 1944.

LAKE WHITEFISH

MIGRATION OF ADULTS

Prespawning: Move inshore to spawning grounds; migration begins in September-October, but occasionally as early as August; historically also ascended rivers to spawn.

Postspawning: Return to deep water occurs soon after spawning.

Spawning

Season: A period of 2-5 weeks in October-January, when water temperature is falling from 53-33°F; spawning at temperatures above 43°F probably not successful; peak spawning usually occurs in late November-early December.

Site: Inshore areas, bays, ledges, shoals, reefs; often same sites used by lake trout.

Substrate: Eggs are broadcast near surface over hard, clean bottom, including stone, rubble, honeycombed rock, gravel, sand, and clay; use a wider variety of substrate types than lake trout; vegetation usually not present, but spawning over "moss" has been reported.

Water Depth: Several inches-100 ft, but usually less than 30 ft; often spawns on shallower portions of same reefs used by lake trout.

INCUBATION AND HATCHING

Site: Demersal eggs incubate on spawning substrate, often in crevices between and under rocks.

Duration: Eggs hatch in late March-May as the temperature approaches 43°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Rise to surface soon after hatching; are carried onto shoals and to protected inshore areas, including bays and harbors; gradually move to the bottom and then to areas farther offshore.

Substrate: Rock and sand.

Water Depth: For about 2 months, larvae are found at the surface in less than 3 ft of water; in May-July, they move toward bottom in 10-80 ft of water; in September and October, they move to deeper water.

REFERENCES

Bean 1903, 1913, 1915; Bower 1898; Crossman 1976; Dymond 1926; Eaton 1928; FWS 1945; Greene et al. 1932; Hankinson 1908; Harris and Eschmeyer 1975; Hay 1894; Hile and Deason 1934; Hubbs and Lagler 1958; Kiel 1874; Lagler 1948; McCrimmon 1956; Peck 1975a; Price 1934, 1935; Scott 1957; Scott and Crossman 1973; Slastenenko 1958; Smith and Moe 1944; Suber 1920; U.S. Army Engin. Dist., Detroit, 1979; U.S. Comm. Fish Fish. 1900; Van Oosten 1939.

BLOATER

MIGRATION OF ADULTS

Prespawning: Move from deep water to spawning grounds in slightly shallower water.

Postspawning: Return to deep water after spawning.

SPAWNING

Season: December-March, but ripe fish are found in all months and spent fish are found as early as August.

Site: Open lake.

Substrate: Eggs are broadcast pelagically over all bottom types, including clay, sand, and mud.

Water Depth: 120-400 ft.

INCUBATION AND BATCHING

Site: Semibuoyant clusters of eggs incubate just above bottom in spawning areas.

Duration: Hatching begins in early April and peaks in mid-June.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae are most abundant near bottom, at water temperatures of 41° F or less; young-of-the-year (YOY) are pelagic.

Substrate: YOY are found over clay, sand, and rocks.

Water Depth: Usually greater than 240 ft; YOY that are occasionally found near shore at depths of less than 30 ft were probably carried there by upwellings.

REFERENCES

Balon 1975; Slastenenko 1958; Smith 1969.

DEEPWATER cisco^{1/}

MIGRATION OF ADULTS

Prespawning: Move from deepwater to spawning grounds in slightly shallower water.

Postspawning: Return to deep water after spawning.

SPAWNING

Season: August and September.

Site: Open lake.

Substrate: Mud.

Water Depth: 360-540 ft.

INCUBATION AND BATCHING

Site: No information.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: No information.

Water Depth: No information.

REFERENCES

Slastenenko 1958; Smith 1969.

^{1/} This species is believed to be extinct in the Great Lakes.

KIYI

MIGRATION OF ADULTS

Prespawning: Move from deep water to spawning grounds in slightly shallower water.

Postspawning: Return to deep water after spawning.

SPAWNING

Season: August-early January; peaks between mid-October and early November.

Site: Open lake.

Substrate: Mud.

Water Depth: 300-540 ft.

INCUBATION AND HATCHING

Site: No information.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: No information.

Water Depth: No information.

REFERENCES

Slastenenko 1958.

BLACKFIN CISCO^{1/}

MIGRATION OF ADULTS

Prespawning: Move from deep water to spawning grounds in slightly shallower water; historical indication of possible movement into bays.

Postspawning: Return to deep water after spawning.

SPAWNING

Season: September-March, usually November-January.

Site: Open water.

Substrate: Eggs were scattered over rock, mud, and clay.

Water Depth: 90-600 ft.

INCUBATION AND BATCHING

Site: Eggs were pelagic in open water.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae were pelagic in open water.

Substrate: No information.

Water Depth: No information.

REFERENCES

Balon 1975; Lagler 1948; Slastenenko 1958; Smith 1969.

^{1/} This species is believed to be extinct in the Great Lakes.

SHORTNOSE CISCO

MIGRATION OF ADULTS

Prespawning: Move from deep water to spawning grounds in slightly shallower water.

Postspawning: Return to deep water after spawning.

SPAWNING

Season: January-September, but usually April-June; peaks in early May; also believed to have spawned in November.

Site: Open water.

Substrate: Eggs are scattered over varied bottom types, including sand, mud, silt, clay, and rock.

Water Depth: 64-582 ft, but usually about 180-350 ft.

INCUBATION AND HATCHING

Site: Eggs are pelagic in open Water.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae are pelagic in open water.

Substrate: No information.

Water Depth: No information.

REFERENCES

Balon 1975; Slastenenko 1958; Smith 1969.

SHORTJAW **cisco**^{1/}

MIGRATION OF ADULTS

Prespawning: Move from deep water to spawning grounds in slightly shallower water beginning in mid-September.

Postspawning: Return to deep water after spawning.

SPAWNING

Season: A period of 1-2 weeks in October-early December; ripe fish found as early as mid-May.

Site: Open water.

Substrate: Eggs are scattered over clay and sand.

Water Depth: 60-300 ft; varies with weather conditions, shallow areas used in calm weather.

INCUBATION AND HATCHING

Site: Eggs are pelagic in open water.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae are pelagic in open water.

Substrate: No information.

Water Depth: No information.

REFERENCES

Balon 1975; Eddy and Underhill 1974; Lagler 1948; Slastenenko 1958; Smith 1969.

^{1/} Now considered to be synonymous with longjaw cisco.

PINK SALMON

MIGRATION OF ADULTS

Prespawning: Congregate off tributary mouths beginning in mid-August; ascend tributaries to spawning grounds in September; upstream migration usually less than 0.5 mi but a migration of 40-50 mi has been reported in one Lake Superior tributary.

Postspawning: None; die soon after spawning.

SPAWNING

Season: A period of 3-5 days in September-early October at 60°F; usually peaks in mid-September.

Site: Usually in brush-choked streams in shoal area nearest stream mouth where there is suitable substrate and water velocity of 0.75-3.25 **fps**^{2/}.

Substrate: Eggs are deposited in redd dug in medium-sized gravel.

Water Depth: 6 **in.**^{2/} - 2 ft.

INCUBATION AND HATCHING

Site: Eggs incubate under gravel in redd.

Duration: Eggs usually hatch in late December-late February; but hatching may sometimes occur as early as late November.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Remain in gravel until yolk is absorbed; emerge in April-May, mainly mid-April, and immediately migrate downstream to lake; habitat occupied in Great Lakes by these young fish is unknown; young entering marine waters remain inshore for several **months**^{1/}.

Substrate: No information.

Water Depth: No information.

REFERENCES

MacKay 1969; Scott and Crossman 1973^{1/}; Slastenenko 1958; Swift 1979^{2/}.

^{1/} Pacific Coast

^{2/} Washington

COHO SALMON

MIGRATION OF ADULTS

Prespawning: Congregate off tributary mouths in August and September; ascend tributaries to spawning grounds usually in September but sometimes in August; movement into tributaries correlated with increased flow.

Postspawning: None; die soon after **spawning^{1/}**.

SPANNING

Season: A 90-day period in mid-September-January when the temperature is falling from 57-40°F; spawning usually peaks in October or November; low temperatures in early winter can delay spawning until spring.

Site: Riffles, with water velocity of 0.25-2.5 **fps^{3/}**, in mid-reaches or headwaters of streams; also reported along shore in St. Lawrence River.

Substrate: Eggs are deposited in redd dug in clean, small or medium-sized gravel; fine sediment detrimental to reproductive success.

Water Depth: Minimum depth reported as 6 **in.^{3/}** and also as shallow as 2 in.

INCUBATION AND HATCHING

Site: Eggs incubate under gravel in redd.

Duration: Eggs hatch in 2-5 months at 32-36°F; hatching usually occurs in March or April.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Remain in gravel 2-16 weeks after hatching until yolk is absorbed; after emerging from gravel, inhabit shallows along sides of streams, then gradually move to deeper pools with slower current, usually under protection of overhanging banks, boulders, or **logs^{2/}**; remain in stream for at least one year.

Substrate: Those present in natal stream.

Water Depth: Those present in natal stream.

REFERENCES

Harry 1969^{1/}; Hartman 1965^{2/}; Scott and Crossman 1973; Smith 1969;
Swift 1969^{3/}; Tody and Tanner 1966.

1/ Pacific Coast

2/ British Columbia

3/ Washington

KOKANEE

MIGRATION OF ADULTS

Prespawning: Move from offshore waters to spawning grounds along the lakeshore and in tributaries; tributary runs begin in mid-August; peak in late September and end by mid-October.

Postspawning: None; die soon after spawning.

SPANNING

Season: September-October when the temperature is falling from 61 to 41°F; peaks in late September or early October.

Site: Mid-reaches and headwaters of tributaries in areas with water velocity of less than 2.2 **fps**^{1/}; if access to tributaries is denied spawning occurs along lake shore, usually on wave-swept beaches or on bars near stream mouth.&.

Substrate: Eggs are deposited in redds dug in fine gravel; also in sand along lake shore.&.

Water Depth: 1-30 ft.

INCUBATION AND HATCHING

Site: Eggs incubate under gravel in redd.

Duration: Eggs hatch in 6-20 weeks at 59-39°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Emerge from redd in early January-May and descend to lake; downstream movement may occur under ice but peaks in mid-March to early May; habitat utilized in Great Lakes by these young fish is unknown.

Substrate: Those described for spawning site in lake; no other information.

Water Depth: Those described for spawning site in lake: no other information.

REFERENCES

Delisle **1962**^{1/}; Eddy and Underhill 1974; Jeppson **1960**^{2/}; Scott and Crossman 1973.

^{1/} California

^{2/} Idaho

CHINOOK SALMON

MIGRATION OF ADULTS

Prespawning: Congregate near tributary mouths usually in late August or September at about 70°F; upstream migration to spawning grounds may begin as early as mid-July, possibly initiated by drop in stream temperature to 65°; a spring run also occurs; spring-run fish inhabit deep pools in the stream until fall, when they spawn.

Postspawning: None; die soon after spawning.

SPAWNING

Season: Late August-mid November when temperature is falling from 50 to 37°F; peaks in October and may last several weeks.

Site: Riffle areas with water velocity of 1-3 fps^{5,7/} in high gradient mid-reaches or headwaters of tributaries; spawning may also occur along lake shore or on shoals 3,4/.

Substrate: Eggs are deposited in redd dug in gravel and small rubble with good interstitial water flow, little mud or silt^{1,6/}, depth of 18-30 in.^{5/}, and diam. less than 6 in.^{5/}, usually less than 1 in.^{6/}; if rocky substrate prevents redd construction, eggs may be deposited on the unmodified substrate.

Water Depth: 1-6 ft. ^{3.5.7/}

INCUBATION AND HATCHING

Eggs incubate in layers of gravel in redd; also in crevices

Duration: Eggs usually hatch in less than 4 months^{2/}.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Emerge from gravel a few weeks after hatching; drift from spawning areas and remain near shore; may move downstream to lake during first summer of life or may remain in stream for 1-2 years^{2/}; most downstream movement occurs after heavy rain.

Substrate: Those described for spawning site or present in natal stream; no other information.

Water Depth: Those described for spawning site or present in natal stream no other information.

REFERENCES

Burner 1951^{1/}; Harry 1969^{2/}; Hoover 1936^{3/}; Kendall 1913^{4/}; Leitritz and Lewis 1976^{5/}; Platts et al. 1979^{6/}; Scott and Crossman 1973; Swift 1979^{7/}.

^{1/} Columbia River

^{2/} Pacific Coast

^{3,4/} New Hampshire

^{5/} Laboratory studies

^{6/} Idaho

^{7/} Washington

PYGMY WHITEFISH

MIGRATION OF ADULTS

Prespawning: Move from deep water to spawning grounds near shore; also ascend tributaries to spawn 1,2,3/.

Postspawning: No information.

SPAWNING

Season: November-December, possibly into early January.

Site: Lakeshore or in tributaries.

Substrate: Eggs are scattered over rock, rubble, or coarse gravel.

Water Depth: Relatively shallow water.

INCUBATION AND HATCHING

Site: Eggs incubate among gravel and rock rubble.

Duration: Eggs hatch in early spring.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Remain in littoral areas most of first summer of life; found Gave-swept ledge&; then move offshore.

Substrate: San&/.

Water Depth: 10-20 ft^{1/}; move to deeper water in late summer^{1/}; thereafter found at depths to about 200 ft.

REFERENCES

Eddy and Underhill 1974; Heard and Hartman 1966^{1/}; Kendall 1921^{2/}; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Weisel and Dillon 1954^{3/}.

1,2/ Alaska

3/ Montana

ROUND WHITEFISH

MIGRATION OF ADULTS

Prespawning: Move inshore to spawning grounds in lake or tributaries beginning in September or October.

Postspawning: No information.

SPAWNING

Season: October-early January when temperature is falling from 40-36°F; spawning peaks in late November-early December.

Site: Along lakeshore, on beaches, shoals, and reefs, in bays, at river mouths; also in tributaries.

Substrate: Eggs are broadcast at the **surface^{1/}** over gravel, sand, and rock in areas free of **silt^{2/}**.

Water Depth: Few **inches^{2/}** - 50 ft; usually less than 30 ft.

INCUBATION AND HATCHING

Site: Eggs settle to **bottom^{1/}** and incubate on substrate at spawning site.

Duration: Eggs hatch in about 140 days at 36°F; hatching begins in late March, peaks in late April, and ends by **mid-May^{2/}**.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae remain on **bottom^{2/}**; young-of-the-year are found along shore and in river mouths.

Substrate: Rock, gravel, and sand with no emergent vegetation.

Water Depth: 5-15 ft.

REFERENCES

Balon 1975; Bean 1902, 1903, 1913; Eddy and Underhill 1974; Hubbs and Lagler 1958; Kendall and Goldsborough **1908^{1/}**; Nash 1913; Normandeau **1969^{2/}**; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; U.S. Comm. Fish Fish. 1900.

^{1/} Connecticut

^{2/} New Hampshire

RAINBOW TROUT

MIGRATION OF ADULTS

Prespawning: Move into nearshore waters and enter tributaries in the fall, beginning in September, however the major run in most tributaries occurs in the spring; runs are stimulated by increased stream flow and water temperatures of 38-45°F.

Postspawning: Most return to lake immediately after spawning, usually by mid-June, but some remain in tributaries throughout the summer.

SPAWNING

Season: November-July at 33-65°F; peak spawning usually occurs in April-May at 43-46°F.

Site: Fast-water areas in mid-reaches or headwaters of cool, clear tributaries; may spawn along lake shore or on reefs or shoals if tributaries unsuitable.

Substrate: Eggs are deposited in redd dug in clean, small or medium-sized gravel.

Water Depth: Usually to depths of 6 ft; spawning in lake reported at depths to 36 ft.

INCUBATION AND HATCHING

Site: Eggs incubate under gravel in redd.

Duration: Eggs spawned in the fall hatch the following spring; those spawned in the spring hatch in 1-2 months at 50-45°F, usually in late May-early July.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: In streams, remain in gravel for 2-3 weeks after hatching; fry first found in shallow areas near shore, then in deeper areas farther from shore; most remain in stream 1-4 years, but some may descend to lake during the first summer.

Substrate: Those present in the natal stream including gravel, rock, rubble, sand, mud, and silt.

Water Depth: To 4 ft. in natal stream.

REFERENCES

Bean 1913; Berst and McCombie 1975; Bower 1910; Eddy and Underhill 1974; Embury 1922, 1928; Hartman 1957, 1959; Hatch 1957a,b; Hubbs and Eschmeyer 1938; Johnson, C., 1971; Lagler 1948; MacKay 1960a, 1969; McCrimmon 1956; Moffett 1958; North Woods Call 1979a; Price and Kelly 1976; Scott 1967; Slastenenko 1958; Smith and Moe 1944; Stone and Hartman 1957; USDI 1966, 1969b.

ATLANTIC SALMON⁸/

MIGRATION OF ADULTS

Prespawning: Migrate long distances from lakes into tributaries and also into lake outlets&?&; runs stimulated by sudden increase in stream flow; some fish may be found in streams in most months; all approach shore in April-October, but at least two separate runs may occur; an early run ascends streams in May-July and remains in the streams until spawning time; a late run ascends in September and October just prior to **spawning^{1,2}/**.

Postspawning: Most leave streams immediately after spawning or after resting in pools for a few weeks; others overwinter in streams.

SPAWNING

Season: A period of 5-14 days in late October-late December; peak spawning usually occurs in November at about 44°F.

Site: Fast-water areas in clear, cold streams with steep gradient; early runs usually spawn in the upper reaches, late runs in lower reaches; also on lake shoals which have seepage from springs^{4,5,6,7}/.

