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# Movement of Rainbow and Brown Trout in Relation to Water Quality and Food Availability in Lake Ogallala, Nebraska

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# MOVEMENT OF RAINBOW AND BROWN TROUT IN RELATION TO WATER QUALITY AND FOOD AVAILABILITY IN LAKE OGALLALA, NEBRASKA

by

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# MOVEMENT OF RAINBOW AND BROWN TROUT IN RELATION TO WATER QUALITY AND FOOD AVAILABILITY IN LAKE OGALLALA, NEBRASKA

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Lake Ogallala has been maintained as a put, grow, and take trout fishery since 1941, but recent competition from other species and water quality problems have led many to question its future. Electrofishing, tag/recapture, and ultrasonic telemetry were used to identify rainbow and brown trout use of and movement within four lake sections which varied in mean depth, water flow, temperature, dissolved oxygen, and macrophyte and macroinvertebrate abundance. Tagged rainbow trout did not move out of cool water areas with low dissolved oxygen but did move out of a warmer aerated section where food abundance was lowest. Tagged brown trout moved into the aerated section when temperature was similar in all sections. An aeration system installed in 1998 does not appear to have improved trout habitat, but a system that does not break stratification and maintains cooler hypolimnetic water temperatures may be more effective. Improving dissolved oxygen levels in sections influenced by hydroelectric discharge from July through September would likely be more effective at preventing trout from leaving the lake and improving growth rates.

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# INTRODUCTION

## Study Site

Lake Ogallala is a 263-hectare tailwater reservoir located below C.W. McConaughy Reservoir (Lake McConaughy) on the North Platte River in western Nebraska (Figure 1). Lake Ogallala was formed by excavation of earth to build Kingsley Dam in 1940-41 and consists of two distinct basins. The main basin, oriented north to south, has a surface area of 103 ha with a mean depth of 7 m and a maximum depth of 12 m. The Keystone basin, oriented east to west, has a surface area of 160 ha with a mean depth of 1.7 m and maximum depth of 4 m. Water levels are controlled by discharges from the Kingsley Hydropower Plant and releases of water from Lake Ogallala into the Sutherland Supply Canal and North Platte River. The hydropower plant generally discharges cool (<20°C), hypolimnetic water year round taken from approximately 44 m beneath the surface of Lake McConaughy. Lake Ogallala has been managed as a put, grow, and take trout fishery since its inception in 1941 (Madsen 1966).

The mean surface elevation of Lake Ogallala is approximately 3124.7 ft above mean sea level and fluctuates between 3122.0-3126.5 ft. The lake can be divided into four sections based on geographic restrictions (Figure 1). The surface area of sections A, B, and C are similar at 328,412, 375,335, and 325,541 $m^2$ respectively (Table 1). Section D has a larger surface area than A, B, and C combined at 1,258,256 $m^2$. Although section D makes up 55% of the surface area, it holds only 22% of the water volume in Lake Ogallala. Section C holds the largest volume of water followed by B, A, and D in decreasing order (Table 1). Section C has a mean water depth of 8.3 m, followed by B at 7.1 m, A at 6.9 m, and D at 1.7 m.

The average bimonthly discharge of water from Lake McConaughy from March through October 1999 ranged from 24,488 x $10^3$ $m^3$ during 1-15 May to 154,418 x $10^3$ $m^3$ during 16-31 July (Table 2). Considerably more water was discharged from Lake McConaughy during March through October 2000 totaling 1,245,768 x $10^3$ $m^3$, compared to 1,097,866 x $10^3$ $m^3$ during the same time in 1999. More than 64% of the total discharge during March through October 2000 occurred from June through August (Table 3).

Discharge of water into the Sutherland Supply Canal in 1999 followed the pattern of the hydroplant and ranged from an average of 21.2 $m^3$/s in early May to 49.0 $m^3$/s in late August (Table 2). Discharges into the North Platte River were more variable and were significantly higher on average from March through August 2000 than the same time in 1999. Average discharge into the river ranged from 0.7-14.6 $m^3$/s from March-May 2000 and 34.4-73.5 $m^3$/s from June-August. The average release of water from Lake Ogallala peaked at approximately 116 $m^3$/s from 16-31 July in 1999 and at 124.2 $m^3$/s from 16-30 June in 2000 (Tables 2,3).

