Summary of Biological Information on Rudd *Scardinius erythrophthalmus*

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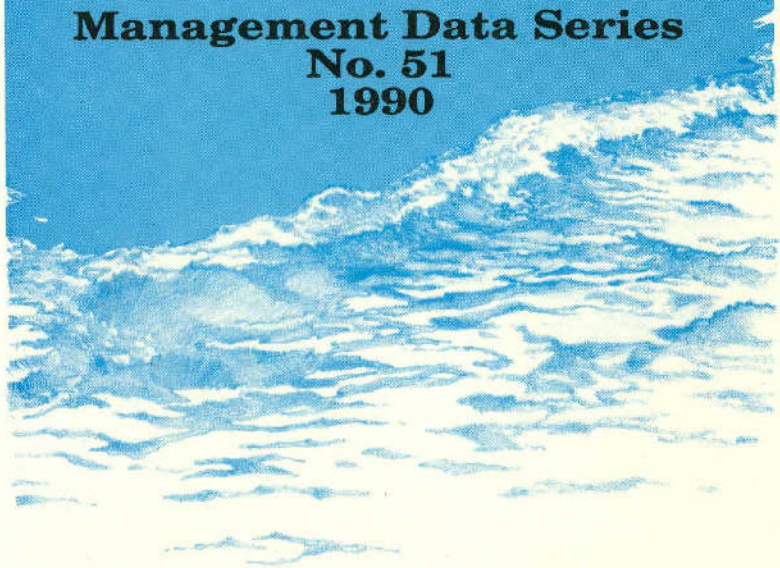

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ABSTRACT

Rudd Scardinius erythrophthalmus is a cyprinid that is deep bodied and laterally compressed with variable color. It is native to most of northern Europe as well as parts of central Asia and USSR. Rudd has no value as a commercial food fish or sport fish in the United States and is used primarily for bait. It has been reported in 16 states including Texas. It is very hardy and can survive in waters of relatively poor quality. It is morphologically very similar to golden shiner Notemigonus crysoleucas and hybridization between the two species has occurred. Rudd is an omnivore but plants constitute a major component of its diet. Habitats suitable for rudd exist in Texas and coupled with its adaptability, omnivory, hardiness and tolerance to diseases, the spread of this species is likely to occur.

INTRODUCTION

Rudd Scardinius erythrophthalmus (Cyprinidae) are native to most of northern Europe as well as parts of central Asia, Asia Minor, and northern USSR (Hensley and Courtenay 1980). They occur in the Ural and Emba Rivers, the Aral Sea Basin, the Gulf of Finland, the Bay of Volkhov in Lake Ozero, and in the Caspian Sea (Courtenay et al. 1984).

Rudd have been introduced into Ireland, Australia (Williams and Jennings 1988), Northern Island of New Zealand (Cadwallader 1977; Coates and Turner 1977; McDowall 1984; Williams and Jennings 1988), and the United States (Myers 1925). Rudd were first reported in the United States in Central Park Lake, New York (Myers 1925). They were collected in New York as recently as 1980 (McCann 1988). They previously occurred in Hudson County Park, Jersey City, New Jersey, but no longer occur in that state (Courtenay et al. 1984). Rudd were first collected in Maine in 1973 and are still established in that state (McCann 1988). They were established in Oconomowoc Lake, Wisconsin, but are now considered extirpated there (Courtenay et al. 1984). An overflow in a bait fish facility resulted in escapement and apparent establishment of rudd in First Creek, Lauderdale County, Alabama (McCann 1988). Rudd are being used as bait in North and South Carolina and have been sold as ornamental fish in Tennessee (McCann 1988). They are also used as bait in Arkansas, Georgia, Illinois, Kansas, Maine, Massachusetts, Mississippi, New York, Oklahoma, Texas, Virginia, and Wisconsin (Dawn Jennings, United States Fish and Wildlife Service (USFWS), National Fisheries Research Center, Gainesville, Florida, personal communication). They have been propagated in Arkansas for about 4 years. Escapement from culture facilities in Arkansas reportedly resulted in the establishment of the species in the White River drainage (McCann 1988). A recent survey indicated rudd occur or are known to have occurred in 16 states (Noel M. Burkhead, USFWS, National Fisheries Research Center, Gainesville, Florida, personal communication). Rudd have been collected in open waters in Arkansas, Illinois, Kansas, Maine, New York, Oklahoma, Texas, Virginia, Wisconsin, and Missouri (Dawn Jennings, USFWS, National Fisheries Research Center, Gainesville, Florida, personal communication).