Substrate: Eggs are deposited in redd dug in clean coarse gravel and small stones with good interstitial water flow; eggs may also be deposited directly on impenetrable substrate where redd construction is impossible³/.

Water Depth: To 4 ft.

INCUBATION AND HATCHING

Site: Eggs incubate under gravel in **redd¹/** or on surface of impenetrable substrate³/.

Duration: Eggs hatch in 110-200 days at 39°F or less, in mid-March to early May but usually in April.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Remain in gravel for 4-6 weeks; emerge in May or June; remain in rapids until 2.5 in. long, then move to slower areas at head of riffles and along edges of stream; young spawned in large rivers may ascend smaller tributaries near spawning site&?&; young remain in streams 1-3 years.

Substrate: Young are found on a variety of substrates, including **gravel³/**.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Bean 1902; Belding 1934¹/; Belding and Kitson 1934²/; Eddy and Underhill 1974; FWS 1945; Havey and Warner 1970³/; Hoover 1937⁴/; Kendall 1913⁵/, 1918⁶/; MacKay 1960b, 1969; Ont. Game and Fish 1913a,b; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Towne 1959⁷/; U.S. Comm. Fish Fish. 1900.

1,2/ Atlantic Coast of Canada

3,6/ Maine, land-locked population

4,5,7/ New Hampshire, land-locked population

8/ Native to Lake Ontario; native stocks extinguished before 1900.

BROWN TROUT

MIGRATION OF ADULTS

Prespawning: Enter and ascend tributaries in late summer and fall, beginning in July; runs are often limited by low stream flow.

Postspawning: Return to lake after spawning.

SPAWNING

Season: September-January; usually October-November when the temperature is falling from 55 to 44°F.

Site: Fast water in headwaters or mid-reaches of cool, shaded streams; if denied access to tributaries, spawning occurs on shoals near stream mouths, or elsewhere along shore.

Substrate: Eggs are deposited in redd dug in clean, coarse gravel and rubble or in firm sand or hard clay if gravel not available.

Water Depth: To 4 ft.

INCUBATION AND HATCHING

Site: Eggs incubate under gravel or on other substrate in redd.

Duration: Eggs hatch in 1-5 months at 57-35°F, usually in early February-early May.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Emerge from gravel and remain near bottom and stream bank in water with velocity of 0.5-1 fps; gradually move to deeper water farther from stream bank; young remain in natal stream 1-2 years before migrating to lake.

Substrate: Firm, clean stream bottom including gravel, rocks, and sand.

Water Depth: 6-16 in.

REFERENCES

Bean 1902, 1903, 1915; Benson 1953; Buller 1927; Calhoun and Coon 1941; Eddy and Underhill 1974; Embury 1922; Greeley 1932; Hansen 1975; Johnson, C., 1971; Lagler 1948; MacKay 1957c, 1969; Mansell 1966; Price and Kelly 1976; Scott 1967; Scott and Crossman 1973; Slastenenko 1958, USDI 1966, 1969b.

BROOK TROUT

MIGRATION OF ADULTS

Prespawning: Lake-run fish ("coasters") enter and ascend streams beginning in mid-August.

Postspawning: May return to lake after spawning.

SPAWNING

Season: August-March, but usually October-December, when the temperature is falling from 55 to 36°F.

Site: Riffles or pools near headwaters of clear, well-shaded streams, in spring-fed areas with gradient not more than 2%; also along lake shores with moderately swift current, usually near sites of upwellings.

Substrate: Eggs are deposited in redd dug in clean rubble, marl, or gravel.

water Depth: 10 in.-5 ft in streams; to more than 8 ft in lake&.

INCUBATION AND HATCHING

Site: Eggs incubate under gravel and sand in redd.

Duration: "Eggs hatch in 32-165 days at 54-37°F, usually in February or March.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Emerge from gravel in January-May; remain in littoral areas close to spawning site for about 2 months, then move to deeper faster water 10-16 ft from streambank; also reported to move upstream into smaller tributaries^{1/} and to move downstream immediately after emergence^{2/}.

Substrate: Varied bottom, including rock, gravel, sand, silt, and mud.

Water Depth: To 6 in. just after emergence; gradually move to deeper water.

REFERENCES

Benson 1953; Bean 1902, 1903, 1915; Brasch et al. 1962; Buller 1927; Calhoun and Coon 1941; Carline 1980; Crossman 1976; Dymond 1926; Eipper 1964; Embody 1922; Greeley 1932; Hazzard 1932; Johnson, C., 1971; Kendall 1918^{1/}; Lagler 1948; MacKay 1956d; Meehan 1895; Miller

1970; Milner 1874a; Moffett 1958; Nash 1913; Ont. Game Fish 1913a;
Salli 1974; Scott and Crossman 19'73; Shetter 1937, 1938a; Smedley
1938;. Spangler and Berst 1978; U.S. Comm. Fish Fish. 1900; USDI 1966,
1969b; White **1930^{2/}**.

1/ Maine

2/ Prince Edward Island, Canada

LAKE TROUT

MIGRATION OF ADULTS

Prespawning: Move from deep water to spawning grounds in shallower water on offshore reefs, in littoral waters, or in tributaries; movement usually begins in late August or September; fish arrive on grounds 1-2 weeks before spawning begins.

Postspawning: Disperse to deeper water several weeks after spawning.

SPAWNING

Season: Most spawning occurs in October and November when the temperature is falling from 58 to 37°F; however some races may begin spawning in June.

Site: Areas with current, including shorelines, reefs, shoals, ledges, bars, channels, bays, river mouths, and rivers.

Substrate: Eggs are broadcast by shallow-water races over rough, silt-free bottom, including honeycomb rock, rubble, boulders, and gravel; deep-water races spawn over clay, sand, mud, and silt; planted varieties spawn over all substrates.

Water Depth: Few inches - 600 ft, depending on race of Lake trout; planted varieties usually at depths less than 30 ft.

INCUBATION AND HATCHING

Site: Eggs usually incubate in crevices in the substrate.

Duration: Eggs hatch in 2-5 months at 47-35°F, in late January-May.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Remain in crevices in substrate for about 1 month; larvae produced in tributaries move into lake soon after hatching; young produced in lakes remain near spawning ground at least through first summer of life.

Substrate: Sand, rock, rubble.

Water Depth: To 150 ft.

REFERENCES

Bean 1902, 1903, 1913, 1915; Crossman 1976; Dymond 1926; Eaton 1928; Eddy and Underhill 1974; Fisherman 1936; FWS 1945; Greene 1955; Greene et al. 1932; Hacker 1957, 1962; Hubbs and Lagler 1958; Martin 1955, 1957, 1960, 1963; Martin and Baldwin 1960; McCrimmon 1956, 1958; Mich. State Comm. Superintendent State Fish. 1875; Moffett 1956, 1958; Ont. Game Fish 1916; Raney 1959; Royce 1936, 1951; Scott 1967; Scott and Crossman 1973; Smith and Moe 1944; Spangler and Berst 1978; Titcomb 1922; USDI 1966.

SPLAKE

MIGRATION OF ADULTS

Prespawning: Congregate on spawning grounds at appropriate depths in mid-October.

Postspawning: No information.

SPAWNING

Season: Mid-October to mid-November at 44-47°F.

Site: Shoals and reefs, especially former lake trout spawning grounds.

Substrate: Eggs are deposited on broken rock, boulders, rubble, and fine-coarse gravel that has been swept clean of silt, vegetation, and detritus.

Water Depth: 18 in. - 16 ft.

INCUBATION AND HATCHING

Site: Eggs incubate on spawning substrate.

Duration: Eggs hatch in about 6 months, after spring ice breakup.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: No information.

Water Depth: No information.

REFERENCES

Martin and Baldwin 1950; Spangler and Berst 1978.

RAINBOW SMELT

MIGRATION OF ADULTS

Prespawning: Move from deep water to inshore areas and into tributaries over a period of 3-30 days; movement begins at about the time of ice breakup in late March or April at 33-40°F; downstream migration into lake outlets may also occur.

Postspawning: Disperse to offshore areas in late May-July immediately after spawning.

SPAWNING

Season: A period of 1-2 weeks in late March-July at 33-65°F; begins just after ice breakup and usually peaks in late April-early May at 40-50°F.

Site: Areas of moderate or swift current in tributaries, usually within 1 mi of mouth, and in wave-swept lake areas, including beaches, shoals, ledges, bars, and stream mouths.

Substrate: Eggs are broadcast over varied substrate, including gravel, cobble, rubble, boulders, bedrock, sand, mud, silt, and filamentous algae.

Water Depth: To 80 ft or more, but usually less than 12 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to substrate at spawning site.

Duration: Eggs hatch in 2-4 weeks, usually in mid-May - July.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae drift out of natal stream into lake soon after hatching and frequent nearshore areas, including beaches, bays, harbors, and river mouths; older larvae disperse widely and are often found considerable distance from shore.

Substrate: Gravel, sand.

Water Depth: To 240 ft, but usually to 30 ft for larvae and to 60 ft for young-of-the-year; become demersal in the fall and move farther offshore.

REFERENCES

Berst and Spangler 1970a; Creaser 1925; Crossman 1976; Eaton 1928; FWS 1945; Greene 1930; Hubbs and Creaser 1924; Hubbs and Lagler 1958; Lagler 1948; Langlois 1935; ODNR, undated; Raney 1959; Smith 1964, 1969.

CENTRAL MUDMINNOW

MIGRATION OF ADULTS

Prespawning: Move onto flooded stream banks; also may migrate extensively upstream beginning in mid-February or March.

Postspawning: No information.

SPAWNING

Season: Mid-March-late April, during spring floods, at about 55°F.

Site: Backwaters, lagoons, ditches, and flooded areas with sluggish water movement.

Substrate: Eggs are deposited singly on soft bottom of vegetation; sometimes also on stones.

Water Depth: About 1 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to vegetation or substrate at spawning site.

Duration: Eggs hatch in about 6 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Remain in littoral areas near spawning Site; move to main stream when just over 1 in. long.

Substrate: Soft bottom, including mud, silt, and vegetation.

Water Depth: About 1 ft.

REFERENCES

Adams and Hankinson 1928; Eddy and Underhill 1974; Evermann and Clark 1920; Faber 1967; Gill 1904; Hubbs and Lagler 1958; ODNR, undated; Peckham 1955; Peckham and Dineen 1957; Scott 1957; Scott and Crossman 1973; Westman 1941, as cited in Scott and Crossman 1973.

GRASS PICKEREL

MIGRATION OF ADULTS

Prespawning: Congregate at tributary mouths when ice begins to breakup; ascend streams just after ice breakup, usually beginning in late February.

Postspawning: No information.

SPAWNING

Season: Late March-early May at 43-53°F, during spring flood; also reported to spawn in the fall.

Site: Marshes, lagoons, sloughs, ditches, and flooded land with sluggish water movement.

Substrate: Eggs are scattered over muck, silt, peat, detritus, or vegetation.

Water Depth: 2 in. - 3 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to vegetation or detritus at the spawning site.

Duration: Eggs hatch in 11-20 days at 46-48°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain near bottom at spawning site for 10-14 days and may attach to vegetation; fry migrate to lake when about 1 in. long.

Substrate: Soft bottom.

Water Depth: To 3 ft for larvae.

REFERENCES

Buss et al. 1978; Buss and Miller 1967; Cahn 1927; Carbine 1938, 1944; Crossman 1962, as cited in Scott and Crossman 1973; Fowler 1921; Hankinson 1908; Karvelis 1964; Kirsch 1895; Kleinert and Mraz 1966; Lagler and Hubbs 1943; McNamara 1937; Richardson 1913a; Scott 1967; Slastenenko 1958; Van Oosten 1960.

NORTHERN PIKE

MIGRATION OF ADULTS

Prespawning: Migrate from deeper water to littoral areas or into tributaries at time of ice breakup, beginning at about 33-40°F; may begin to congregate at river mouths in late February before ice breakup.

postspawning: Return to lake after spawning.

SPANNING

Season: A period of 10-24 - days in mid-March - June, after ice leaves streams, at 35-64°F; usually late March-late April at 40-50°F.

Site: Areas with sluggish water current, including shoreline weed beds and marshes, sloughs, bays and harbors, backwaters, river mouths, ditches, feeder streams, and temporarily flooded lowlands.

Substrate: Eggs are scattered over soft bottom, with abundant emergent and submergent vegetation; may also spawn over gravel and rock.

Water Depth: To 24 ft, but usually less than 6 ft and often less than 2 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to vegetation or debris at spawning site.

Duration: Eggs hatch in 1 - 3-1/2 weeks, usually in 10-18 days at 52-42°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain in attached to vegetation at spawning site for 5-10 days; young remain in sheltered, weed-choked areas; young produced in tributaries move downstream to harbors and lakeshores when they are 1-2 in. long.

Substrate: Soft bottom with abundant vegetation.

Water Depth: 1 - 2-1/2 ft; move to deeper water in late summer.

REFERENCES

Alldridge and White 1980; Allen 1914; Rensley 1915; Bean 1903, 1912, 1913; Bennett 1948; Buss 1960, 1961; Buss et al. 1978; Cahn 1927; Calhoun and Coon 1941; Carbine 1938, 1941, 1944; Crossman 1976; Dymond 1926; Eddy and Underhill 1974; Embury 1915, 1918, 1922; Evermann and Latimer 1910; Faber 1963; Forny 1967, 1968; Franklin and

Smith 1963; Greely 1928; Hubbs (and Eschmeyer 1938; Hubbs and Lagler 1958; Johnson, C., 1971; Johnson, F., 1957; Jordan 1877; Karvelis 1964; Kramer and Smith 1960; Lagler 1948; Leach 1927; MacKay 1959f, 1969; McCrimmon 1956; McNamara 1937; Nash 1913; Peterka and Kent 1976; Price and Kelly 1976; Prisegel and Krohn 1975, 1971; Raney 1959; Reighard 1913; Scott 1967; Scott and Crossman 1973; Shetter 1937; Slastenenko 1958; Smith and Moe 1944; Smith et al. 1958; Spinner 1968; Surber 1920; Threinen and Oehmke 1950; Threinen et al. 1966; Titcomb 1922; USDI 1966, 1969b; Van Oosten 1946, 1960; Westerman 1946; Williams 1954a; Williams and Jacob 1971; Williamson 1942.

MUSKELLUNGE

MIGRATION OF ADULTS

Prespawning: Make extensive migrations into tributaries, often to the headwaters, or to lake shallows, when the temperature rises to 42°F, following ice breakup.

Postspawning: Males return to lake when water temperature reaches about 60°F; females remain in river channels several weeks and return to lake by mid-August.

SPAWNING

Season: Late March-June at 46-65°, but usually May and June.

Site: Protected bays, harbors, marshes, stream mouths, feeder streams, and flooded lowlands; also in current-swept areas at edges of channels.

substrate: Eggs are scattered over mud, muck, clay, or sand with decayed vegetation and woody debris, including brush, logs, and stumps.

water Depth: 6 in. - 15 ft; usually less than 3 ft.

INCUBATION AND HATCHING

Site: Eggs incubate on vegetation and debris at spawning site.

Duration: Eggs hatch in 8-15 days at 62-50°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain among vegetation for about 10 days; young may remain near spawning site for several months or may drift into deeper waters of bays and marshes as shallows dry up.

Substrate: Mud, silt, sand, vegetation.

Water Depth: To 6 ft, near surface.

REFERENCES

Bean 1903, 1908, 1913, 1915; Becker 1976; Bensley 1915; Buss 1960; Buss et al. 1978; Calhoun and Coon 1941; DeBoer and Williams 1954; Dombeck 1979; Eddy and Underhill 1974; Faber 1963, 1967; Forney, undated; Garland 1973; Hay 1894; Hubbs and Lagler 1958; Johnson, C., 1971; Johnson, L., 1958; Karvelis 1964; Leach 1927; MacKay 1931, 1956c, 1969; McCrimmon 1956; Minor and Crossman 1978; Nevin 1901a; ODNR, undated; Oehmcke et al. 1962; Ont. Game Fish 1913b, 1930; Price and Kelly 1976; Raney 1959; Scott 1967; Scott and Crossman 1973;

Slastenenko 1958; Smith and Moe 1944; Surber 1920; Threinen and Oehmke 1950; U.S. Comm. Fish Fish. 1900; USDI 1966, 1969b; Van Oosten 1946, 1960; Webster 1929; Wickcliff 1933b; Williams 1954a,b, 1959; Williamson 1942; Winchester 1912.

STONEROLLER

MIGRATION OF ADULTS

Prespawning: Ascend small streams beginning in February.

Postspawning: No information.

SPAWNING

Season: Late March-early July at 53-80°F.

Site: Clear smoothly flowing water, at head of riffle near deeper pool or overhanging bank.

Substrate: Eggs are deposited in a nest constructed by male in gravel, cock, and sand.

Water Depth: 6 in. - 2 ft.

INCUBATION AND HATCHING

Site: Eggs incubate in crevices among gravel in nest.

Duration: Eggs hatch in about 3 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: **Gravel^{1/}**.

Water Depth: No information.

REFERENCES

Breder and Rosen 1966; Cahn 1927; Eddy and Underhill 1974; Fish 1932; Fowler 1909; Hankinson 1919, 1932; Hubbs and Cooper 1936; Meek and Hildebrand 1910; Miller 1962, 1964; Minckley 1963^{1/}; Raney 1949; Reed 1958; Reighard 1913; Smith 1935, Trautman 1957.