Several factors in the 1980's combined to bring physical, chemical, and biological changes to Lake Ogallala. Completion of the hydropower plant in 1985 eliminated the natural aeration process that occurred during the discharge of water from Lake McConaughy (Madsen and Eichner 1996). The anoxic water now has to be aerated using a spray discharge from a high-pressure valve. Discharge from this valve bypasses the hydroelectric generation unit and thus results in reduced revenues for its operator, Central Nebraska Public Power and Irrigation District (CNPPID). Water is discharged through the bypass valve to maintain minimal dissolved oxygen conditions at the buoy line below the outlet structure set forth by the Nebraska Department of Environmental Quality. Unfortunately, these standards appear to be ineffective at keeping oxygen levels in section D of Lake Ogallala high enough to avoid chronic episodes of rainbow trout mortality (D. Eichner, Nebraska Game & Parks Commission, personal communication).

In addition to water quality standards set for all surface waters of the state of Nebraska, site-specific criteria have been developed for Lake Ogallala (Nebraska Department of Environmental Control 1988). The following criteria apply from 1 July-15 October at daily mean hydroplant discharge temperatures of 18°C or less: dissolved oxygen must not fall below 3.0 mg/L, have a daily mean less than 4.0 mg/L, or a 7-day mean of less than 4.3 mg/L. If the mean daily water temperature rises above 18°C from 1 July-15 October then dissolved oxygen standards increase to: one-day minimum of not less than 4.0 mg/L, 7-day mean minimum of not less than 5.0 mg/L, and a 30-day mean of not less than 6.5 mg/L.

Alewife were introduced into Lake McConaughy in 1986, to supplement a declining gizzard shad (*Dorosoma cepedianum*) population. Movement through the hydroplant resulted in their establishment in Lake Ogallala by 1989 (Madsen et al. 1992). This led to a shift in zooplankton size structure by reducing numbers of larger (>1 mm) daphnids and copepods and increasing numbers of small bosminids and rotifers (Madsen et al. 1992; Laux 1996). Herbivory and sediment disturbance from large carp and white sucker populations led to declines in macrophyte production and diversity from 1989 to 1995, reducing benthic invertebrate production (Harris and Gutzmer 1996; Laux et al. 1996). Fresh weight biomass of aquatic plants declined from an average of 6,887 g/m$^2$ in 1989 to 20 g/m$^2$ by 1995 (Harris and Gutzmer 1996). Frequent water level fluctuations of up to 1.5 m per day periodically expose some macrophyte and invertebrate communities, which can lead to reduced density and diversity of benthic macroinvertebrates versus areas that are continually immersed (Fisher and LaVoy 1972).

Due to the deteriorating trout fishery and abundant non-game fish species, the Nebraska Game & Parks Commission (NGPC) performed a chemical eradication of the fish community on October 10, 1997. The objectives were to improve water quality, increase macrophyte production and the size of zooplankton, and to improve trout survival, growth, and catch rates (Madsen and Eichner 1996). Since the renovation, catchable size rainbow trout have been stocked regularly to provide a fishery for anglers, and brown trout have been stocked for the primary purpose of controlling alewife densities. A 20-inch minimum length limit has been in effect for brown trout since the renovation.

Two mechanical aeration systems were installed in the main basin to eliminate stratification and circulate water from the bottom to the surface where it can be oxygenated. Operation of the first system, located in section A, began on 4 June 1998, while the second system, located in section B, began operation on 14 July 1999. The aerators were scheduled to run from May through September with the goal of attaining dissolved oxygen concentrations of 6 mg/L or more, one meter from the bottom during July, August, and September (Madsen and Eichner 1996). The system in section B was not operated in 2000 apparently because of its limited effectiveness in 1999. Approximately 71,000 and 66,000 catchable size (20-30-cm total length) rainbow trout were released into Section A (north basin) of Lake Ogallala from March through December 1999 and March through October 2000 respectively (Table 4). Four strains of rainbow trout were stocked: Fish Lake DeSmet, Erwin, fall, and Shasta, in order of decreasing number. Approximately 20,000 catchable size brown trout were stocked each year during March, April, and September in 1999 and March, April, and October in 2000 (Table 5). Seeforellen strain trout were stocked in the spring and Wild Rose strain trout were stocked in autumn in approximately equal numbers.

## Literature Review

Establishing and maintaining conditions favorable to fish survival and growth over the entire year is necessary for the success of a put, grow, and take fishery. Some stocked fish are bound to leave an open tailwater system, but controlling emigration through habitat manipulation can be an important management tool. Seasonal changes in temperature and dissolved oxygen due to thermal stratification or releases of water from a hydroelectric facility may expose fish to conditions unfavorable for growth or cause them to move out of the system. Lake Ogallala has been considered the most important trout fishery in Nebraska, however recent competition from non-game fish populations along with chronic water quality problems have led many to question its future. Low dissolved oxygen (DO) levels due to summer stratification and hypolimnetic releases from Lake McConaughy have been persistent concerns for managing Lake Ogallala since the construction of the Kingsley Hydropower Plant in 1985. Barrow (1998) concluded that increased macroinvertebrate densities and dissolved oxygen concentrations after a chemical renovation in 1997 significantly improved the length of time rainbow trout (*Oncorhynchus mykiss*) remained in Lake Ogallala before leaving into the Sutherland supply canal or North Platte River.