Rudd were collected from Lake Texoma, Oklahoma-Texas on February 26, 1989 (Jimmie Pigg, State Environmental Laboratory, Oklahoma State Department of Health, Oklahoma City, Oklahoma, personal communication), and on April 19, 1989 a single specimen was collected from that lake by personnel of the Texas Parks and Wildlife Department (TPWD). A single specimen was collected from Victor Braunig Reservoir, Texas on June 13, 1989 (Robert G. Howells, TPWD, personal communication) and two specimens were collected in Calaveras Reservoir, Texas on October 17, 1989 (John Wray, TPWD, personal communication). On November 7, 1989, TPWD personnel purchased a single specimen from a bait dealer in Lake Whitney, Texas and a 295-mm TL specimen was caught in that lake November 16, 1989 (Ken Holder, TPWD, personal communication).

Possession of rudd is prohibited in Wisconsin (Mike Staggs, Wisconsin Department of Natural Resources, personal communication), Alabama, Connecticut, Louisiana, Michigan, Oklahoma, Texas, Illinois, Kansas, and Virginia. Arkansas allows the propagation of rudd for export purposes but prohibits its use as bait within the state (Larry Ryder, Arkansas Game and

Fish Commission, personal communication). Other states considering the prohibition/restriction of rudd include Massachusetts (Elli Horwitz, Massachusetts Department of Fisheries, Wildlife and Environmental Law Enforcement, personal communication) Nebraska, New York, North Carolina, and South Carolina, (Dawn Jennings, USFWS, National Fisheries Research Center, Gainesville, Florida, personal communication).

In western Europe, rudd are important sport fish because of their abundance, size and the ease with which they accept bait (Wheeler 1969). However, they are very bony and have little value as human food. Although rudd are not considered very palatable, they are fished commercially in eastern Europe (Wheeler 1969). Because of its hardiness and small size, the species is commonly used as bait (Muus and Dahlstrom 1971). Rudd have recently become a bait of choice among winter striped bass Morone saxatilis anglers in Lake Texoma (Jimmie Pigg, State Environmental Laboratory, Oklahoma State Department of Health, Oklahoma City, Oklahoma, personal communication). Pigg determined, in an informal survey of bait shops around Lake Texoma, that rudd were being sold in eight out of nine shops.

Because of the widespread use of rudd for bait and their potential negative impacts on aquatic ecosystems and capture of rudd in Texas reservoirs, TPWD was concerned about the spread of this exotic species in the waters of the state. Acting under authority granted by the 71st Texas Legislature, TPWD defined rudd as a harmful or potentially harmful exotic fish on March 7, 1990. Possession, transportation and propagation of rudd are now prohibited in Texas. This report is a summary of biological information on rudd used in making this decision. It also addresses the potential ecological impacts of this species on Texas ichthyofauna.

MATERIALS AND METHODS

The materials used in the preparation of this report were compiled primarily through literature review and personal communication. Literature search services of the Fish and Wildlife Reference Service and DIALINDEX^R Information Services also were employed. Scientists (especially those at the USFWS National Fisheries Research Center, Gainesville, Florida) engaged in rudd research also were contacted.

RESULTS

Description

Rudd is a deep-bodied and laterally compressed species with variable color. The head is usually dark green, the sides silvery to brassy yellow and the belly white (Wheeler 1969; Muus and Dahlstrom 1971; Coates and Turner 1977; Williams and Jennings 1988). The fins are reddish orange (Williams and Jennings 1988) but color variations including brown dorsal and caudal fins and

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red anal, pectoral, and pelvic fins have been observed (Wheeler 1969; Muus and Dahlstrom 1971; Wheeler 1976; Coates and Turner 1977). During the spawning season, males become brightly colored and develop white tubercles on their head and scales (Wheeler 1969).

Some of the distinguishing characteristics of rudd include yellow to orange eyes and position of the pelvic fins well in front of the dorsal fin (Wheeler 1969; Muus and Dahlstrom 1971). Rudd have 11-12 dorsal fin rays (Wheeler 1969). They have large scales, exposed portions of which are equal in diameter to the eye depth. Rudd have a sharp, scale-covered keel running between the pelvic and anal fins.

Rudd are considered to be more closely related to certain Eurasian cyprinids than to any North American group. They closely resemble and are often confused with roach Rutilus rutilus, another cyprinid sympatric with rudd. They also closely resemble golden shiner Notemigonus crysoleucas (Figure 1), a common cyprinid in North America (Hensley and Courtenay 1980). Williams and Jennings (1988) listed the morphometric and meristic characters for identifying rudd and golden shiner (Table 1). Rudd are also confused by the public in Texas with the red shiner Notropis lutrensis because of this species' orange-colored fins.