^{1/} Kentucky

GOLDFISH

MIGRATION OF ADULTS

Prespawning: Move inshore short distances into littoral areas or tributaries beginning at about 45°F.

Postspawning: No information.

SPAWNING

Season: Mid-April - mid-August, usually May and June, beginning at about 55°F; spawning may continue throughout the summer if water temperature remains above 60°F.

Site: Current-free areas in lower reaches of rivers, bays, harbors, lagoons, marshes, and flooded lowlands.

Substrate: Eggs are scattered over thick vegetation and mud, sand, clay, or gravel; also deposited on undersides of boats and harbor pilings.

water Depth: 2-12 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to substrate, usually vegetation, at spawning site.

Duration: Eggs hatch in 2-1/2 to 7 days at 82-60°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young frequent river mouths, harbors, and protected shoreline areas through the first summer of life.

Substrate: Vegetation and mud.

Water Depth: 1-7 ft.

REFERENCES

Dobie et al. 1956; Emboldy 1915; Hubbs and Cooper 1936; Scott 1967.

LAKE CHUB

MIGRATION OF ADULTS

Prespawning: Migrate from deeper water to littoral areas or ascend tributaries for short distances.

Postspawning: Return to lake from tributaries after spawning.

SPAWNING

Season: April.-early July.

Site: Tributaries and lake shores.

Substrate: Sand, gravel, and rubble.

Water Depth: Ripe fish found at 3-30 ft.

INCUBATION AND HATCHING

Site: No information.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year found in streams, stream mouths, and along lake shores.

Substrate: No information.

Water Depth: No information.

REFERENCES

Dymond 1926; Eddy and Underhill 1974; Radforth 1944; Scott 1967; Scott and Crossman 1973; Slastenenko 1955.

CARP

MIGRATION OF ADULTS

Prespawning: Move from littoral waters into marshes beginning in April or early May at about 45°F; also ascend tributaries, usually only short distances, but sometimes as far as 10-15 mi.

Postspawning: Disperse after spawning but remain in shallows throughout the summer; move to depths greater than 6 ft in late August; tributary spawners return to lakes by early June.

SPAWNING

Season: May-August at 52-90°F; peak spawning occurs in late May-early June at 65-73°F; spawning may extend throughout summer subject to interruption by cool weather.

Site: Protected areas of lakes and rivers, including bays, harbors, marshes, backwaters, sloughs, flooded shorelines, and river mouths; also on shoals and reefs.

Substrate: Eggs are broadcast at random near the surface over mud, muck, silt, sand, matted roots or dead grass, and abundant emergent, submergent, and floating vegetation; also over gravel, rock, and rubble.

Water Depth: To 20 ft, but usually less than 3 ft, and often 3 in. - 1 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on firm substrate including plants, dead grass, tree roots, stones, and Cladophora fronds (thalli).

Duration: Eggs hatch in 1-3 weeks.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae settle to bottom immediately after hatching and attach to plants or other objects; fry tend to leave spawning areas about 2 weeks after hatching but remain along shore among vegetation through summer; larvae are also abundant in riffle areas in rivers.

Substrate: Mud, clay, gravel, rock, sand, and vegetation.

Water Depth: About 1 in. for newly hatched larvae; 4-6 in. for young-of-the-year (YOY) about 0.5-1 in. long; 6-12 in. for those 1-3 in. long; in late summer YOY 3-4 in. long are found to depths of 20 ft but they are usually in 1-2 ft of water.

REFERENCES

Adams and Hankinson 1928; Allen 1974; Bean 1903; Becker 1976; Brasch 1958; Cahn 1927; Eaton 1928; Eddy and Underhill 1974; Embody 1915, 1922; Evermann and Clark 1920; Frey 1940; FWS 1945; Gammon 1976; Greeley 1928; Harris et al. 1882; Hubbs and Cooper 1936; Hubbs and Lagler 1958; Kramer and Smith 1960b; Lagler 1948; MacKay 1960c, 1969; McCrimmon 1956; McCrimmon and Swee 1967; Miller 1952; Mraz and Cooper 1957; Nash 1913; Price and Kelly 1976; Raney 1959; Richardson 1913b; Scott 1967; Slastenenko 1958; Smallwood and Struthers 1928, 1931; Smith and Moe 1944; Struthers 1929, 1931; Taft 1975; USDI 1966, 1969b; Wickliff 1936, 1957.

SILVERJAW MINNOW

MIGRATION OF ADULTS

Prespawning: May move from streams into smaller creeks.

Postspawning: No information.

SPAWNING

Season: Late April-late July; spawning peaks in late April-early May and late June-early July.

Site: Streams.

Substrate: Eggs are scattered over clean sand and gravel.

Water Depth: 2-3 in.

INCUBATION AND HATCHING

site: Eggs incubate on spawning substrate.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are collected upstream in creeks and also in the lower reaches of rivers.

Substrate: Sand.

Water Depth: No information.

REFERENCES

Forbes and Richardson 1920; Hankinson 1919; Osburn 1901; Smith 1963; Wallace 1973.

SILVER CHUB

MIGRATION OF ADULTS

Prespawning: Historically ascended rivers.

Postspawning: No information.

SPAWNING

Season: Late May-early August at 66-74°F; peak spawning occurs in late June-early July at 73°F.

Site: Historically rivers; presently beaches, bays, open lake.

Substrate: Eggs are scattered in mid-water over clean gravel.

Water Depth: No information.

INCUBATION AND HATCHING

Site: Possibly open water.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Open lake; possibly also on reefs.

Substrate: No information.

Water Depth: No information.

REFERENCES

ODNR, undated; Raney 1969a; Slastenenko 1958.

RIVER CHUB

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: Mid-May - early July at 60-83°F.

Site: River shoals or lower pools just above riffles, in slow or moderate current 2-10 ft from shore.

Substrate: Eggs are scattered in nest made in clean gravel.

water Depth: 6 in. to 2-1/2 ft.

INCUBATION AND HATCHING

Site: Eggs incubate in nest constructed of stones to form a low mound up to 4 ft in diameter.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: No information.

water Depth: No information.

REFERENCES

Forbes and Richardson 1920; Greeley 1929; Hankinson 1920, 1932; Lachner 1952; Miller 1964; Raney 1949, 1969a; Reighard 1943; Hubbs and Cooper 1936; White et al. 1975; Wickliff 1957.

GOLDEN SHINER

MIGRATION OF ADULTS

Prespawning: Movement to shallows may begin as early as April.

Postspawning: No information.

SPAWNING

Season: Mid-May to early August at 60-80°F; spawning may occur throughout the summer; peak spawning occurs in mid-June - July.

Site: Sheltered areas of lakes, including bays, marshes, lagoons, sloughs, and creek mouths.

Substrate: Eggs are scattered over dense vegetation, mud, silt, and detritus; also reported to spawn in largemouth bass nests.

Water Depth: To 4-1/2 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on vegetation at spawning site.

Duration: Eggs hatch in 7-10 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Sheltered areas near spawning site, including marshes, harbors, and river mouths.

Substrate: Sand, mud, silt, and vegetation.

Water Depth: Shallow: no specific information.

REFERENCES

Adams and Hankinson 1928; Allen 1914; Buller 1927; Cahn 1927; Cooper 1935, 1938; Eddy and Underhill 1974; Embury 1915, 1922; Forbes and Richardson 1920; Forney 1956; Greeley 1929; Hedges and Ball 1953; Hubbs and Cooper 1936; Kramer and Smith 1960a,b; Langlois 1954; ODNR, undated; Price and Kelly 1976; Scott 1967; Slastenenko 1958; Smith and Moe 1944; Surber 1940.

PUGNOSE SHINER

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

season: June or July.

Site: Protected areas, such as bays.

Substrate: Gravel, sand, and mud, with vegetation.

Water Depth: Shallow; no specific information.

INCUBATION AND HATCHING

Site: No information.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Protected areas.

Substrate: Sand, mud, and vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

ODNR, undated; Scott and Crossman 1973.

EMERALD SHINER

MIGRATION OF ADULTS

Prespawning: Move from deep water to inshore areas beginning as early as May at 64°F; also enter harbors and creek mouths.

Postspawning: Disperse to deeper water soon after spawning.

SPAWNING

Season: Mid-May to late August, usually June and July, at 68-74°F.

Site: Open lake often several miles from shore and clear, quiet areas along shore, in harbors, and in rivers.

Substrate: Eggs are scattered at surface or midwater over sand, gravel, or rock, with or without vegetation.

Water Depth: To 42 ft or more.

INCUBATION AND HATCHING

Site: Nonadhesive eggs incubate in open lake or on vegetation.

Water Depth: Eggs hatch in 24-32 hours.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae lie on bottom for about 4 days until they are free-swimming; large schools of young-of-the-year occur in clear, quiet water along shore, in bays, and river mouths, and several miles offshore; all move offshore by late summer.

Substrate: Sand, rock, clay, silt, and vegetation.

Water Depth: Usually in the upper 6-12 ft of water, over depths to 200 ft.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Campbell and MacCrimmon 1970; Dymond 1926; Fish 1929; Gordon 1968; Greeley 1928; Raney 1969b; Trautman 1957.

BRIDLE SHINER

MIGRATION OF ADULTS

Prespawning: Little movement.

Postspawning: Little movement.

SPAWNING

Season: Mid-April. to mid-July, at 58-80°F^{1/}.

Site: Still water, 9-30 ft from shore, in creeks and lakes.

Substrate: Eggs are scattered near surface in open water, 6-18 in. above submerged vegetation growing in silt and detritus.

Water Depth: To 2 ft.

INCUBATION AND BATCHING

Site: Eggs settle onto vegetation.

Duration: 2-1/2 to 3 **days**^{1/}.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Fry remain among vegetation for about 2 weeks, then move to more open water in littoral zone.

substrate: Vegetation initially; then move to bottom with little vegetation.

water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Fowler 1909; Harrington **1947a,b**^{1/}; Raney 1969b.

^{1/} New Hampshire

COMMON SHINER

MIGRATION OF ADULTS

Prespawning: Migrate to lake shores and ascend creeks in early May at 55-60°F.

Postspawning: Return to lake after spawning.

SPANNING

Season: A period of 10-days in mid-May to late July at 58-83°; peak spawning occurs at 74°F.

Site: Fast-water areas in or near stream riffles, in stream mouths, and on lake shoals.

Substrate: Eggs are deposited in a depression made in clean gravel or possibly sand; prefers to spawn over nests cleared by other species, such as smallmouth bass or chubs.

Water Depth: To 3 ft, but usually 8-10 in.

INCUBATION AND HATCHING

Site: Slightly adhesive eggs fall among gravel and are buried.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in streams, first in pools and then also in fast water; also found along lakeshores.

Substrate: No information.

Water Depth: 5 ft.

REFERENCES

Adams and Hankinson 1928; Becker 1976; Bensley 1915; Cooper 1938; Eddy and Underhill 1974; Forbes and Richardson 1920; Greeley 1927; Hankinson 1908, 1920, 1932; Hubbs and Cooper 1936; Lachner 1952; Miller 1964; Moyle 1973; Nash 1913; Nurnberger 1931; Osburn and Williamson 1898; Parker et al. 1899; Price and Kelly 1976; Raney 1940b, 1949, 1969a; Reighard 1915; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Trautman 1957.

PUGNOSE MINNOW

MIGRATION OF ADULTS

Prespawning: Reported to migrate into bays in mid-late April.

Postspawning: No information.

SPAWNING

Season: June - mid-July.

Site: No information.

Substrate: Vegetation required.

Water Depth: No information.

INCUBATION AND HATCHING

Site: No information.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: Vegetation required.

Water Depth: No information.

REFERENCES

Becker 1976; Scott and Crossman 1973; Slastenenko 1958.

BLACKCHIN SHINER

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPANNING

Season: Mid-May to late July.

Site: Sheltered locations, including weed beds.

Substrate: Eggs are scattered over vegetation.

Water Depth: Shallow.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on submerged vegetation.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

substrate: Vegetation and mud.

Water Depth: No information.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Eddy and Underhill 1974;
Hankinson 1908; Haney 1969b; Slastenenko 1958.

BLACKNOSE SHINER

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: Mid-May to August.

Sites: Lakes, ponds, and streams.

Substrate: Eggs are scattered over sand or fine roots of vegetation growing in sand.

Water Depth: No information.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on spawning substrate or on roots.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year frequent weedy areas and are numerous in lagoons.

substrate: Sand, vegetation.

Water Depth: No information.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Cahn 1927; Dymond 1926; Moore 1922; ODNR, undated; Haney 1969b; Scott and Crossman 1973.

SPOTTAIL SHINER

MIGRATION OF ADULTS

Prespawning: Migrate inshore as early as March; also enter harbors and stream mouths and may ascend 200-300 yd upstream.

Postspawning: Disperse offshore to depths of 19-46 ft in July and August after spawning.

SPAWNING

Season: Late April-late August, but usually June and July at 64-72°F.

Site: Quiet, protected nearshore areas, including shorelines, beaches, shoals, bays, and stream mouths.

Substrate: Eggs are scattered over clean sand, rock, gravel, and vegetation.

Water Depth: To 30 ft, but often less than 1 ft.

INCUBATION AND HATCHING

Site: Eggs incubate on substrate, among masses of Cladophora, or on other vegetation.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Protected nearshore areas, including shorelines, beaches, shoals, bays, lagoons, and stream mouths.

Substrate: Sand, gravel, rock, and vegetation.

Water Depth: To 30 ft; move to deeper water in early fall.

REFERENCES

Adams and Uankinson 1928; Becker 1976; Dymond 1926; Eddy and Underhill 1974; Gordon 1968; Greeley 1928; Hubbs 1923; Hubbs and Cooper 1936; Osburn 1901; Raney 1969b; Reighard 1915; Scott 1967; Slastenenko 1958; Smith and Kramer 1964.

ROSYFACE SHINER

MIGRATION OF ADULTS

Prespawning: Little movement; move onto shoals and riffles at about 68°F.

Postspawning: No information.

SPAWNING

Season: Mid-May to mid-July at 68-84°F.

Site: Stream riffles or small pools below riffles in areas of moderate to swift current.

Substrate: Eggs are scattered several inches above a bottom of clean gravel, sand, rubble, limestone shingles, or bedrock; also over nests of chubs.

Water Depth: 8-16 in.

INCUBATION AND HATCHING

Site: Eggs develop on substrate at Spawning Site.

Duration: Eggs hatch in about 2-1/2 days at 70°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in bays.

Substrate: No information.

Water Depth: No information.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Bean 1915; Eddy and Underhill 1974; Forbes and Richardson 1920; Hankinson 1920, 1932; Hubbs and Brown 1929; Hubbs and Cooper 1936; Lachner 1952; Miller 1964; Parker et al. 1899; Pfeiffer 1955; Price and Kelly 1976; Raney 1969b; Reed 1957; Slastenenko 1958; Trautman 1957.

SPOTFIN SHINER

MIGRATION OF ADULTS

Prespawning: Little movement.

Postspawning: Little movement.

SPAWNING

Season: Mid-May to late August at 68-85°F.

Site: Stream riffles; also in sheltered areas, such as weed beds, harbors, and creek mouths, at locations with a slight current.

Substrate: Masses of eggs are deposited under loose bark or in crevices of submerged branches, logs, tree roots, or pilings on firm bottom of gravel or sand; occasionally scattered over exposed substrate.

Water Depth: 1-4 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on the spawning substrate.

Duration: Eggs hatch in 5 days at 72°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in quiet pools below spawning riffles, in lower reaches of rivers, and in river mouths.

substrate: No information.

Water Depth: No information.

REFERENCES

Adams and Hankinson 1928; Hankinson 1930; Hubbs and Cooper 1936; Osburn and Williamson 1898; Pflieger 1960, 1965; Raney 1969b; Schlueter 1977; Scott 1967; Slastenenko 1958; Stone 1940; Trautman 1957.

SAND SRINER

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: Late May-July, beginning at about 70°F.

Site: Lake shoals, beaches, and sheltered locations, including bays creek mouths, and harbors.

Substrate: Eggs are scattered over clean gravel or sand or roots of plants.

water Depth: Shallow; no specific: information.

INCUBATION AND BATCHING

Site: Adhesive eggs incubate on spawning substrate.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year prefer sheltered locations, including lagoons, river mouths, and lower reaches of rivers.

Substrate: Sand, gravel.

Water Depth: Shallow, no specific information.

REFERENCES

Balon 1975; Dymond et al. 1929; Hubbs and Cooper 1936; ODNR, undated; Raney 1969b; Smith 1963.

MIMIC SHINER

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: Mid-May to mid-August.

Site: Clear, quiet water in weed beds and harbors and on shoals and sand bars.

Substrate: Eggs are broadcast over vegetation or other objects on sand bottom.

Water Depth: Shallow; possibly to 15-20 ft.

INCUBATION AND HATCHING

Site: Eggs incubate at spawning site.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: young-of-the-year are found in sheltered areas, including bays and coves.

Substrate: Sand, mud.

Water Depth: To 20-30 ft.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Black 1945; Moyle 1973; ODNR, undated; Raney 1969b.

NORTHERN REDBELLY DACE

MIGRATION OF ADULTS

Prespawning: Ascend streams in April and May.

Postspawning: Return to lake after spawning.

SPAWNING

Season: May-August at 65-78°F; two spawnings may occur.

Site: Riffles and quiet water in streams.

Substrate: Eggs are scattered over masses of filamentous algae on gravel; also over nests of chubs.