## Trout movement

Hansen and Stauffer (1971) found that the primary direction of movement of stocked rainbow trout in the Great Lakes to be down-lake, with migrations of 100 miles or more being common. Jenkins (1971) found that dispersal of rainbow trout following release was extensive, but apparently resulted from individual differences in response to the habitat. Large groups of schooling trout sometimes undertook radical movements that individuals or small groups normally wouldn't have. Some rainbow trout released below a reservoir in Tennessee were caught 80-90 miles downstream (Parsons 1956). Van Velson (1974) monitored a self-sustaining rainbow trout population in Lake McConaughy and found that juveniles migrated from tributary streams to the reservoir in the spring. Certain strains of stocked rainbow trout have been shown to exhibit more significant movements than others (Moring and Buchanan 1978).

High flows from runoff events or discharges from a peaking hydroelectric facility may influence fish movement (Cushman 1985; Niemela 1989). Rainbow trout in a Tennessee tailwater moved into refuges along the stream bank at the onset of a generation surge and remained there until the surge had resided (Niemela 1989). Fourteen of the 20 rainbow trout that were displaced by surge events moved upstream. Only three of seventeen juvenile rainbow trout in a Wyoming tailwater were displaced when flow was increased eight-fold, and those moved upstream into slower-velocity refugia (Simpkins et al. 2000). Adult rainbow trout behavior was variable in a California stream as some remained in higher-velocity habitat and some moved horizontally into slower-velocity refugia during increased discharge from a peaking hydropower facility (Pert and Erman 1994).

## Dissolved Oxygen

Reduction in the level of dissolved oxygen has a significant effect on physiological, biochemical, and behavioral processes in fish. Van Velson (1974) defined trout supporting water as 21.1°C or colder containing at least 3.0 mg/L dissolved oxygen. Mathias and Barica (1985) found that at dissolved oxygen concentrations below 5 mg/L, fingerling rainbow trout died showing symptoms of asphyxia. Davis (1975) found that freshwater salmonids showed symptoms of low-oxygen stress at an average DO concentration of 6.00 mg/L at average temperature of 15°C, and that at 4.16 mg/L a large proportion of the fish population may be affected, severely if exposed beyond a few hours. He suggested that this level should be applied only to populations of marginal significance or marginal economic importance, and are dispensable.

## Temperature

Water temperature can also have a direct effect on the distribution and movements of salmonids. Dissolved oxygen, temperature, and time of year appeared to be the most important variables affecting trout movements in Lake Ogallala in 1997-98 (Peters et al. 1999). Over two years, 84% of all ultrasonically tagged fish were located in water temperatures between 9.1 and 18.0°C and 73% were in DO concentrations between 6.1 and 13.0 mg/L. Cherry et al. (1975) found that rainbow trout preferred water between 15° and 18° C and that temperatures above 24°C resulted in mortality. Rainbow trout in an artificially oxygenated lake avoided shallow water where water temperature exceeded 20°C (Overholtz et al. 1977). Horak and Tanner (1964) found that rainbow trout and white suckers were more abundant at depths where water temperature was 19-21°C, while Tabor et al. (1996) found that during summer stratification, rainbow trout inhabited the metalimnion at approximately 18-19°C. Wurtsbaugh and Davies (1977) concluded that optimal temperatures for rainbow trout growth are 16-17°C. The scope for activity of rainbow trout increased as temperature increased from 5° to 20°C to but decreased between 20° and 25°C (Dickson and Kramer 1971). Rainbow trout in a reservoir in Kentucky selected water temperatures of 12-16 °C in late summer, however they were apparently restricted by DO levels <3.1 mg/L below that depth (Jones 1982). Fingerling rainbow trout in vertical and horizontal temperature gradients selected for a 17-20°C range (McCauley and Pond 1971). A summary of studies indicating preference or avoidance of rainbow trout to water temperature is detailed in Table 6.