Wheeler (1976) described the morphometric and meristic characters of rudd, roach and rudd x roach hybrids. Child and Solomon (1977) provided information on electrophoretic characterization of rudd and its hybrids.

Habitat

Rudd occur in still or slow moving waters including ponds, reservoirs, and streams and overwinter in deep water. Larvae under 10 mm TL stay close to shore and at 10 mm TL, they move to deeper water (Mark et al. 1987). During the warmer months of the year, rudd feed at the surface and graze over weeds in shallow water (Kennedy and Fitzmaurice 1974). Although the species is most commonly found in lowland regions, rudd have been collected in altitudes as high as 1,829 m (Wheeler 1969) and in brackish waters (Shindler 1957).

Rudd are very hardy and can survive in water of relatively poor quality and can tolerate a wide range of water temperatures. They are found in ice-covered waters (Niederholzer and Hofer 1980), and their upper lethal temperature may exceed 34 C (Varley 1967). One subspecies of rudd S. e. racovitzai, found in the warm springs of western Romania, has adapted to water temperatures of 28-34 C (Muus and Dahlstrom 1971).

Age and growth

Growth of rudd is relatively slow (Muus and Dahlstrom 1971). Boystov (1971) concluded that rudd in the vicinity of thermal effluents in heated reservoirs had growth rates six times faster than those of fish not under the influence of thermal effluent.

Novak (1983) investigated growth of rudd in selected waters and concluded growth was slowest in central European backwaters and fastest in rivers and

lakes of southern USSR where the fish had been introduced. Kennedy and Fitzmaurice (1974) indicated fastest growing rudd were found in limestone lakes in Ireland and stunted populations were found in small weedy ponds. Rudd grow most rapidly when water temperature exceeds 13 C. Females grow faster than males (Zerunian et al. 1986). Under culture conditions, larval rudd attained a weight of 25 mg in 10 days at 15 C and 5.8 g in 100 days at 21-29 C (Breteler 1979). Growth in Lake Kastoria, Greece was fastest during the first year of life and age-I rudd averaged 53 mm TL (Papageorgiou and Neophytou 1982). Growth decreased to 21 mm/year through age IV and remained at 13 mm/year thereafter. Kubecka et al. (1985) determined the modal length of rudd in Klicava Reservoir, Czechoslovakia was 56 mm TL by the end of the first year of life.

Rudd grow to an average length of 200-250 mm, less frequently to 300 mm and only exceptionally to 410 mm and can attain a weight of 1 kg (Wheeler 1969). The maximum weight of the species will exceed 1 kg (Williams and Jennings 1988). The mean life span of the species is 7 years for males and 8 years for females (Papageorgiou and Neophytou 1982), but fish 17 years old have been reported (Kennedy and Fitzmaurice 1974).

Reproduction

Sexual maturity was attained in rudd by age I in males and by age II or older in females in Lake Kastoria, Greece (Papageorgiou and Neophytou 1982) and Lake Braciano, Italy (Zerunian et al. 1986). However, some investigators have concluded rudd mature at older ages. For example, Muus and Dahlstrom (1971) indicated maturity occurs at 2-3 years of age in European waters, and Kennedy and Fitzmaurice (1974) concluded that on the average females in 173 Irish waters spawned when 4 years old, whereas males spawned when 3 years old. Shikhshabekov (1979) found that rudd spawn at 3-4 years of age in the Dagestan River, USSR.

Rudd spawn from May through June in some parts of Europe but in southern Europe, spawning occurs in April (Muus and Dahlstrom 1971). Spawning occurred in April when water temperature reached 10 C in Piburger See Lake, Austria (Papageorgiou and Neophytou 1982; Mark et al. 1987) and from June through July in Ireland (Kennedy and Fitzmaurice 1974) and the Volga River, USSR (Shikhshabekov 1979). In the Dagestan River, USSR, rudd usually commenced spawning in June when water temperature was 18-20 C (Shikhshabekov 1979). Breteler (1979) propagated rudd fingerlings at temperatures between 21 and 29 C. Papageorgiou and Neophytou (1982) determined spawning occurred at a mean water temperature of 10 C in Greek waters. Water temperature greatly influences the onset of spawning and age at sexual maturity (Papageorgiou and Neophytou 1982).