Water Depth: No information.

INCUBATION AND HATCHING

Site: Eggs incubate among filamentous algae or clumps of rootless vegetation.

Duration: Eggs hatch in 8-10 days at 80-70°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: No information.

water Depth: No information.

REFERENCES

Cahn 1927; Cooper 1935, 1938; Dymond 1926; Hankinson 1932; Hubbs and Cooper 1936; Lachner 1952; Price and Kelly 1976; Raney 1969a; Scott 1967; Smith and Moyle 1944.

BLUNTNOSE MINNOW

MIGRATION OF ADULTS

Prespawning: Usually little movement, but may enter and ascend creeks.

Postspawning: Male remains at spawning site to guard eggs and fry.

SPAWNING

Season: April-September at 65-82°F, but usually May-July.

Site: Quiet, protected inshore areas, including lake margins, shoals, lagoons, marshes, harbors, creek mouths, and stream pools.

Substrate: Masses of eggs are deposited on the flat undersides of stationary objects, such as stones, sticks, or boards, on firm bottom of sand, gravel, or rock.

water Depth: To 8 ft, but usually less than 3 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on spawning substrate.

Duration: Eggs hatch in 1-2 weeks at 80-70°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year remain near spawning sites in marshes, lagoons, beaches, harbors, creek mouths, and shoals.

Substrate: Firm bottom.

Water Depth: No information.

REFERENCES

Adams and Hankinson 1928; Allen 1914; Cahn 1927; Cooper 1935, 1938; Dymond et al. 1929; Eigenmann 1896; Evermann and Clark 1920; Forbes and Richardson 1920; Forney 1956; Greeley 1927; Greeley and Bishop 1932; Hankinson 1908, 1919, 1920, 1932; Hay 1894; Hubbs and Cooper 1936; Hubbs and Lagler 1958; Lake 1936; Langlois 1954; Moyle 1973; Osburn and Williamson 1898; Parker et al. 1899; Price and Kelly 1976; Raney 1949; Reighard 1913, 1915; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Smith 1963; Surber 1940; Trautman 1957; Van Cleave and Markus 1929; Voris 1899; Wascko and Clark 1951; Westman 1938; White et al. 1975; Wickliff 1957; Winn 1958.

FATHEAD MINNOW

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: Male remains at spawning site to guard nest.

SPAWNING

Season: Late April-early September at 60-85°F; spawning occurs more than once, and the season extends through most of the summer.

Site: Protected areas, such as lake margins and marshes.

Substrate: Eggs are laid in a nest hollowed out in mud or sand under submerged objects, such as rocks,, sticks, or cans; they are deposited in a mass on the underside of the objects.

Water Depth: 3-18 in.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on the spawning substrate.

Duration: Eggs hatch in 4-6 days at about 77°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in protected areas, such as marshes, harbors, and creek mouths.

Substrate: Mud, sand.

Water Depth: Shallow; no specific information.

REFERENCES

Becker 1976; Cahn 1927; Cooper 1938; Dobie et al. 1956; Dymond 1926; Eddy and Underhill 1974; Forney 1956; Greeley 1927; Hedges:and Ball 1953; Hubbs and Cooper 1936; Langlois 1954; ODNR, undated; Raney 1949; Scott 1967; Slastenenko 1958; Trautman 1957; Wascko and Clark 1951; Williamson 1939.

BLACKNOSE DACE

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: Late May to mid-July, beginning at about 70°F.

Site: Stream riffles.

Substrate: Eggs are broadcast on clean gravel, rubble, or sand; also in creek chub nests.

water Depth: 2-8 in.

INCUBATION AND HATCHING

Site: Eggs develop on spawning substrate.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year (YOY) are found on shoals near stream margins; move to quiet pools as they growl/.

Substrate: Mud.

water Depth: No specific information; YOY move from shallows to deeper water.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Eddy and Underhill 1974; Forbes and Richardson 1920; Greeley 1929, 1934; Hubbs and Cooper 1936; Minckley 1963^{1/}; Parker et al. 1899; Price and Kelly 1976; Raney 1940a, 1969a; Slastenenko 1958; Smith and Moyle 1944; Traver 1929.

^{1/} Kentucky

LONGNOSE DACE

MIGRATION OF ADULTS

Prespawning: Migrate inshore or into streams in mid-April to late May at about 46-57°F.

Postspawning: Return to lake after spawning.

SPAWNING

Season: Late April-late July at 52-75°; spawning peaks at 57-66°F.

Site: Stream riffles, river mouths, and wave-swept lake shores, beaches, and bars.

Substrate: Eggs are deposited on sand, gravel, rubble, and rock of 3-4 in. diam.; also over nests of river **chubs**^{1/}.

Water Depth: To 10 ft, but usually less than 1 ft.

INCUBATION AND HATCHING

Site: Eggs incubate on spawning substrate.

Duration: Eggs hatch in 3-4 days at 70°F^{2/}.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae hide among rocks for about 1 week, then rise to surface; young-of-the-year are pelagic in quiet nearshore areas, river mouths, lower reaches of rivers, beaches, shoals, and breakwaters.

substrate: Gravel, sand, rock.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Becker 1962, as cited in Becker 1976; Cooper ^{1,2/}1980; Dymond 1926; Eddy and Underhill 1974; Scott and Crossman 1973; Slastenenko 1958.

^{1/} Pennsylvania, West Virginia, Maryland

^{2/} Laboratory study

CREEK CHUB

MIGRATION OF ADULTS

Prespawning: Migrate upstream in creeks in late March; also move inshore in lakes.

Postspawning: Both parents desert nest after spawning.

SPAWNING

Season: April-early July at 55-80°F.

Site: Smooth, swift water, with a velocity of 1-2 fps, just above riffles in small, clear streams; also littoral zones of lakes.

Substrate: Eggs are deposited in a depression made in coarse gravel, sand, or rubble; also over nest of common shiner and stoneroller.

Water Depth: 3-12 in., but usually 5-6 in.

INCUBATION AND HATCHING

Site: Nonadhesive eggs drop to bottom of nest, a trench up to several feet long with a ridge of stones on upstream edge, and are subsequently covered with gravel and stones.

Duration: Eggs hatch in 6-10 days at 65-55°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain under gravel; -young-of-the-year are found in quiet water in streams or in protected areas along lake shores.

Substrate: Sand, gravel, some vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Becker 1976; Buynak and Mohr 1979b; Cahn 1927; Copes 1978; Eddy and Underhill 1974; Embury 1914; Greeley 1934; Hankinson 1908, 1919, 1932; Hedges and Ball 1953; Hubbs and Cooper 1936; Hubbs and Lagler 1958; Lagler 1948; Markus 1934; Miller 1964; Nash 1913; Raney 1969a; Reighard 1910; Ross 1977; Scott and Crossman 1973; Slastenenko 1958; Smith and Moyle 1944; Smith 1963; Washburn 1948; Wickliff 1957.

FALLFISH

MIGRATION OF ADULTS

Prespawning: Move to lake margins and probably ascend streams.

Postspawning: Both male and female remain to guard nest.

SPAWNING

Season: Late April to mid-June,, beginning at 54^{2/} - 58°F^{1/}.

Site: Quiet water just above or below stream riffles, and on lake margins and shoals.

Substrate: Eggs are deposited in a depression made in gravel.

Water Depth: 18 in. 3/ - 3 ft.

INCUBATION AND HATCHING

Site: Eggs drop to bottom of nest, a cleared area up to several feet long with a high mound of pebbles on upstream edge, and are subsequently covered with gravel.

Duration: Eggs hatch in 20 days at 63°F^{1/}.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain in gravel about 5 days^{1/} until yolk sac is absorbed; fry remain over nest area for a short period; older young-of-the-year are found along shore.

Substrate: Vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Embury 1922; Fowler 1909, 1932; Greeley 1934; Miller 1964; Raney 1949, 1969a; Reed 1971^{1/}; Richardson 1935^{2/}, as cited in Scott and Crossman 1973; Ross and Reed 1978^{3/}; Slastenenko 1958.

1,3/ Massachusetts

2/ Quebec

RIVER CARPSUCKER

MIGRATION OF ADULTS

Prespawning: Move to current-swept areas and ascend rivers^{2/}.

Postspawning: Return to deep water after spawning ^{2/} .

SPAWNING

Season: April-July at 57-82°F 1,2,3,4/.

Site: Large tributaries^{3/}.

Substrate: Eggs are scattered over firm sand^{3,5/}.

Water Depth: 1-3 ft^{5/}.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on objects onto which they settle^{3,5/}.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year remain in large tributaries^{3/} or move downstream to harbors.

Substrate: Sand^{3/}.

Water Depth: Shallow?!; no specific information.

REFERENCES

Buchholz 1957^{1/}; Curry and Spacie 1979; Hodson 1973^{2/}; June 1977^{3/};
Walburg and Nelson 1966^{4,5/}

1/ Iowa

2/ Texas

3,4/ south Dakota

5/ Oklahoma

QUILLBACK

MIGRATION OF ADULTS

Prespawning: Lake-run fish migrate inshore and into harbors and lower reaches of rivers in April and May; riverine stocks migrate upstream into very small creeks.

Postspawning: Move downstream in late summer or fall.

SPAWNING

Season: Mid-April to July at 50-68°F.

Site: Lake-run fish spawn along lake shores, on shoals, and in bays, harbors, and lower rivers; riverine stocks spawn in small creeks.

Substrate: Eggs are scattered at random over sand, gravel, clay, mud, rock, and vegetation.

Water Depth: 1-6 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on substrate at spawning site.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in sheltered areas along lake shores, in harbors, lower rivers, and low-gradient streams; stream-spawned fish drift downstream in late summer or early fall.

Substrate: Sand, mud, vegetation.

water Depth: Shallow; no specific information.

REFERENCES

Balon 1975; Currie and Spacie 1977; Evermann and Latimer 1910; Forbes and Richardson 1920; Gale and Mohr 1976, as cited in Fuiman 1979; Greeley 1929; Meek and Hildebrand 1910; ODNR, undated; Scott 1967; Scott and Crossman 1973; Trautman 1957; Trautman and Gartman 1974.

LONGNOSE SUCKER

MIGRATION OF ADULTS

Prespawning: Migrate inshore and ascend tributaries in March or April shortly after ice breakup.

Postspawning: Return to deeper water after spawning.

SPAWNING

Season: Late March-July at 36-59°F.

Site: Current-swept areas on lakeshores, beaches, and shoals and in streams and lower reaches of rivers.

Substrate: Eggs are broadcast over gravel or sand.

Water Depth: To 25 ft; as shallow as 6-12 **in.**^{1/}

INCUBATION AND HATCHING

Site: Eggs incubate among gravel.

Duration: Eggs hatch in 1-2 weeks.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae remain in gravel for 1-2 **weeks**^{1/} and then drift downstream to stream mouths, harbors, and shorelines, or offshore.

Substrate: Sand.

water Depth: **Shallow**^{2/}; no specific information.

REFERENCES

Dymond 1926; Eddy and Underhill 1974; Fuiman and Witman 1979; Galloway and Kevern 1976; Geen et al. **1966**^{1/}; Hayes **1967**^{2/}; Price and Kelly 1976; Scott 1967; Slastenenko 1958; Smith 1969; Surber 1920.

^{1/} British Columbia

^{2/} Colorado

WHITE SUCKER

MIGRATION OF ADULTS

Prespawning: Ascend tributaries soon after ice breakup, beginning as early as late March at 38°F; run may occur under the ice.

Postspawning: Usually spend only a few days in stream and return to lake after spawning; some may take up temporary residence in deep stream pools before returning to lake.

SPAWNING

Season: February-early July at 43-74°F; usually April and May at 50-68°F.

Site: Riffles of clean streams, with velocity of 1.6-2.0 fps, or stream pools if water level is low; also lake shoals, beaches, or river mouths with sufficient current.

Substrate: Eggs are broadcast over clean gravel, rock, rubble, or sand, usually with no vegetation.

Water Depth: 4 in. - 4 ft.

INCUBATION AND HATCHING

Site: Eggs are usually buried in gravel and incubate at spawning site; some may drift downstream and collect in pools.

Duration: 5-15 days at 60-50°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain in gravel about 2 **weeks^{1/}**; soon after emergence, fry move downstream and are found in protected water along lake shores, in marshes, bays, and harbors; may also spend several months in streams before moving downstream.

Substrate: Gravel for prolarvae; sand and rock for young-of-the-year (YOY) until they are 1-3 in. long; dense vegetation for larger YOY.

Water Depth: To 20 ft.

REFERENCES

Adams and Hankinson 1928; Allen 1914; Anthony and Jorgensen 1977; Buller 1927; Cahn 1927; Carbine 1943; Curry and Spacie 1979; Dymond 1926; Eaton 1928; Eddy and Underhill 1974; Embury 1915, 1922; Faber 1963, 1967; Fish 1929; Forbes and Richardson 1920; Forney 1956; Fuiman 1979; Galloway and Kevern 1976; Geen et al. **1966^{1/}**; Greeley

1928; Greeley and Bishop 1932; Hankinson 1908, 1913, 1919, 1932;
Hedges and Ball 1953; Hubbs and Creaser 1924; Johnson, C., 1971;
Lagler 1948; MacKay 1959a, 1969; Olson and Scidmore 1962; Price and
Kelly 1976; Raney 1943, 1959; Raney and Webster 1942; Reighard 1913,
1915, 1920; Schneberger 1972b; Scott 1967; Shetter 1938a; Slastenenko
1958; Smith 1969; Spoor 1938; Stewart 1926; Surber 1920, 1940;
Trautman 1957; UPI 1979; Werner 1979; Wickliff 1936.

1/ British Columbia

CREEK CHUBSUCKER

MIGRATION OF ADULTS

Prespawning: Move along shorelines; may move upstream in **creeks^{1/}**.

Postspawning: Migrate downstream to larger waters after spawning.

SPAWNING

Season: Late April and May at 59-72°F.

Site: River mouths or pools, with velocity of 0.3-0.8 fps.

Substrate: Eggs are deposited in a small cleared depression in fine gravel, sand, or mud.

water Depth: 1 to 2-1/2 ft.

INCUBATION AND HATCHING

Site: Eggs incubate at spawning site.

Duration: Eggs hatch in 4 days at **63-73°F^{2/}**.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are abundant in **marshes^{1/}** and small streams^{3/}.

Substrate: No information.

Water Depth: No information.

REFERENCES

Adams and Hankinson **1928^{1/}**; Carnes **1958^{2/}**, as cited in Jones et al. 1978; Curry and Spacie 1979; Forbes and Richardson **1920^{1/}**; Fuiman 1979; Hankinson **1919^{1/}**; Richardson **1913a^{1/}**; Smith 1963; Trautman 1957; Surber and Friddle **1946^{3/}**.

^{1/} Erismyzon sucetta oblongus; probably creek chubsucker

^{2/} North Carolina

^{3/} West Virginia

LAKE CHUBSUCKER

MIGRATION OF ADULTS

Prespawning: Migrate into bays and lower reaches of rivers.

Postspawning: No information.

SPAWNING

Season: Late March to mid-July.

Site: Bays, lower reaches of tributaries, ponds, and marshes.

Substrate: Eggs are scattered over beds of rooted aquatic vegetation, filamentous algae, or dead grass.

Water Depth: Shallow; no specific information.

INCUBATION AND HATCHING

Site: Eggs incubate among vegetation.

Duration: 6-7 days at 85-72°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are abundant in marshes and lagoons.

Substrate: Vegetation, mud.

Water Depth: Shallow; no specific information.

REFERENCES

Bennett and Childers 1966; Cooper 1935, 1938; Meek and Hildebrand 1910; ODNR, undated.

NORTHERN HOG SUCKER

MIGRATION OF ADULTS

Prespawning: Ascend creeks from larger, deeper waters, beginning in late March at 40°F.

Postspawning: Return downstream after spawning.

SPAWNING

Season: April and May at 57-66°F.

Site: Fast-water areas, with velocity of 1.3-1.8 fps, at the head of creek riffles.

Substrate: Eggs are scattered over coarse gravel and sand.

Water Depth: 4-18 in.

INCUBATION AND HATCHING

Site: Eggs are buried and incubate under gravel.

Duration: Eggs hatch in 10 days at 63°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain in gravel for about 8 days; young-of-the-year are found in warm tributaries and along lake shores near stream mouths.

substrate: No information.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Buynak and Mohr 1978; Currie and Spacie 1979; Eddy and Underhill 1974; Fuiman 1979; Gerking 1953; Hankinson 1919, 1932; Meek and Hildebrand 1910; Meyer 1967; Raney and Lachner 1946; Reighard 1920; Trautman 1957.

BIGMOUTH BUFFALO

MIGRATION OF ADULTS

Prespawning: Move inshore during spring flooding^{1,2,3,4}/; also ascend tributaries.

Postspawning: No information.

SPAWNING

Season: Late March to mid-July at 56¹/ - 68°F⁴/.

Site: Bays, marshes, sloughs, backwaters, creek mouths, tributaries, small ditches.

Substrate: Eggs are scattered over vegetation or debris on mud, gravel, or rock.

Water Depth: To 12 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on vegetation or debris; some may sink to the bottom^{1,3}/.

Duration: Eggs hatch in 9-10 days at 62°F¹/.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Newly hatched larvae rise immediately to surface¹/; young-of-the-year are common in sloughs and backwaters.