All tagged adult brown trout (*Salmo trutta*) in a coolwater reservoir in Washington moved into tributary streams that were 16°C when temperatures exceeded 19°C in the reservoir (Garrett and Bennett 1995). Movements into tributaries were not observed the following year when reservoir temperatures were cooler. McMichael and Kaya (1991) found that as water temperature in a stream exceeded 19°C, rainbow and brown trout catch rates declined and were unsatisfactory to anglers. They concluded that preventing water temperatures from exceeding 19°C should be a management objective for waters supporting brown trout. Schulz and Berg (1992) found tagged adult brown trout to prefer a water temperature of 14°C.

### Food selection

Availability and preference of food can also influence fish movement and the types of habitat selected. Rainbow trout movements in a small Ontario lake appeared to be influenced by food availability (Betteridge 1985). All rainbow trout stomachs examined during May and June contained Chironomidae larvae or pupae. Rainbow trout will eat a variety of prey including large zooplankton, crustaceans, insects, snails, leeches, and fish. Rainbow trout in Lake DeSmet, Wyoming consumed cladoceran zooplankton most frequently, however insects contributed the most biomass to their diet (Hubert et al. 1994). Insects, primarily chironomids (89% by number) became increasingly important during summer. Diet selection did not vary significantly between 50-mm size classes as fish were found in only 1.5% of stomachs and accounted for 14% of total food biomass.

The gill rakers of rainbow and brown trout are widely spaced, making them unable to retain smaller zooplankton. Galbraith (1967) found that rainbow trout 21-43 cm long fed only on *Daphnia* spp. that were usually >1.3 mm in size even though there were many other genera of zooplankton present. Warner and Quinn (1995) concluded that depth and movement patterns of tagged rainbow trout in Lake Washington suggested feeding on *Daphnia pulicaria* during the day, spending 90% of their time within 3 m from the surface. A later study showed that small rainbow trout < 250 mm FL in Lake Washington ate primarily *D. pulicaria* during summer and autumn while larger trout ate fish throughout the year (Beauchamp 1990). Consumption of fish increased to over 90% of the diet, by weight, for rainbow trout over 350 mm, even though large rainbow trout (>250 mm) continued to consume *Daphnia* at a rate similar to that of smaller trout. Large rainbow trout fed on *Daphnia* during daylight and on fish during twilight (Beauchamp 1990).

*Daphnia pulex* made up 99.7% and 94.4% of zooplankton found in rainbow trout and kokanee stomachs, respectively in Flaming Gorge Reservoir, even though they represented only 14.0% of the zooplankton available (Schneidervin and Hubert 1987). Rainbow trout ate the largest daphnids (mean length =1.70 mm) and along with kokanee, they showed negative selectivity for daphnids <1.2 mm long. Dipteran pupae and chironomids accounted for 74% of the diet of brown and rainbow trout in a California reservoir (Marrin and Erman 1982). *Daphnia* spp., which were two to five times larger, were preferred over *Bosmina* spp. and copepods. Piscivorous brown and rainbow trout were generally longer than 300 mm and fed primarily on small fish and crayfish. Large *Daphnia* spp. appeared to be the preferred prey item of rainbow trout in two reservoirs in Utah, and growth rates declined when alternative prey composed a large portion of the diet (Tabor et al. 1996). Maximum rainbow trout consumption was most closely correlated to total daphnid biomass. For the first month after stocking, juvenile rainbow trout fed extensively on large (1.5-2.5 mm) daphnids. This pattern continued throughout the year in the reservoir where daphnids were abundant, while in the reservoir where they were less abundant, ingested daphnids were smaller throughout the year, declining from 1.9 to 1.45 mm. As daphnids became progressively less important, snails, aquatic and terrestrial insects, tubificid worms, and algae became more important. Small rocks and pieces of wood were also present in many rainbow trout stomachs.

Small rainbow trout in Lake Michigan fed primarily on invertebrates year round but also ate fish in the fall, while larger rainbows fed primarily on fish (Jude et al. 1987). Brown trout fed on alewife (*Alosa pseudoharengus*) year round, which made up 78-90% of their diet by weight. Alewife were the preferred prey of all five salmonines studied. Large brown trout (> 280 mm) in a Virginia creek ate several fish species, ranging in length from 25 to 110 mm, consistently from May through November while small trout rarely ate fish (Garman and Nielsen 1982).

During 1997-1998, rainbow trout in Lake Ogallala fed primarily on chironomid larvae and pupae, corixidae, and terrestrial insects (Peters et al. 1999). Zooplankton made up less than 1% by number of organisms found in trout stomachs, due to the low abundance of large zooplankton (Laux et al. 1996). Gastropods made up 8.7% of the organisms eaten after the renovation compared to just 0.38% before, indicating an increase in gastropod abundance apparently resulting from an increase in macrophyte growth after the renovation (Peters et al. 1999).