Reports of rudd fecundity vary widely. For example, Papageorgiou and Neophytou (1982) reported the mean absolute fecundity of 71-176-mm female rudd in Lake Kastoria, Greece was 3,712 eggs (range 563-12,284); however, Muus and Dahlstrom (1971) determined fecundity of the species ranged from 100,000 to 200,000 eggs. Two or three batches of eggs are produced during a protracted spawning season. Spawning season can be intermittent because of interruptions resulting from fluctuations in water temperature (Wheeler 1969). Adhesive

eggs measure 1.38-1.75 mm in diameter and are deposited among vegetation (Muus and Dahlstrom 1971; Kennedy and Fitzmaurice 1974). Eggs hatch in 5-7 days depending on temperature and the newly hatched larvae are 5.0-5.9 mm TL (Kennedy and Fitzmaurice 1974). Fry attach to vegetation by means of an adhesive organ on their head.

Hybridization

Rudd school with several species and participate in the spawning activities of those species. Consequently, they hybridize with several species including roach, bream Abramis brama and bleak Alburnus alburnus (Muus and Dahlstrom 1971). Hybridization between rudd and golden shiner has occurred under laboratory conditions (Noel M. Burkhead, USFWS, National Fisheries Research Center, Gainesville, Florida, personal communication).

Diet

Larval rudd under 10 mm TL feed heavily on filamentous algae and at 10 mm TL, feed on benthic and pelagic cladocerans (Mark et al. 1987). The diet of older rudd consists mainly of macrophytes, filamentous algae and aquatic insects (Kennedy and Fitzmaurice 1974). Rudd also consume fish larvae, particularly those of pelagic species (Cadwallader 1977).

Although rudd are omnivorous, plants constitute a major component of their diet during some periods of their life. Macrophytes constituted 65-95% (by weight) of the diet of rudd 45-285 mm TL and along with filamentous algae, was the mainstay of the diet in Lake Warniak, Poland (Prejs 1984). The most important macrophytes, ranked in descending order (based on availability and energetics) were Elodea canadensis, Ceratophyllum dermesum, Potamogeton pectinalis, and Chara spp. In fact, rudd consumed 277 kg/hectare/year of E. canadensis. Planktonic algae were sparingly consumed by rudd.

The amount of plant forage consumed by rudd is temperature dependent. Prejs (1984) determined that rudd foraged more intensively at water temperatures between 16 and 18 C and Hofer and Niederholzer (1980) found foraging activity was higher at 16-20 C under laboratory conditions. Below 16 C, the contribution of plants to rudd diet dropped rapidly (Prejs 1984).

Foraging behavior of rudd has been suggested as a method to stimulate macrophyte production because rudd, unlike grass carp Ctenopharyngodon idella, pluck particular leaves or fragments rather than uprooting whole plants (Prejs 1984). Although rudd are primarily herbivorous, they are capable of utilizing alternative food sources when faced with drastic reductions in forage availability (Niederholzer and Hofer 1980). Rudd are efficient grazers and inefficient assimilators, suggesting they (especially in high numbers) might play a role in the eutrophication process in lakes (Prejs 1984).

Pathology

Rudd are relatively resistant to most bacterial diseases. The most common parasites of the species are acanthocephalans and the trematode Posthodiplostomulum cuticula (Kennedy and Fitzmaurice 1974).

Species interactions

Associations between rudd and other fish species have been investigated in detail. Some of the interactions examined include rudd and roach (Burrough et al. 1979; Prejs 1984; Johansson 1987), and rudd, roach, and dace Leuciscus cephalus (Mark et al. 1987). Rudd and roach are the main plant consumers in some European waters and frequently dominate in biomass and numbers. Burrough et al. (1979) investigated the decline of rudd and the coinciding increase of roach in Slapton Ley Lake, England and suggested competition during the larval phase may have been one of the primary reasons for the decline.

In their native range, rudd are found in association with other cyprinids including roach, tench Tinca tinca, bream, common carp Cyprinus carpio, barbel Barbus barbus and dace as well as pike Esox lucius, pike perch Lucioperca spp., perch Perca fluviatilis, eel Anguilla anguilla, and grayling Thymallus thymallus. They are preyed upon by pike and pike perch as well as piscivorous birds.

DISCUSSION

The use of rudd for bait and forage in Texas could be detrimental to native fishes. Although rudd have been introduced into the state, further introductions could result in their establishment in most waters containing submerged aquatic macrophytes suitable for reproduction. Vegetated habitats which are found throughout Texas would offer rudd protection from predation and provide forage and reproductive habitat. The ability to thrive in waters of relatively poor quality give rudd a competitive advantage over native game fish. Rudd will thrive in weedy, shallow farm ponds, reservoirs and streams, and tolerate brackish water and a wide range of water temperatures. Rudd are primarily herbivorous hence it is unlikely competition for plant forage will occur between this species and native game fish. Rudd could be expected to switch to animal forage if suitable plant forage is not available. Such a shift could lead to utilization of common food resources with native fishes and result in competition.