Substrate: Bud, vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Balon 1975; Becker 1976; Canfield 1922¹/; Eddy and Underhill 1974; Forbes and Richardson 1920; Garman 1889; Johnson, R., 1963²/; June 1977³/; ODNR, undated; Richardson 1913a; Surber 1920; Walburg and Nelson 1966.

¹/ Iowa

²/ Saskatchewan

^{3,4}/ South Dakota

SILVER REDHORSE

MIGRATION OF ADULTS

Prespawning: Ascend rivers at ice-out, usually in April.

Postspawning: Return to lake after spawning; may remain in harbors throughout the summer.

SPAWNING

Season: April-late June, beginning. at 50-56°F^{1/}.

Site: Riffles^{1/} in rivers and streams, usually in main channels; also shoals in harbors.

Substrate: Eggs are deposited on gravel, rock/, or **rubble**^{2/}.

Water Depth: 1-3 **ft**^{2/}.

INCUBATION AND HATCHING

Site: Eggs develop on spawning substrate.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Newly hatched larvae drift downstream to harbors and river mouths; some young-of-the-year remain in tributaries in slow-water areas near overhanging banks^{2/}.

Substrate: Soft bottom^{2/}.

water Depth: No information.

REFERENCES

Balon 1975; Curry and Spacie 1979; Galloway and Kevern 1976; Hackney et al. 1971^{1/}; Jenkins 1970; Meyer 1962^{2/}; Scott and Crossman 1973.

^{1/} Alabama

^{2/} Iowa

BLACK REDHORSE

MIGRATION OF ADULTS

Prespawning: Enter rivers; river residents move upstream or downstream to spawning **site^{1/}**.

Postspawning: Females return to deep pools; males return to respective territories,^{1/}.

SPAWNING

Season: Late April^{1/} to mid-May at 56-72°F^{1/}.

Site: Riffles in clean rivers.

Substrate: Eggs are scattered over fine rubble, coarse gravel, or sand^{1/}.

Water Depth: To 2 **ft^{1/}**.

INCUBATION AND HATCHING

Site: Eggs develop on spawning substrate.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in quiet pools, backwaters, and lower reaches of rivers; may also be found in quiet water upstream from spawning site^{1/}.

Substrate: Beds of water willow^{1/}.

Water Depth: No information.

REFERENCES

Balon 1975; Bowman **1970^{1/}**; Curry and Spacie 1979; Trautman 1957.

^{1/} Missouri

GOLDEN REDHORSE

MIGRATION OF ADULTS

Prespawning: Enter rivers and smaller streams.

Postspawning: Return to lake in May-July.

SPAWNING

Season: April-early June at 59-72°F.

Site: Fast-water areas, with velocity of 1.3-3.0 fps, in or just above riffles in rivers and streams; may spawn in main stream or smaller tributaries, but avoid high gradient streams.

Substrate: Eggs are deposited on large gravel, possibly in small depressions.

water Depth: Less than 6 in. - 3 ft^{1/}.

INCUBATION AND HATCHING

Site: Eggs incubate on spawning substrate.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in slow-water areas of streams near overhanging banks^{1/}, in backwaters, lower reaches of rivers, and river mouths.

Substrate: Soft bottom^{1/}.

Water Depth: No information.

REFERENCES

Balon 1975; Beeker 1976; Curry and Spacie 1979; Eddy and Underhill 1974; Fuiman and Witman 1979; Galloway and Kevern 1976; Gerking 1953; Hankinson 1932; Meyer **1962**^{1/}; Trautman 1957.

^{1/} Iowa

SHORTHEAD REDHORSE

MIGRATION OF ADULTS

Prespawning: Migrate from lakes into larger tributaries usually in April before ice-out.

Postspawning: Return to lake by mid-May; may remain in harbors all summer.

SPAWNING

Season: April-June, usually at 52-70°F; spawning has been reported at water temperatures less than 52°F.

Site: Fast-water areas, with velocity of 2-3 fps, in tributaries more than 30-40 ft wide; also shoals in harbors.

Substrate: Eggs are scattered in small groups over wide area of clean medium-sized gravel and sand.

Water Depth: 6 in. - 3 ft^{1/}.

INCUBATION AND HATCHING

Site: Nonadhesive eggs settle among gravel and rocks.

Duration: Eggs hatch in 8 days at 60°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain on bottom for about 5 days, then drift downstream to harbors or other sheltered areas; young-of-the-year may also remain in fast-water areas of river&/ or ascend smaller creeks.

Substrate: Gravel for prolarvae.

Water Depth: No information.

REFERENCES

Adams and Hankinson 1928; Burr and Morris 1977; Buynak and Mohr 1979a; Crossman 1976; Curry and Spacie 1979; Dymond 1926; Eddy and Underhill 1974; Forbes and Richardson 1920; Galloway and Kevern 1976; Hay 1894; Hankinson 1919; Meyer 1962^{1/}; Parker et al. 1899; Reighard 1920; Slastenenko 1958; Surber 1920.

^{1/} Iowa

GREATER REDHORSE

MIGRATION OF ADULTS

Prespawning: Ascend rivers.

Postspawning: No information.

SPAWNING

Season: April-early July at 62-66°F.

Site: River channels and rapids.

Substrate: Eggs are deposited among boulders.

Water Depth: 10 ft.

INCUBATION AND HATCHING

Site: Eggs develop on spawning substrate.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year spend the first summer in fast-water areas of rivers or sheltered areas downstream.

substrate: No information.

Water Depth: Shallow; no specific information.

REFERENCES

Balon 1975; Becker 1976; Greeley 1929; Meek and Hildebrand 1910; Slastenenko 1958.

BLACK BULLHEAD

MIGRATION OF ADULTS

Prespawning: Move inshore and into rivers, usually beginning in early May at about 52°F.

Postspawning: Adults guard nest and fry, then presumably return to lakes.

SPAWNING

Season: April-August, usually late May to mid-July at 53-77°F.

Site: Wetlands along lake margins, sheltered bays and harbors, lower reaches of rivers with overhanging banks and abundant deadfall.

Substrate: Eggs are deposited in natural depressions or nests scooped out in sand or mud among abundant vegetation; also among rocks on harbor breakwalls or in muskrat burrows.

Water Depth: 1-3 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to substrate in nest or to vegetation or debris.

Duration: Eggs hatch in 5-7 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae remain in nest up to 12 days; adults herd fry, until they are about 1 in. **long^{1/}**, in dense schools near the surface along vegetated shorelines; older young-of-the-year are found in protected areas, such as sloughs, marshes, bays, and lower rivers.

Substrate: Vegetation, mud, sand, silt.

Water Depth: Shallow; no specific information.

REFERENCES

Balon 1975; Cahn 1927; Eddy and Underhill 1974; Forbes and Richardson 1920; Fowler 1917; Forney **1955^{1/}**; Garman 1889; Olson 1970, 1971, 1972, 1978; ODNR, undated; Olson and Koopman 1976; Osburn and Williamson 1898; Richardson 1913a; Slastenenko 1958; Smith and Moe 1944.

^{1/} Iowa

YELLOW BULLHEAD

MIGRATION OF ADULTS

Prespawning: Move inshore and into bays.

Postspawning: Adults guard nest and fry and then return to lakes.

SPAWNING

Season: A 2-week period in May or June.

Site: Weed beds and lagoons in lakes, under overhanging banks in rivers, or at entrance of deserted muskrat burrows.

Substrate: Eggs are deposited in depression or burrow hollowed out in soft bottom of mud and heavy vegetation, usually beside or under banks, logs, or tree roots; also deposited on boards or other debris.

Water Depth: $1\frac{1}{2}$ - 4 ft.

INCUBATION AND HATCHING

Site: Eggs are often attached to small roots in nest.

Duration: Eggs hatch in 5-10 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Until they are about 2 in. long, fry remain in large schools in quiet water; adults guard these schools; older young-of-the-year are found near spawning grounds, in protected waters such as bays and marshes; also in small creeks.

Substrate: Vegetation, mud, sand, silt.

Water Depth: To 6 ft.

REFERENCES

Adams and Hankinson 1928; Aitken 1936^{1/}; Cahn 1927; Eddy and Underhill 1974; Forbes and Richardson 1920; Fowler 1917; Hankinson 1913; Langlois 1954; McCrimmon '1956; ODNR, undated; Richardson 1913a; Scott 1967; Slastenenko 1958.

^{1/} Iowa

BROWN BULLHEAD

MIGRATION OF ADULTS

Prespawning: Move inshore and into rivers, beginning in early April at 50-55°F.

Postspawning: Adults guard nest and fry and then return to lake in summer and fall.

SPAWNING

Season: April-August, usually June or July, at 62-72°F; spawning may occur twice a year.

Site: Marshes in bays, harbors, coves, creek mouths, and lower reaches of creeks; also rivers with overhanging banks and abundant deadfall.

Substrate: Eggs are deposited in depression or burrow made in mud, sand, or clay under logs and roots; nest is excavated down to firm bottom of stones, gravel, or coarse sand; nests also made on breakwalls, in muskrat burrows, or in debris, including cans, tires, or stumps.

Water Depth: 3 in. - 5 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate in bottom of nest, often attached to exposed fibrous roots.

Duration: Eggs hatch in 5-20 days at 77°F11,

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae remain in nest up to 12 days; adults guard fry in weedy shallows for 2-3 weeks; older young-of-the-year (YOY) remain in protected vegetated areas near spawning grounds; some YOY move downstream from river marshes during the summer.

Substrate: Vegetation, sand, mud, gravel, rock.

Water Depth: 1-18 in.

REFERENCES

Adams and Hankinson 1928; Allen 1914; Armstrong 1962; Becker 1976; Breder 1935; Buller 1927; Calhoun and Coon 1941; Eddy and Underhill 1974; Embury 1922; Eycleschmyer 1901; Forbes and Richardson 1920; Fowler 1917; Greeley 1928; Hankinson 1908; MacKay 1957d, 1969;

McCrimmon 1956; Meek and Hildebrand 1910; Moore 1922; Olson 1972;
Raney 1959; Raney and Webster 1940; Reighard 1915; Richardson 1913a;
Sibley 1922; Slastenenko 1958; Smith and Harron 1904^{1/}; Surber 1920;
Titcomb 1920, 1922.

^{1/} Laboratory study.

CHANNEL CATFISH

MIGRATION OF ADULTS

Prespawning: Move inshore from deep water; may enter and migrate long distances up tributaries.

Postspawning: One or both adults guard nest and fry until they are about 1 in. long, then return to lakes in fall.

SPAWNING

Season: Mid-April to August at 65-85°F³/; two spawning peaks may occur⁶/

Site: Nearshore areas, including wetlands, marshes, bays, harbors, and creek mouths; backwaters, pools⁴/, and shoals in rivers, especially areas of strong current.

Substrate: Eggs are deposited in nest or burrow made in crevices, hollow logs, undercut banks, or stumps, on bottom of rock, rubble, gravel, mud, sand, clay, or vegetation; also on rock breakwalls.

Water Depth: To 42 ft; usually less than 12 ft.

INCUBATION AND HATCHING

Site: Mass of adhesive eggs incubates on bottom of nest^{1,5}/.

Duration: Eggs hatch in 5 days at 72-82°F and in 10 days at 60°F^{1,2,3,5,7}/.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae remain in nest up to 8 days⁶/; young-of-the-year are abundant on shoals in small creeks; apparently move downstream to bays, harbors, creek mouths and protected marshes, beaches, and shorelines.

Substrate: Rock, gravel, vegetation, mud; also in crevices between rocks in diking.

Water Depth: To 15 ft in early summer; to 58 ft by August.

REFERENCES

Adams and Hankinson 1928; Calhoun and Coon 1941; Canfield 1947¹/; Clapp 1929²/; Clemens and Sneed 1957³/; Doze 1925⁴/; Eddy and Underhill 1974; Forbes and Richardson 1920; Garman 1889; Greeley 1928; Jordan 1885a; Lenz 1947⁵/; MacKay 1969; Marzolf 1957⁶/; McCormick 1892; Price and Kelly 1976; Raphael and Jaworski 1979;

Scott 1967; Scott and Crossman 1973; Shira 1917^{7/}; Slastenenko 1958;
Smith 1969; Surber 1920; Trautman 1957; USDI 1969b.

1,2,5,6/ Hatchery data

3,7/ Laboratory study

4/ Kansas

STONECAT

MIGRATION OF ADULTS

Prespawning: Short movement inshore; may ascend creeks.

Postspawning: Adults guard eggs and fry until fry leave nest.

SPAWNING

Season: Early June-late August; spawning usually peaks last 2 weeks in June.

Site: Sheltered shoreline areas, bays, creek mouths, lake reefs, and lower riffles in rivers.

Substrate: Eggs are deposited in nest dug underneath flat objects, such as boards, stones, or logs, on gravel, rock, or boulder bottom with no vegetation.

Water Depth: 1-42 ft.

INCUBATION AND HATCHING

Site: Mass of adhesive eggs incubates in nest.

Duration: Eggs hatch in about 2 weeks, beginning in mid-June.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae remain in nest for several days; young-of-the-year (YOY) are found under stones, on riffles, in sheltered nearshore areas and creek mouths; YOY may migrate downstream to lakes.

Substrate: Sand and gravel with sparse vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Eddy and Underhill 1974; Eigenmann 1896; Forbes and Richardson 1920; Greeley 1934; Meek and Hildebrand 1910; Slastenenko 1958; Taylor 1969; Trautman 1957.

TADPOLE MADTOM

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: Male guards nest and fry.

SPAWNING

Season: May-August.

Site: Quiet areas along lake shores, in bays, harbors, and low-gradient streams.

Substrate: Eggs are deposited in nest made under boards, logs, or tree roots, in cans or crayfish burrows, on bottom of mud, organic debris, marl, or vegetation.

Water Depth: 3 ft.

INCUBATION AND HATCHING

Site: Eggs incubate in nest.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in protected nearshore areas, including marshes.

Substrate: Sand, mud, silt, vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Allen 1914; Cahn 1927; Evermann and Clark 1920; Forbes and Richardson 1920; Hankinson 1908; ODNR, undated; Richardson 1913a; Slastenenko 1958; Taylor 1969; Trautman 1948.

BRINDLED MADTOM

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: Male guards nest and fry.

SPAWNING

Season: May-early August at about 78°F.

Site: Lakeshores, beaches, and reefs; in pools and riffles in low-gradient streams.

Substrate: Eggs are deposited in nest made under boulders, rocks, logs or in discarded cans, on bottom of rock, gravel, boulders, mud, or silt, with vegetation and debris, including fallen trees and roots.

Water Depth: Shallow; no specific information.

INCUBATION AND HATCHING

Site: Mass of adhesive eggs incubates in nest.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in marshes and tributaries.

substrate: Sand, mud, silt, vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; ODNr, undated; Osburn and Williamson 1898; Taylor 1955, 1969; Trautman 1948.

FLATHEAD CATFISH

MIGRATION OF ADULTS

Prespawning: Migrate from lakes into rivers.

Postspawning: Male guards eggs.

SPAWNING

Season: Late **June^{2/}** - August.

Site: Large rivers and river mouths, especially under overhanging banks.

Substrate: Eggs are deposited in nest dug in gravel or on cleaned areas of rocks.

Water Depth: No information.

INCUBATION AND HATCHING

Site: Mass of adhesive eggs incubates in nest.

Duration: Eggs hatch in 6 or 7 days at **75-82°F^{1/}**.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Fry are carried from nest to swift riffles where they remain until 2-4 in. long, then spread out to other areas of **stream^{2/}**.

Substrate: Rubble.

Water Depth: No information.

REFERENCES

Balon 1975; Guidice **1965^{1/}**; Lagler 1948; Minckley and Deacon **1959^{2/}**.

^{1/} Hatchery data

^{2/} Kansas

TROUT-PERCH

MIGRATION OF ADULTS

Prespawning: Migrate from depths greater than 210 ft to nearshore areas or into tributaries, usually beginning as early as April.

Postspawning: Return to lakes by late September or October.

SPAWNING

Season: A 2-1/2 month period in mid-March to late September at 40¹/₇ - 70°F; most spawning occurs in June-August at 67-68°F; two peaks of spawning may occur.

Site: Quiet nearshore areas, including beaches, shoals, harbors, sloughs, and river mouths, with a slight current near surface; also on riffles in swift streams.

Substrate: Eggs are scattered at random near surface over sand, gravel, rubble, mud, silt¹/₇, and vegetation.

Water Depth: 2¹/₇ - 125 ft.

INCUBATION AND HATCHING

Site: Eggs settle to bottom and fall between rocks or adhere to vegetation or other substrate.

Duration: Eggs hatch in 6-7 days at 68-73°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae develop on spawning substrate; young-of-the-year (YOY) remain inshore near spawning grounds, on beaches, in river mouths, harbors, and bays, until late summer and then move offshore.

Substrate: Sand, gravel, mud.

Water Depth: Most YOY are found near bottom in less than 30 ft of water; in late summer they move offshore to deeper water.

REFERENCES

Adams and Hankinson 1928; Balon 1975; Butler 1962; Dymond 1926; Eddy and Underhill 1974; Fish 1929; Forbes and Richardson 1920; Hubbs and Lagler 1958; Lawler 1954¹/₇; Magnuson and Smith 1963; ODNR, undated; Price and Kelly 1976; Priegel 1962; Reed and Wright 1909; Reighard 1915; Scott and Crossman 1973; Slastenenko 1958.

BURBOT

MIGRATION OF ADULTS

Prespawning: Move from deep water to nearshore areas and into harbors and rivers, usually beginning in early November.

Postspawning: Usually return to deeper water by April; may remain in harbors until mid-June before moving into lakes; often move from lakes into rivers after spawning.

SPAWNING

Season: A 1-week period in November-May, at 33-50°F; varies considerably with locality; eggs have also been collected in September.

Site: Nearshore areas, including shorelines, river mouths, bays, and harbors; offshore bars and reefs; swift, open water in streams.

Substrate: Eggs are scattered in mid-water over rock, gravel, shale, sand, clay, or mud.

Water Depth: 1-480 ft; both deepwater and shallow-water spawners are reported.

INCUBATION AND HATCHING

Site: Nonadhesive^{2/}, semibuoyant eggs settle to bottom in quiet water; may be carried from spawning site by slight current.

Duration: Eggs hatch in 30 days at 43°F^{1/}.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Newly hatched larvae are found along shores, in harbors, bays, river mouths, and tributaries; older young-of-the-year (YOY) disperse throughout surface waters in mid-lake.

Substrate: Sand/, gravel?!, shale, rock, some vegetation.

Water Depth: Less than; 1 ft^{3/} - 200 ft; larvae hatched in deeper water may move to shallows; older YOY move to deeper water.

REFERENCES

Adams and Hankinson 1928; Bean 1884a, 1903; Becker 1976; Bjorn 1939^{1/}; Cahn 1936; Dymond 1926; Eddy and Underhill 1974; Eaton 1928; Faber 1963, 1967; MacKay 1957a, 1969; McCrimmon 1956, 1959; McCrimmon and Devitt 1954; Miller 1970a^{2/}, b^{3/}; Noble 1968; Reighard 1915; Robins and Deubler 1955; Scott 19167; Scott and Crossman 1973; Smith and Moe 1944; Weber 1971.

BANDED KILLIFISH

MIGRATION OF ADULTS

Prespawning: Little movement.

Postspawning: Little movement.

SPAWNING

Season: May-August at **70^{1/}** - 90°F^{2/}.

Site: Quiet areas; including bays, harbors, creek mouths, and lagoons; also moderately swift streams.

Substrate: Eggs are scattered over sand, gravel, rubble, emergent vegetation, and filamentous algae.

Water Depth: 6-8 **in.^{2/}**

INCUBATION AND HATCHING

Site: Eggs have adhesive filaments which hold them in place in masses of filamentous algae or on other vegetation.

Duration: Eggs hatch in 9-12 days at 72-80°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year remain in sheltered areas in or near spawning site, including beaches, marshes, and lagoons.

Substrate: Sand, gravel, vegetation **^{2/}**.

Water Depth: Less than 1 **in.^{2/}** - 20 ft.

REFERENCES

Adams and Hankinson 1928; Cahn 1927; Cooper 1935, 1938; Eddy and Underhill 1974; Eigenmann 1896; Evermann and Clark 1920; Fish 1929; Forbes and Richardson 1920; Foster 1967; Fowler 1922; Greeley 1928, 1935; Langlois 1954; Osburn and Williamson 1898; Price and Kelly 1976; Richardson **1939^{1/}**; Scott 1967; Webster **1941^{2/}**.

^{1/} Quebec

^{2/} Connecticut

BROOK SILVERSIDE

MIGRATION OF ADULTS

Prespawning: Move inshore from deep water.

Postspawning: No information.

SPAWNING

Season: Mid-April to early August at 68-73°F; peak spawning usually occurs in late May or early June.

Site: Protected lake shorelines, shoals, bays, river mouths, and marshes; also areas of moderate current in rivers,

Substrate: Eggs are scattered in mid-water over sand, gravel, and vegetation.

water Depth: 1-3 ft.

INCUBATION AND BATCHING

Site: Eggs settle to bottom and attach to substrate or vegetation by adhesive filament.

Duration: Eggs hatch in 8-9 days at 73°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Newly hatched larvae are found in pelagic areas along shores and beaches and in marshes, bays, and river mouths; older young-of-the-year (YOY) are found in mid-lake.

Substrate: Sand, rock, gravel, clay, mud; if vegetation is present, YOY are found in open water between clumps of plants.

Water Depth: Newly hatched larvae are found near surface at depths to 4 ft; they soon move to depths of 33-66 ft where they are found in the upper few inches of water; YOY return to shallow water in late summer*

REFERENCES

Adams and Hankinson 1928; Bensley 1915; Breder 1962; Cahn 1927; Eddy and Underhill 1974; Nubbs 1921; Hubbs and Lagler 1958; Langlois 1954; Nelson 1968a; Price and Kelly 1976; Richardson 1913a; Zimmerman 1970.

BROOK STICKLEBACK

MIGRATION OF ADULTS

Prespawning: Move from deeper over-wintering areas to shallow areas, just after ice breakup^{1/}.

Postspawning: Male guards nest and fry, then gradually moves downstream to deeper water; a large downstream migration may occur.

SPAWNING

Season: April to mid-July at 40-74°F; may spawn twice a season.

Site: Margins of ponds and stream pools, in concealed locations, including overhanging banks; also where meltwater runoff enters streams^{1/}.

Substrate: Eggs are deposited in nest built on vegetation or gravel and attached to grass, rootlets, stems, sticks, or vertical surfaces of rocks.

Water Depth: May nest at any level in water column in water up to 1 ft deep.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate in nest, constructed of algae, dead grass, small twigs, or organic debris held together by secretions of the male.

Duration: Eggs hatch in 7-10 days at 65-61°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae hang from vegetation in nest; male constructs nursery of old nest materials above or adjacent to nest, in which he restrains fry after they rise from nest; after a couple days, fry leave nursery but remain in vegetated areas.

Substrate: Vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Applegate 1961; Braekevelt and McMillan 1967; Cahn 1927; Eddy and Underhill 1974; Faber 1963; Greeley 1934; Harkness and Ricker 1929; Jacobs 1948; Lamsa 1963a; Langlois 1954; MacLean and Gee 1971^{1/}; McKenzie 1974; Manion 1977; Nelson 1968; price and Kelly 1976; Reisman and Cade 1967; Scott 1967; Slastenenko 1958; Wooton 1976.

^{1/} Manitoba

THREESPINE STICKLEBACK

MIGRATION OF ADULTS

Prespawning: Move from deeper water to nearshore areas, creek mouths, and bays, and often ascend tributaries.

Postspawning: Male guards nest and newly hatched fry for maximum of 9 day.& and then begins return to deeper water^{1/}.

SPAWNING

Season: April-September at 50^{4/} - 73°F^{3/}; several spawnings may occur each season.

Site: Sheltered, current-free^{3/} areas along lake shore& and in bays, creek mouths, and tributaries, usually close to shore ^{3/}.

Substrate: Eggs are deposited in nest built on mud^{3,4/}, sand, vegetation, or flat surface of a rock^{5/}; also scattered onto vegetation^{2/}.

Water Depth: About 10 in. but as shallow as 1-2 in.^{3/}

INCUBATION AND HATCHING

Site: Adhesive masses of eggs incubate in nest constructed of sand grains and plant fragments held together by secretions of the male.

Duration: Eggs hatch in 4-27 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Fry leave nest about 1-2 weeks after hatching; young-of-the-year are found in protected coves, river mouths, and marshes.

Substrate: Vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Bean 1903; Bigelow and Schroeder 1953^{1/}; Greenbank and Nelson 1959^{2/}; Fish 1932; Hagen 1967^{3/}; Kynard 1978^{4/}; Nash 1913; Scott 1967; Seal 1892^{5/}; Slastenenko 1958; Wooton 1976.

1/ Gulf of Maine

2/ Alaska

3/ British Columbia

4/ Washington

5/ Laboratory study

NINESPINE STICKLEBACK

MIGRATION OF ADULTS

Prespawning: Move inshore to shoals and harbors or upstream into creeks.

Postspawning: Male guards nest and fry.

SPAWNING

Season: May-July at 49-62°F; peak spawning occurs at 52-54°F^{1/}; may spawn more than once a season.

Site: Quiet areas in vegetated bays and creeks, 1-5 ft from shore; may also spawn along exposed shoreline but this is not as successful.

Substrate: Eggs are deposited in nest built on vegetation, rock, or rubble, or in highly organic mud or sand.

Water Depth: To 144 ft, but usually less than 60 ft; usually nests 1-8 in. above substrate.

INCUBATION AND BATCHING

Site: Eggs incubate in nest constructed of fine plant fragments held together by secretions of the male.

Duration: Eggs hatch in 9 days or less; in 4 or 5 days at 64-66°F

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Male may construct nursery of plant fragments; nursery is located above the nest and contains young fry; when fry are about 2 weeks old and 0.5 in. long, they scatter into vegetation; older young-of-the-year (YOY) hide among rocks nearshore.

Substrate: Rock, vegetation.

Water Depth: To 30 ft; older YOY may move to deeper water.

REFERENCES

Dymond 1926; Dymond et al. 1929;; Griswold and Smith 1972^{1/}; Morris 1958; Nelson 1968b; Price and Kelly 1976; Scott and Crossman 1973; wooton 1976.

^{1/} Laboratory study

WHITE PERCH

MIGRATION OF ADULTS

Prespawning: Move inshore and enter tributaries usually beginning in April.

Postspawning: Return downstream after spawning^{5/},

SPAWNING

Season: A period of 1-33/ weeks in April-early July at 50-73°F; eggs have been found as late as September.

Site: Nearshore reefs and shoals, bays, or tributaries.

Substrate: Eggs are scattered at random in open water over almost any substrate^{3/}, including fine gravel^{4/}, rock, muck^{1/}, or submerged vegetation.

Water Depth: To 12 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on rocks or vegetation.

Duration: 30 hours at 68°F - 6 days at **52°F^{2/}**.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae sink to bottom^{6/}; larvae become pelagic and are carried by currents^{1/}; young-of-the-year are found in quiet water along shore and in bays and also on current-swept shoals.

Substrate: Sand, clay, gravel, pulverized snail shells, mud^{7/}, or vegetation.

Water Depth: To 12 **ft^{7/}**.

REFERENCES

Auclair 1956^{1/}; Bigelow and Schroeder 1953^{2/}; Christie and Regier 1973; Foster 1919^{3/}; Hoover 1937^{4/}; Lagler 1948; Mansueti 1961^{5/}, 1964^{6/}; Raney 1959; Richards 1960; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Toman 1955; Webster 1941^{7/}.

1,3/ Maine

2/ Gulf of Maine

4/ New Hampshire

5,6/ Chesapeake Bay

7/ Connecticut

WHITE BASS

MIGRATION OF ADULTS

Prespawning: Move inshore from deep water and enter tributaries, beginning in April at about 55°F; often move many miles upstream.

Postspawning: Return to lakes or deeper water in rivers after spawning.

SPAWNING

Season: A period of 5-10 days in April-early July, usually late May-early June, at 55-79°F.

Site: Clear, swift tributaries; if tributaries are not available, will spawn on current-swept lake shores or shoals or in bays.

Substrate: Eggs are scattered at random at surface or in mid-water usually over firm bottom of rock, gravel, rubble, sand, or clay; occasionally over mud; abundant vegetation may be present.

Water Depth: To 36 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on rocks or vegetation; in flowing water, eggs may be carried a short distance from spawning site.

Duration: Eggs hatch in 46 hours at 60°F²/.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Most prolarvae are carried downstream to bays and harbors; young-of-the-year remain in littoral areas along shore, including bays, harbors, marshes, river mouths, and along exposed shoreline.

Substrate: Rock, rubble, gravel, sand, hard clay, and muck with some submerged vegetation; usually avoid dense weed beds and organic substrata/.

Water Depth: Usually more than 6 ft; greatest densities have occurred in 6-12 ft of water.

REFERENCES

Adams and Hankinson 1928; Baily and Harrison 1945^{1/}; Bean 1902, 1903, 1913; Cahn 1927; Calhoun and Coon 1941; Eddy and Underhill 1974; Fws 1945; Garman 1889; Hassler et al. 1958; Horrall 1961; Hubbs and Eschmeyer 1938; Hubbs and Lagler 1958; Lagler 1948; MacKay 1958c, 1969; MSBFC 1893^{2/}; Nash 1913; Pell 1859; Riggs 1955; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Smith 1969; Trautman 1957; USDI 1966, 1969b; Wickliff 1934, 1936, 1957.

^{1/} Iowa

^{2/} Laboratory study

ROCK BASS

MIGRATION OF ADULTS

Prespawning: Move inshore beginning at 55°F; often move many miles along shore to reach bays and creek mouths; stream residents congregate in pools just before spawning.

Postspawning: Male guards nest and newly hatched fry; lake residents then return to lake.

SPANNING

Season: April-early August, usually late May-June, at 57-75°F.

Site: Sheltered nearshore areas, including bays, harbors, lagoons, marshes, creek mouths, and lower reaches of tributaries; current-swept lake shoals and ledges; moderate-swift water in streams; inconspicuous nest is usually in shaded site, next to or under a log, rock, or other shelter.

Substrate: Eggs are deposited in shallow depression excavated in gravel, rock, sand, mud, clay, marl, or vegetation to expose fibrous plant rootlets; may nest on rock breakwalls or spawn over nests of other centrarchids.

Water Depth: To 20 ft; usually less than 6 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on rootlets or vegetation in nest.

Duration: Eggs hatch in 3-4 days at 69-70°F¹/ or 10-12 days at 60°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain in nest 2-3 days; after leaving nest, young remain near littoral spawning grounds, in weed beds, bays, harbors, marshes, and on shoals and beaches.

Substrate: Dense vegetation and rubble, gravel, rock, or mud.

Water Depth: To 10 ft; some may assume pelagic existence.

REFERENCES

Adams and Hankinson 1916, 1928; Bean 1902, 1903; Breder 1936¹/; Cahn 1927; Calhoun and Coon 1941; Carbine 1939; Crossman 1976; Eddy and Underhill 1974; Embury 1915; Ernest 1960; Evermann and Clark 1920; Faber 1963, 1967; Forbes and Richardson 1920; Fowler 1923; Greeley 1928; Hankinson 1908; Hile 1941; Hubbs and Eschmeyer 1938; Johnson

and Hale 1970; Lagler 1948; MacKay 1958d, 1969; McCrimmon 1956; Nichols 1954; Osburn and Williamson 1898; Parker et al. 1899; Pell 1859; Price and Kelly 1976; Reighard 1915; Schneberger 1973; Scott 1967; Skille 1968; Slastenenko 1958; Smith and Moe 1944; Surber 1920; Trautman 1957; U.S. Comm. Fish Fish. 1900.

1/ Laboratory study

GREEN SUNFISH

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: Male guards nest and newly hatched fry.

SPAWNING

Season: Mid-May to late August at 68-82°F; peaks in June; possibly several spawnings at intervals of 8-9 days.

Site: Sheltered nearshore areas, including lagoons, harbors, lower reaches of rivers, and quiet waters of streams; nesting sites are usually unshaded and within 6 ft of shore.

Substrate: Eggs are deposited in shallow excavation made in sand, stones, gravel, or marl; also in mud or muck, where excavation reaches firm bottom; nest is often in exposed site, among dense vegetation, next to a log or rock; may spawn on rock breakwalls or in abandoned nests of other species.

Water Depth: To 15 in.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on rootlets, gravel, or lumps of clay in bottom of nest.

Duration: Eggs hatch in 9 days or less; in 50 hours at 75°F^{1/}.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in lower reaches of rivers, harbors, and marshy lagoons.

Substrate: Mud, vegetation.

Water Depth: 1-7 ft.

REFERENCES

Cahn 1927; Childers 1967^{1/}; Crossman 1976; Eddy and Underhill 1974; Forbes and Richardson 1920; Hankinson 1908, 1919; Hubbs and Cooper 1935; Hunter 1963; Lagler 1948; Osburn and Williamson 1898; Parker et al. 1899; Slastenenko 1958; Taylor 1978.

^{1/} Laboratory study

PUMPKINSEED

MIGRATION OF ADULTS

Prespawning: Move short distances inshore and enter creeks.

Postspawning: Male guards nest and newly hatched fry.

SPAWNING

Season: May-August, beginning at 55°F; occurs at water temperatures as high as 84°F^{1/}.

Site: Quiet nearshore areas, including bays, harbors, marshes, lagoons, backwaters, and creek mouths; also running waters of tributaries.

Substrate: Eggs are deposited in conspicuous depression made in sand, gravel, or marl, or in mud or detritus excavated to expose coarse gravel or plant roots; nest is always among vegetation; may spawn over nests of other centrarchids.

Water Depth: 3 in.^{1/} - 7 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on gravel, plants, or roots in nest.

Duration: Eggs hatch in 10 days or less; in 3 days at 82°F^{2/}.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Fry leave nest soon after hatching; young are found near spawning grounds, especially in thick weed beds, in bays, harbors, and lower reaches of rivers; some are found on open shoals.

Substrate: Dense vegetation, sand.

Water Depth: To 6 ft; some may assume a pelagic existence.

REFERENCES

Adams and Hankinson 1916, 1928; Allen 1914; Amundrud et al. 1974; Bean 1902, 1903; Breder 1936^{1,2/}; Cahn 1927; Carbine 1939; Clark and Keenleyside 1967; Colgan and Ealey 1973; Crossman 1976; Eddy and Underhill 1974; Embury 1915, 1922; Emery 1973; Evermann and Clark 1920; Faber 1963; Forbes and Richardson 1920; Fowler 1923; Gill 1907b; Greeley 1928, 1929; Hankinson 1908; Hubbs 1919; Hubbs and Eschmeyer 1938; Johnson, C., 1971; Keenleyside 1978; Lagler 1948; Langlois 1954; MacKay 1959c, 1969; McCrimmon 1956; Nash 1913; Nichols 1954; Olson and Koopman 1976; Peterka and Kent 1976; Raney and

Lachner 1942; Reed and Wright 1909; Reighard 1913, 1915; Richardson 1913a; Slastenenko 1958; Taylor 1978; Werner 1967; Wickliff 1957.