Rudd eggs laid on vegetation are likely to be consumed by native game fish such as sunfish Lepomis spp. On the other hand, rudd consumption of fish larvae may adversely impact game fishes through predation or competition for forage. The ecological adaptability of rudd and the use of this fish for bait and forage make dispersal relatively easy. The spread of rudd in Texas waters could result in their domination over native species as has occurred in some European waters.

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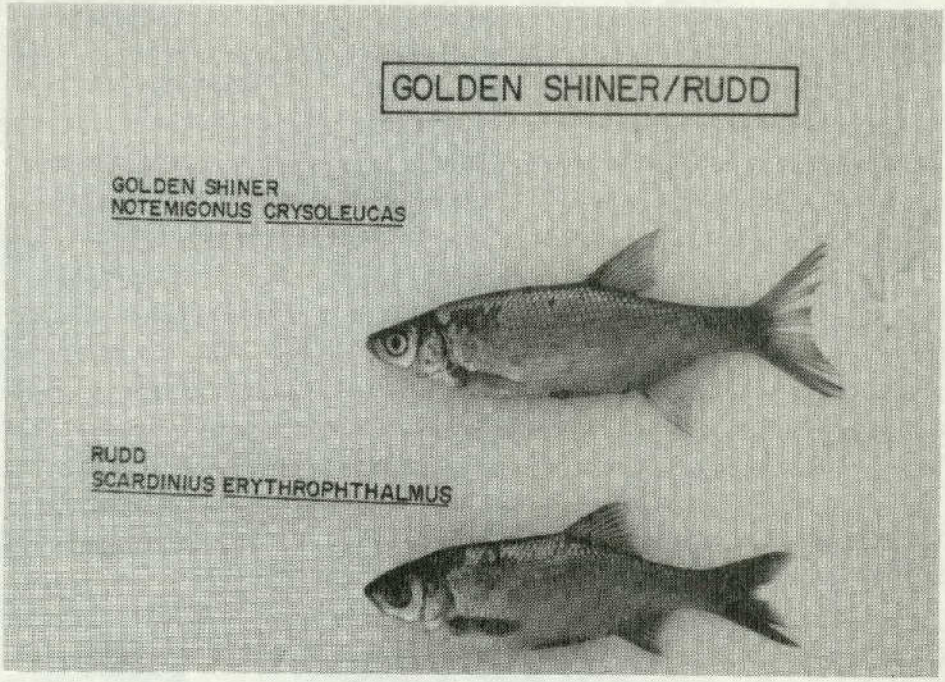
Table 1. Selected characters for separating golden shiner Notemigonus crysoleucas and rudd Scardinius erythrophthalmus. (Reproduced from (Williams and Jennings 1988), with permission).

Character	Golden shiner	Rudd
Meristic		
Lateral line scales	39-55	38-45
Scale rows above lateral line	8-11	7-8
Scale rows below lateral line	3	3-5
Dorsal fin rays	7-9	11-12
Anal fin rays	8-19	12-14
Pectoral fin rays	15-16-17	15-16
Pharyngeal teeth	0,5-5,0	3,5-5,3
Vertebrae	37-39	35-38
Gill rakers	17-19	9-12
Fin pigmentation	median fins red-orange only in large nuptial males	median fins red-orange in juveniles ≥ 38 mm TL
Morphometric		
Length	up to 310 mm TL	up to 410 mm TL
Body depth	greatest in front of pelvic fin origin	greatest near pelvic fin origin
Head length/standard length	21-22%	25%
Body depth/standard length	33%	31-37%
Eye diameter/head length	26-28%	21-28%
Head shape	triangular profile	short, triangular
Dorsal fin origin	well behind pelvic fin base	posterior to pelvic fin
Gill rakers	fine	moderately stout
Mid-ventral keel	naked	scaled
Tooth morphology	crown hooked, smooth	crown hooked, crenate
Dorsal fin shape	tips of anterior rays much longer than posterior rays when fin is depressed	tips of anterior about equal to posterior rays when fin is depressed

Figure 1. Morphological comparison of golden shiner Notemigonus crysoleucas and rudd Scardinius erythrophthalmus.


GOLDEN SHINER/RUDD
GOLDEN SHINER
NOTEMIGONUS CRYSOLEUCAS
RUDD
SCARDINIUS ERYTHROPHTHALMUS

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