1/ New Jersey

2/ Laboratory study

ORANGESPOTTED SUNFISH

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPANNING

season: Late May-early August beginning at 65°F^{1/}; ripe adults have been collected at 77°F^{2/}.

Site: Marshy areas of lakes and low-gradient streams; also in harbors.

Substrate: Eggs are deposited in nest made in pebbles or sand or in silt or mud excavated down to solid bottom; may nest on harbor breakwaters.

Water Depth: 1-3 ft^{1/}.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on pebbles in nest^{1/}.

Duration: Eggs hatch in 5 days at 65-70°F^{1/}.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in the lower reaches of rivers.

Substrate: No information.

Water Depth: No information.

REFERENCES

Barney and Anson 1923^{1/}; Cross 1950^{2/}; Forbes and Richardson 1920; Richardson 1913a.

^{1/} Iowa

^{2/} Oklahoma

BLUEGILL

MIGRATION OF ADULTS

Prespawning: Little movement; may move short distance inshore.

Postspawning: Male guards nest until newly hatched fry leave nest; may then remain with fry for a few additional days until they disperse.

SPAWNING

Season: Early May to mid-August at 60-87°F; probably peaks in July.

Site: Quiet nearshore areas of lakes or stream pools, including wetlands, marshes, bays, coves, harbors, lagoons, and creek mouths; nest is usually adjacent to emergent vegetation.

Substrate: eggs are deposited in nest; nest is a large depression made in sand, gravel, marl, or clay or in mud or detritus excavated down to firm bottom or rootlets; nest is usually among vegetation; may nest on rock breakwalls or spawn over nests of other centrarchids.

Water Depth: To 15 ft; usually less than 5 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on fibrous roots or stones in bottom of nest.

Duration: Eggs hatch in 2-4 days at 76-67°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain in nest; fry move into littoral zone after leaving nest; when less than 0.5 in. long, move into limnetic zone for 6-7 weeks; when about 0.8-1.0 in. long, return to littoral zone and remain in dense weed beds in marshes, bays, or lower reaches of rivers for rest of summer.

Substrate: Vegetation.

Water Depth: From the shoreline, at depths of 4-6 in., into the limnetic zone.

REFERENCES

Adams and Hankinson 1928; Amundrud et al. 1974; Beard 1971, 1972; Beyerle 1978; Brass 1938; Calhoun and Coon 1941; Carbine 1939;

Childers 1967; Clark and Keenleyside 1967; Coggeshall 1924; Crossman 1976; Eddy and Underhill 1974; Embody 1915; Evermann and Clark 1920; Faber 1963, 1967; Forbes and Richardson 1920; Hall and Warner 1977; Hankinson 1908; Hubbs 1919; Hubbs and Eschmeyer 1938; Johnson, C., 1971; Lagler 1948; Langlois 1954; Latta 1969; Morgan 1951; Mraz and Cooper 1957; Nichols 1954; Osburn and Williamson 1898; Paxton and Day 1974; Peterka and Kent 1976; Price and Kelly 1976; Raney 1959; Raphael and Jaworski 1979; Reighard 1915; Richardson 1913a,b; Scott and Crossman 1973; Slastenenko 1958; Smith and Moe 1944; Snow et al. 1960; Stevenson 1966; Storck et al. 1978; Surber 1920; Taylor 1978; Werner 1967; Wickliff 1957.

SMALLMOUTH BASS

MIGRATION OF ADULTS

Prespawning: Migrate inshore and enter bays and tributaries; movement begins when water temperature rises above 40°F; peak movement occurs at 55°F.

Postspawning: Male guards nest and fry until fry are about 1 in. long; adults move downstream or offshore to depths of 36-42 ft as water temperature approaches 77°F, usually by July.

SPAWNING

Season: A period of 6-10 days in March to mid-August, usually May-July, at 51-70°F; nest building may begin at water temperatures below 60°F, but spawning usually does not begin until the water temperature reaches about 62°F.

Site: Clear water in tributaries, river mouths, bays, harbors, lake shores or shoals; nest usually built close to boulders, logs, docks or other such structures; sometimes among rooted macrophytes; in an area with good water movement that is protected from wave action.

Substrate: Eggs are deposited in nest, a shallow depression excavated in cleaned gravel, rock, rubble, or sand; spawning may also occur on harbor breakwalls.

Water Depth: To 20 ft; usually less than 6 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to stones, short stems, or roots on bottom of nest.

Duration: Eggs hatch in 2-15 days at 70-55°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Fry gradually disperse from nest when 1-2 weeks old and are then found along edges of vegetation beds; young-of-the-year are found in littoral zones of streams, river mouths, bays, harbors, coves, or lake shores, or also on lake shoals; usually near structures.

Substrate: Rock, gravel, rubble, sand, or vegetation; avoid mud.

Water Depth: To 60 ft; usually less than 20 ft; move to deeper water during late summer.

REFERENCES

Adams and Hankinson 1916, 1928; Bean 1902, 1903, 1913; Beeman 1924; Brynildson 1965; Cahn 1927; Calhoun and Coon 1941; Clady 1970; Crossman 1976; Dymond 1931; Eaton 1928; Eddy and Underhill 1974; Embury 1915, 1922; Evermann and Clark 1920; Faber 1963, 1967; Fowler 1925; Greeley 1927, 1928; Hay 1894; Holt 1888; Hough 1902; Hubbs and Baily 1938; Johnson and Hale 1970, 1977; Lagler 1948; Langlois 1941; Latta 1975; Lydell 1903; MacKay 1960d, 1969; Marinac 1976; McCrimmon 1956; Meehan 1910; Moore 1922; Mraz 1960, 1964b; Needham 1922; Price and Kelly 1976; Raney 1959; Reighard 1905, 1913, 1915; Robbins and McCrimmon 1977; Schneberger 1972a; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Smith and Moe 1944; Stockwell 1876; Surber 1920; Tester 1930; Titcomb 1922; Turner 1920b; Turner and McCrimmon 1970; U.S. Comm. Fish Fish. 1900; USDI 1966, 1969b; Webster 1953.

LARGEMOUTH BASS

MIGRATION OF ADULTS

Prespawning: May move short distances inshore or into marshes.

Postspawning: Little movement from spawning site; male guards nest and fry until fry are about 1 in. long; may move to somewhat deeper water after **spawning**^{1/}.

SPAWNING

Season: April-August, usually late May-early July, at 58-70°F.

Site: Protected littoral areas in lakes or tributaries, including marshes, bays, harbors, sloughs, lagoons, and creek mouths; nest is usually among vegetation or near structures, such as logs or stumps.

Substrate: Eggs are deposited in a nest made in almost any substrate, including gravel, rock, clay, sand, mud, detritus, or vegetation; soft substrate is excavated down to firm bottom; may spawn over nests of rock bass.

Water Depth: To 15 ft; usually less than 6 ft.

INCUBATION AND HATCHING

Site: Eggs adhere to roots or stones on bottom of nest.

Duration: Eggs hatch in 2-15 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Larvae remain in nest for 5-10 days, then gradually disperse; young spend the first summer of life in sheltered, littoral, weedy areas near spawning grounds and move offshore in fall.

Substrate: Vegetation, sand, mud, detritus; occasionally stone or rubble.

Water Depth: Usually to 6 ft; also found at depths of 14-20 ft around structures.

REFERENCES

Adams and Hankinson 1916, 1928; Bean 1903; Bennett 1954; Cady **1945**^{1/}; Cahn 1927; Clady 1970; Calhoun and Coon 1941; Carbine 1939; Crossman 1976; Eaton 1928; Eddy and Underhill 1974; Embury 1922, 1915; Evermann and Clark 1920; Faber 1963, 1967; Garman 1889; Greeley 1928, 1929; Hamilton and Powles 1979; Hankinson 1908; Hough 1902; Hubbs 1919; Hubbs and Baily 1938; Johnson, C., 1971; Kramer and Smith 1960,

1962; Lagler 1948; Latta 1974; Lydell 1903; MacKay 1960e, 1969; McCrimmon 1956; Mraz 1954, 1964b; Mraz and Cooper 1957; Mraz et al. 1963; Nash 1913; Olson and Koopman 1976; Paxton and Day 1974; Raney 1959; Rathbun and Wakeham 1897; Reighard 1905, 1913, 1915; Richardson 1913a; Scott 1967; Shealy 1971; Slastenenko 1958; Smith et al. 1958; Smith and Moe 1944; Surber 1920;; Turner 1920b; USDI 1966, 1969b; U.S. Comm. Fish Fish. 1900; Williamson and Churchill 1948.

1/ Tennessee

WHITE CRAPPIE

MIGRATION OF ADULTS

Prespawning: Migrate inshore and ascend tributaries.

Postspawning: Male guards nest and newly hatched fry; female usually returns to deep water immediately after spawning^{2/}.

SPAWNING

Season: A 1-week period in late March-early July, usually in May-June, at 40°-80°F; spawning peaks at 61-68°F^{2/}.

Site: Clear water, usually with some current, in tributaries, river mouths, harbors, bays, coves, or marshes; nest is usually 2-30 ft from shore and sheltered by ledges, banks, brush, stumps, or vegetation.

Substrate: Eggs are deposited in nest on gravel, hard clay, sand or vegetation, swept clean of debris and silt.

Water Depth: To 20 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on nest bottom or on vegetation a few inches above bottom of nest.

Duration: Eggs hatch in about 24-27 hours at 70-72°F, or 42-103 hours at 73-58°F^{2/}.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in sheltered areas in lower reaches of rivers, bays, harbors, or lake shorelines; also may avoid shoreline and migrate into open water during summer^{1, 3, 4/}

Substrate: Vegetation, mud, sand.

Water Depth: May migrate from shallow shorelines to pelagic zone during summer ^{1, 3, 4/}.

REFERENCES

Cahn 1927; Eddy and Underhill 1974; Forbes and Richardson 1920; Gasaway 1970^{1/}; Greeley 1929; Hansen 1943, 1951, 1965; Hubbs and Eschmeyer 1938; Lagler 1948; Morgan 1951, 1954; ODNR, undated; Schnerberger 1972c; Siefert 1968^{2/}, 1969^{3/}; Slastenenko 1958; Surber 1920; Taber 1969^{4/}.

^{1, 2, 3/} South Dakota

^{4/} Oklahoma, Texas

BLACK CRAPPIE

MIGRATION OF ADULTS

Prespawning: Move inshore and enter tributaries as early as late March.

Postspawning: Male guards nest and newly hatched fry.

SPAWNING

Season: Late March-August, usually late May-early July, at 61-79°F.

Site: Sheltered nearshore areas, including bays, harbors, marshes, sloughs, lagoons, creek mouths, and lower reaches of rivers; usually near vegetation beds or plant roots.

Substrate: Eggs are deposited in nest excavated in sand, gravel, mud, or vegetation.

Water Depth: To 10 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on vegetation 2-4 in. above nest bottom or on roots at bottom of nest.

Duration: Eggs hatch in 3-10 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found close to spawning grounds in sheltered nearshore areas, including lake shores, bays, creek mouths, and weed beds; may quickly move to open water^{1/}.

Substrate: Mud, sand, silt, vegetation.

Water Depth: To 8 ft; also found in pelagic zone.

REFERENCES

Adams and Hankinson 1928; Amundrud et al. 1974; Cahn 1927; Crossman 1976; Curtis 1949^{1/}; Eddy and Underhill 1974; Embody 1915; Erickson 1952; Evermann and Clark 1920; Faber 1963, 1967; Forbes and Richardson 1920; Fowler 1923; Greeley 1928, 1929; Hansen 1951; Hubbs and Eschmeyer 1938; Lagler 1948; MacKay 1957b, 1969; Morgan 1951; Nash 1913; ODNR, undated; Olson 1970; Olson and Koopman 1976; Pearse 1918b, 1919; Richardson 1913a; Scott 1967; Scott and Crossman 1973; Slastenenko 1958; Smith and Moe 1944; Surber 1920.

GREENSIDE DARTER

MIGRATION OF ADULTS

Prespawning: Migrate several miles upstream.

Postspawning: Male guards spawning territory; moves downstream to deeper riffle areas after spawning.

SPAWNING

Season: A period of 5-9 weeks period in April-June at 51-66°F^{1/}; observed at 73°F in laboratory.

Site: Swift riffles of moderate-high gradient streams; possibly weedy bays.

Substrate: Eggs are deposited on large rocks or rubble covered with algae, primarily Cladophora; also under small pieces of wood.

water Depth: 1-4 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on algae.

Duration: Eggs hatch in 18 days at 55-58°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found on stream riffles and along shorelines.

Substrate: Algae, rock.

water Depth: Few inches - 2 ft.

REFERENCES

Baker **1979^{1/}**; Cahn 1927; Fahy 1954; Trautman 1957; Winn 1954, 1957, 1958a,b.

^{1/} Tennessee

RAINBOW DARTER

MIGRATION OF ADULTS

Prespawning: Lake residents migrate from deeper water to inshore areas; stream residents migrate upstream beginning in late March.

Postspawning: Male guards nest area for short period before returning to deeper water.

SPAWNING

Season: April-June at water temperatures above 59°F.

Site: Wave-swept lake shorelines and creek mouths or stream riffles.

substrate: Eggs are deposited at random on gravel, rock, pebbles, sand, or dense vegetation^{1/}.

Water Depth: 4 in.-2 ft.

INCUBATION AND BATCHING

Site: Adhesive eggs are buried in gravel.

Duration: Eggs hatch in 10-12 days at 63-66°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain buried in spawning substrate; young-of-the-year are found along lake shores.

Substrate: Gravel for prolarvae.

Water Depth: No information.

REFERENCES

Balon 1975; Cahn 1927; Cooper 1979; Eddy and Underhill 1974; Hankinson 1919, 1932; Hubbs and Lagler 1958; Reeves 1907; Scott '1967; Seal **1892^{1/}**; Slastenenko 1958; Surber 1920; Toth 1978; Winn 1954, 1957, 1958a,b.

^{1/} Laboratory study

IOWA DARTER

MIGRATION OF ADULTS

Prespawning: Move from deeper water to inshore areas.

Postspawning: Return to deeper water after spawning.

SPANNING

Season: Late March to mid-July, at 54-59°F^{1/}.

Site: Sheltered, sluggish nearshore areas, including creek mouths and stream margins, especially beneath undercut banks.

Substrate: Eggs are deposited on rock, marl, vegetation, mud, organic debris, or compacted root material.

Water Depth: 4 in. - 4 ft^{1/}.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on bottom, usually in crevices, or on plant roots.

Duration: Eggs hatch in 18-26 days at 55-61°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year are found in sheltered areas, including marshes.

Substrate: Vegetation, mud, sand, silt.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Bensley 1915; Cahn 1927; Dymond 1926; Eddy and Underhill 1974; Evermann and Clark 1920; Greeley 1929; Hankinson 1908; Hubbs and Lagler 1958; Jaffa 1917^{1/}; ODNR, undated; Price and Kelly 1976; Scott 1967; Slastenenko 1958; Winn 1954, 1958a,b.

^{1/} Colorado

FANTAIL DARTER

MIGRATION OF ADULTS

Prespawning: Migrate from swift riffles in streams to areas of moderate current in late March-April at 44-58°F.

Postspawning: Male guards eggs; female leaves spawning site almost immediately after spawning and returns downstream to larger riffles.

SPAWNING

Season: April-early July at 66-76°F; usually peaks in May.

Site: Areas of moderate current usually just below or above stream riffles or in pools.

Substrate: Eggs are attached to undersides of flat rocks or pieces of wood on bottom of rubble, rock, gravel, or sand.

Water Depth: 12-20 in.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on spawning substrate.

Duration: Eggs hatch in 14-35 days at 74-63°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae are dispersed by current among gravel and vegetation; young-of-the-year are found near spawning riffles or along wave-swept beaches; also may be found in quiet **waters^{1/}**.

Substrate: Rock, rubble, sand, some vegetation; possibly soft **bottom^{1/}**.

Water Depth: Shallow; no specific information.

REFERENCES

Adams and Hankinson 1928; Cahn 1927; Cooper 1979; Forbes and Richardson 1920; Greeley 1927, 1929; Hankinson 1932; Hubbs and Lagler 1958; Lake 1936; Langlois 1954; Minckley **1963^{1/}**; Parker et al. 1899; Toth 1978; Trautman 1957; Winn 1954, 1958a.

JOHNNY DARTER

MIGRATION OF ADULTS

Prespawning: Move from deeper water of lakes or streams, possibly several miles, to shallow inshore areas in early April.

Postspawning: Male guards eggs: returns to deeper areas of lake or stream.

SPAWNING

Season: A 6-week period in April-August, usually in May and June at 63-77°F.

Site: Sheltered nearshore areas, including shorelines, bays, harbors, and creek mouths; areas of moderate current in stream pools.

Substrate: Eggs are attached to undersides of stones, wood, or other objects, on bottom of loose stone, rock, gravel, sand, clay, or silt.

Water Depth: 8 in. - 15 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate on spawning substrate.

Duration: Eggs hatch in 5-24 days at 75-61°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Young-of-the-year (YOY) are found in sheltered areas near spawning grounds, including shorelines; bays, harbors, and lower reaches of rivers; may be near weed beds.

Substrate: Rock, gravel, sand, clay, silt, mud, vegetation.

Water Depth: As shallow as 2 in. for newly hatched larvae; to 82 ft for older YOY.

REFERENCES

Adams and Hankinson 1928; Cahn 1927; Dymond 1926; Eddy and Underhill 1974; Forbes and Richardson 1920; Greeley 1929; Hankinson 1908, 1919, 1932; Hubbs and Lagler 1958; Osburn 1901; Price and Kelly 1976; Raney and Lachner 1942, 1943; Reighard 1913, 1915; Slastenenko 1958; Smith 1963; Speare 1958, 1965; Tilton et al. 1978; Toner 1943; Trautman 1957; Winn 1954, 1958a,b.

YELLOW PERCH

MIGRATION OF ADULTS

Prespawning: Migrate inshore or ascend tributaries, possibly long distances, beginning as early as March at 34°F, just before or after ice breakup; may overwinter in bays prior to spawning.

Postspawning: Return downstream or to offshore areas of lakes.

SPAWNING

Season: A period of 1-4 weeks in April-August, usually April-June, at 37-72°F; spawning peaks at about 43-54°F.

Site: Sheltered littoral areas in lakes and tributaries, including shorelines, harbors, bays, creek mouths, marshes, backwaters, and lagoons; usually near vegetation.

Substrate: Eggs are deposited at random on submerged objects, including vegetation, rocks, brush, and debris, on almost any bottom type.

Water Depth: To 72 ft; usually less than 30 ft.

INCUBATION AND BATCHING

Site: Semibuoyant strands of eggs incubate among vegetation or other submerged objects; current may move eggs away from spawning site.

Duration: Eggs hatch in 5-27 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain near spawning grounds for 3-4 days; larvae then become pelagic in the upper 20 ft of water and are widely distributed by currents; young-of-the-year (YOY) become benthic usually after 4-5 weeks and are found in sheltered nearshore areas; YOY move downstream in tributaries in fall.

Substrate: Vegetation, gravel, rubble, sand, mud, silt.

Water Depth: To 66 ft; highest densities at less than 30 ft.

REFERENCES

Adams and Hankinson 1916, 1928; Amundrud et al. 1974; Bardach 1949; Bean 1912; Buller 1927; Cahn 1927; Calhoun and Coon 1941; Clady 1975, 1976, 1977; Crossman 1976; Eaton 1928; Eddy and Underhill 1974; Embury 1915, 1922; Evermann and Kendall 1920; Faber 1963, 1967; Forbes and Richardson 1920; Forney 1971; FWS 1945; Greeley 1928;

Hankinson 1908; Herman et al. 1959; Houde 1968, 1969a,b; Johnson, C., 1971; Johnson, F., 1969; Lagler 1948; Langlois 1941; Leach 1927; MacKay 1959e, 1969; Maloney and Johnson 1955; McCrimmon 1956; Nash 1913; Noble 1968, 1972, 1975; Patterson 1978; Paxton and Day 1974; Pearse 1918b; Pearse and Achtenberg 1920; Price and Kelly 1976; Raney 1959; Haney and Lachner 1942; Raphael and Jaworski 1979; Reed and Wright 1909; Schneider 1972; Scott 1967; Slastenenko 1958; Smith 1969, 1972; Smith and Moe 1944; Surber 1920; Titcomb 1922; U.S. Comm. Fish Fish. 1900; USDI 1969b; Webster 1975.

LOGPERCH

MIGRATION OF ADULTS

Prespawning: Migrate in large schools from deep water to nearshore areas and into tributaries.

Postspawning: Presumably return to deep water.

SPAWNING

Season: A period of 1-2 weeks in April-August, usually June-July; spawning begins at water temperatures of 50-59°F¹/.

Site: Lake shoals and beaches, stream riffles or swift channels, river mouths, and harbors.

Substrate: Eggs are broadcast at random over sand, fine gravel, or rock of 4-6 in. diam., with little or no vegetation.

Water Depth: 4 in. - 15 ft.

INCUBATION AND BATCHING

Site: Adhesive eggs become loosely buried in sand.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae are found at the surface **inshore²/** near spawning grounds; fry less than 0.6 in. long are dispersed in open **water²/** in June; larger fry return to protected nearshore **areas²/** and are found near bottom along sheltered beaches, in creek mouths, bays, and harbors; young-of-the-year in streams move downstream to lakes by August.

Substrate: Sand, gravel, rock, rubble; submerged vegetation may or may not be present.

Water Depth: To 132 ft by August.

REFERENCES

Adams and Hankinson 1928; Amundrud et al. 1974; Crossman 1976; Eddy and Underhill 1974; Eigenmann 1896; Faber 1963, 1967; Ellis and Roe 1917; Fish 1929; Greeley and Bishop 1932; Hubbs and Lagler 1958; Hubbs and Strawn **1963¹/**; Langlois 1954; Price and Kelly 1976; Reighard 1915, 1920; Scott 1967; Taber **1969²/**; Trautman 1948, 1957; Winn 1954, 1958a,b.

^{1,2}/ Texas

CHANNEL DARTER

MIGRATION OF ADULTS

Prespawning: Move inshore or ascend tributaries.

Postspawning: Return to deeper water immediately after spawning.

SPAWNING

Season: Late June-late July at 69-72°F.

Site: Current-swept lake shoals or stream riffles; spawning territory of each male is centered by a large rock.

Substrate: Eggs are scattered at random over gravel, rock, boulders, or sand.

Water Depth: 18 in. - 5 ft.

INCUBATION AND HATCHING

Site: Adhesive eggs become buried in gravel.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: Sand, mud, silt, vegetation.

Water Depth: Shallow; no specific information.

REFERENCES

Greeley and Bishop 1932; ODNR, undated; Winn 1954, 1958a,b.

SAUGER

MIGRATION OF ADULTS

Prespawning: Migrate inshore and enter tributaries beginning in March, often before ice breakup; river residents move upstream.

Postspawning: Return to deeper water after spawning.

SPAWNING

Season: A 2-week period^{2/} in late March-early July, usually April and May, at 39^{1/} - 54°F.

Site: Lake shorelines, bars, and reefs; bays; riffles in tributaries.

Substrate: Eggs are broadcast on a variety of substrates, including gravel, rock, cobble, boulders, sand, clay, mud, and vegetation.

Water Depth: Less than 2 ft^{2/} -- 30 ft.

INCUBATION AND BATCHING

Site: Adhesive eggs settle to bottom and incubate in cracks and crevices among gravel or boulders^{2/}.

Duration: Eggs hatch in 9 days at about 55°F^{3/} - 29 days at 40°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain on bottom 7-9 days^{2/}; larvae hatched in rivers move downstream to lakes^{2,4/}; larvae smaller than 0.6 in. are planktonic in open water; those larger than 0.6 in. are found inshore in harbors, bays, and river mouths, especially in turbid water; young-of-the-year disperse offshore in July or August^{4/}.

Substrate: Sand, gravel.

Water Depth: Shallow for most of summer; move to depths as great as 198 ft in late summer.

REFERENCES

Carufel 1963^{1/}; Crossman 1976; Curry and Spacie 1979; Dymond 1926; Eddy and Underhill 1974; Fish 1929; Gammon 1976; Greeley 1929; Langlois 1941; Nelson 1968a^{2/}; Nelson et al. 1965^{3/}; ODNR, undated; Priegel 1968, 1969; Scott and Crossman 1973; Slastenenko 1958; Smith and Koenst 1975; Walburg 1972^{4/}.

^{1/} North Dakota

^{2,4/} South Dakota

^{3/} Laboratory study

WALLEYE

MIGRATION OF ADULTS

Prespawning: Migrate inshore from deep water and enter tributaries, beginning as early as late February, under the ice or just after ice-out; often migrate long distances up tributaries.

Postspawning: Migrate downstream or offshore in May-August and disperse widely; may remain in harbors for 2-3 months before moving into lakes.

SPAWNING

Season: A period of 1-4 weeks in February-June at 34-64°F; usually peaks at 41-53°F.

Site: Exposed, wave-swept lakeshores, reefs, or shoals; bays and river mouths; fast-water areas of tributaries, usually just below waterfalls, rapids, or dams; occasionally in marshes with good current.

Substrate: Eggs are broadcast over clean, firm bottom of rock, rubble, boulders, gravel, sand, or clay, usually free of mud or silt; also over vegetation on firm substrate.

Water Depth: To 30 ft.

INCUBATION AND HATCHING

Site: Eggs may be carried from spawning site by current before settling to bottom; eggs adhere to clean substrate.

Duration: Eggs hatch in 1-4 weeks at 57-40°F.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae remain on bottom 3-5 days; postlarvae are carried by current into limnetic zone, especially in bays, where they remain for 2-7 weeks until about 1 in. long; the larger young-of-the-year (YOY) concentrate along shore, then move offshore by October.

Substrate: Clean sand, rock, gravel, hard clay, or mud; usually no vegetation, but YOY may be found near large weed beds.

Water Depth: To 40 ft; YOY larger than 1 in. usually at depths less than 12 ft,

REFERENCES

Adams and Hankinson 1928; Allbaugh and Manz 1964; Anthony and

Jorgensen 1977; Bean 1902, 1903, 1913, 1915; Bennett 1948; Beyerle 1978; Bower 1897; Bradshaw and Muir 1960; Buller 1927; Buss 1960; Cahn 1927; Calhoun and Coon 1941; Cheney 1897; Chevalier 1977; Cobb 1923; Colvin 1975; Cross 1964; Crossman 1976; Dymond 1926; Eddy and Underhill 1974; Evermann and Latimer 1910; Faber 1963, 1967; Forbes and Richardson 1920; Forney 1953, 1963, 1966, 1977; Greeley and Bishop 1932; Hankinson 1908; Hay 1894; Herman 1947; Houde 1967, 1968, 1969a,b; Houde and Forney 1970; Hubbs and Eschmeyer 1938; Hubbs and Lagler 1958; Johnson, C., 1971; Johnson, F., 1961, 1969; Johnson and Hale 1970, 1977; Johnson and Johnson 1971; Johnson et al. 1977; Kmiotek 1952; Lagler 1948; Leach 1927; Maloney and Johnson 1955; McCrimmon 1956; Meehan 1895; Momot et al. 1977; Newburg 1975; Niemuth et al. 1959; Noble 1972; Olson 1972; Olson and Scidmore 1962; Olson et al. 1978; Paxton and Day 1974; Price and Kelly 1976; Priegel 1963, 1966, 1967b, 1968, 1970; Raney 1959; Raney and Lachner 1942; Reighard 1890; Ryder 1977; Schneberger 1938, 1939, 1940; Scidmore 1972, 1974; Scott 1967; Slastenenko 1956, 1958; Smith 1969, 1972; Smith and Koenst 1975; Smith et al. 1952; Smith and Moe 1944; Smith and Pycha 1960; Stoudt 1939; Stoudt and Eddy 1939; Surber 1920; Tucker 1968; U.S. Comm. Fish Fish. 1900; USDI 1969b; Van Oosten and Deason 1957.

BLUE PIKE¹/

MIGRATION OF ADULTS

Prespawning: Migrated inshore and into tributaries.

Postspawning: Returned to deep water by July.

SPAWNING

Season: A 2-week period in late April-early July at 38-48°F.

Site: Lake shoals, bays, and tributaries,

Substrate: Eggs were deposited on gravel, rock, sand or mud.

Water Depth: 15-130 ft.

INCUBATION AND HATCHING

Site: No information.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: No information.

Substrate: No information.

Water Depth: No information.

REFERENCES

Smith 1978a.

¹/ This species is believed to be extinct in the Great Lakes.

FRESHWATER DRUM

MIGRATION OF ADULTS

Prespawning: Migrate inshore from deep water and enter bays and tributaries beginning in April at about 43°F.

Postspawning: Return to deep water in lakes during summer.

SPAWNING

Season: April-August at 55-77°F.

Site: Tributaries, harbors, bays, river mouths, lake shores, shoals, or offshore in open water.

Substrate: Eggs are scattered at random in midwater over sand, gravel, rock, rubble, clay, mud or vegetation.

Water Depth: To 42 ft.

INCUBATION AND HATCHING

Site: Buoyant eggs incubate in open water and are widely distributed by currents.

Duration: Eggs hatch in 1-3 days.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae are carried by currents; pelagic postlarvae 0.4-0.8 in. long are abundant offshore; young-of-the-year larger than 0.8 in. become benthic and concentrate in quiet, open water along shorelines, in sloughs, bays, river mouths, and lower reaches of rivers; seem to prefer turbid water.

Substrate: Mud, sand, gravel, vegetation.

water Depth: To 60 ft.

REFERENCES

Barker 1940; Butler 1962, 1965; Butler and Smith 1950; Eddy and Underhill 1974; Fish 1929; Forbes and Richardson 1920; Garman 1889; Lagler 1948; Langlois 1954; Lannoyeux 1951; McLeod 1953; ODNR, undated; Priegel 1967; Schneider and Hasler 1960; Slastenenko 1958; Smith 1969; Wirth 1958.

MOTTLED SCULPIN

MIGRATION OF ADULTS

Prespawning: Migrate inshore from deep water; may ascend tributaries.

Postspawning: Female returns to deep water immediately after spawning; male guards nest and newly hatched fry; male leaves spawning ground usually by late May.

SPAWNING

Season: Mid-March to late May at 42-62°F.

Site: Current-swept lake shores and shoals, harbors, and riffles in streams.

Substrate: Eggs are deposited under stones or logs on bottom of gravel, rubble, boulders, sand, or firm loam; possibly other substrate if shelter is available; spawning may also occur on rock breakwalls.

Water Depth: 6-14 in.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate where deposited on undersides of stones or logs, or among gravel or on vegetation.

Duration: Eggs hatch in about 7 weeks.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae drop to substrate; larvae may remain near spawning site for several days; young-of-the-year (YOY) are pelagic for short time, then concentrate under rocks along exposed shorelines or in harbors.

Substrate: Rock, rubble, gravel, or vegetation; YOY may move to mud bottom in mid-July.

water Depth: Larvae to 50 ft; YOY 0.6 in. long at 2-10 in.

REFERENCES

Faber 1963, 1967; Fish 1929; Greeley 1927; Hankinson 1908; Hann 1927; Koster 1936; Ludwig and Norden 1969; Manion 1977; Price and Kelly 1976; Reighard 1915; Ricker 1934; Smith 1922; Speare 1958; Turner 1922; Winn 1958.

SLIMY SCULPIN

MIGRATION OF ADULTS

Prespawning: Move from deep water to intermediate depths or to shorelines.

Postspawning: Gradually return to deeper water during summer.

SPAWNING

Season: Late March-late July, usually May and June, at 41-52°F.

Site: Current-swept lakeshores and tributary rapids; swiftest current is avoided.

Substrate: Eggs are deposited under stones or logs on bottom of rubble, boulders, or gravel; possibly sand or mud if shelter is available; spawning may occur on rock jetties.

Water Depth: More than 1 ft in streams - 270 ft in lakes.

INCUBATION AND HATCHING

Site: Adhesive eggs incubate where deposited on underside of stones or logs.

Duration: Eggs hatch in about 4 weeks.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Prolarvae drop to substrate; larvae may remain near spawning site for several days; young-of-the-year are found inshore, among rocks, and near jetties.

Substrate: Pock, hard clay.

Water Depth: 40-76 ft, mainly at midlevel in the hypolimnion.

REFERENCES

Hubbs and Lagler 1958; Koster 1936; Price and Kelly 1976; Quick 1971; Scott 1967; Scott and Crossman 1973.

SPOONHEAD SCULPIN

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPAWNING

Season: Perhaps late summer or early fall; males collected August 1 at 40°F were running **ripe**^{1/}, and females collected in August had large eggs.

Site: Perhaps offshore; also in harbors.

Substrate: Eggs may be deposited under stones or logs on rock bottom.

Water Depth: Running-ripe males were collected at 140 ft.

INCUBATION AND HATCHING

Site: Eggs probably incubate where deposited.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Perhaps harbors.

Substrate: No information.

Water Depth: Young-of-the-year 1.1 in. long found at 73 ft in late August.

REFERENCES

Balon 1975; Delisle and Van Vliet **1968**^{1/}; Fish 1929; Scott and Crossman 1973.

^{1/} Quebec

FOURHORN SCULPIN

MIGRATION OF ADULTS

Prespawning: No information.

Postspawning: No information.

SPANNING

Season: November-May, mainly mid-winter; spawning may occur all year; ripe adults are also found in May-August.

Site: Offshore.

Substrate: Eggs are probably deposited underneath objects on bottom of rock or gravel.

Water Depth: Greater than 240 ft; ripe adults collected at 690 ft.

INCUBATION AND HATCHING

Site: Eggs probably incubate where deposited.

Duration: No information.

DISTRIBUTION AND MOVEMENT OF YOUNG

Site: Postlarvae may be found along shore just after ice breakup; young-of-the-year (YOY) are found offshore, and also in nearshore waters, including bays and harbors, when low water temperatures prevail.

Substrate: Rock, boulders.

Water Depth: Greater than 20 ft; YOY 0.8 in. long to 714 ft; at lesser depths if water cold enough; larvae usually in hypolimnion.

REFERENCES

Balon 1975; Eddy and Underhill 1974; Fish 1929, 1932; Dymond et al. 1929; Scott 1967; Scott and Crossman 1973.

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