Production of submerged macrophytes is important for providing habitat for benthic invertebrates. Johnson and Brinkhurst (1971) found a distinct littoral assemblage of invertebrates associated with macrophytes including chironomids, isopods, amphipods, mayflies, and lepidopterans. Barrow (1998) concluded that rainbow trout in Lake Ogallala selected areas where macrophyte growth was highest because of the higher density of invertebrates. Common carp often use submergent macrophytes and the edges of cattail marshes for breeding and foraging, which results in the altering of habitat by uprooting plants and disturbing sediment (Painter et al. 1988). Harris and Gutzmer (1996) found a decline in macrophyte production in Lake Ogallala in the early 1990's and concluded that it was likely due to herbivory and sediment disturbance by carp (*Cyprinus carpio*) and white sucker (*Catastomus commersoni*) populations. Macrophyte growth and macroinvertebrate abundance increased in 1998 and 1999 after the chemical removal of all fish in 1997 (Peters et al. 1998, 1999).

Competition from planktivores can negatively effect trout growth and survival (Hutchinson 1975; Fraser 1978; Schneidervin and Hubert 1987). Fraser (1972) found that recoveries of stocked brook trout (*Salvelinus fontinalis*), rainbow trout, and splake (*S. fontinalis* x *S. namaycush*) were considerably lower in lakes inhabited by white suckers, minnows, and spiny-rayed species. A survey of 26 Quebec lakes indicated similar competitive effects of white sucker on brook charr populations, significantly reducing charr yield (Magnan 1988). Introductions of alewife into freshwater lakes have been shown to alter zooplankton populations from large daphnids and copepods to smaller bosminids and rotifers (Brooks and Dodson 1965; Lackey 1969; Wells 1970; Brown 1972; Hutchinson 1975; Kohler and Ney 1981; Mills et al. 1992; Laux 1996). Unfortunately controlling alewife populations in cool water fisheries is difficult since they have a similar temperature preference range to trout, approximately 11-21°C (Otto et al. 1976).

### Ultrasonic telemetry

The study of fish movement patterns using ultrasonic telemetry has steadily improved and become more popular since it's development in the 1950's. Telemetry provides an opportunity for continuous surveillance without the disturbance of recapture, but in order to obtain useful results the transmitter must not interfere with the normal behavior of the fish. Three methods of attachment have been developed and tested: surgical implantation, gastric implantation (stomach), and external attachment. Due to recent technological advances that have reduced transmitter size and weight, surgical implantation has become popular and is considered the best method for long-term attachment (Stasko and Pincock 1977; Tyus 1988; Lucas 1989; Moore et al. 1990; Martin et al. 1995; Winter 1996). Advantages of surgical implantation include not creating external drag forces while swimming, not being lost or entangled in vegetation, and being close to the fish's normal center of gravity. Stomach tags have been found to interfere with the digestive process, affecting growth and feeding behavior, and may be regurgitated shortly after attachment (Hart and Summerfelt 1975; Mellas and Haynes 1985; Adams et al. 1998). External transmitters have been shown to impair swimming performance in rainbow trout (Lewis and Muntz 1984; Mellas and Haynes 1985).

**Objectives**

1) Estimate the proportion of lake volume defined as suitable and optimal rainbow trout habitat in each section monthly from March through September 1999 and 2000.
2) Estimate the frequency of use of lake sections by newly stocked and resident rainbow and brown trout and use this to quantify possible affects of mechanical aeration.
3) Identify movement patterns between lake sections and out of the lake into the Sutherland Supply Canal and North Platte River by newly stocked and resident rainbow and brown trout.
4) Identify movement patterns within lake sections by resident rainbow and brown trout.
5) Relate movement patterns and frequency of use to food availability, water residence time, and water temperature and dissolved oxygen concentration.

Answering these questions will help determine if current management objectives are being met and will benefit future decisions in returning Lake Ogallala to a quality trout fishery.

## METHODS

This study took place in two phases. Phase 1 involved ultrasonic tagging of newly stocked and resident rainbow and brown trout and subsequent location of these fish from March 1999 through January 2000. Phase 2 implemented a mark-recapture study and electrofishing survey in conjunction with ultrasonic tagging of resident rainbow and brown trout as well as ultrasonic tagging of newly stocked rainbow trout from March through September 2000.

### Phase 1.

Ultrasonic transmitters were surgically implanted in hatchery trout weighing >200 g so transmitter weight in air was <2% of the fish's body weight (Meyers et al.1992; Winter 1996). These transmitters were 28 mm in length, 8 mm in diameter, weighed approximately 4 g in air, and had an estimated battery life of 60 days.

Large (750-950 g) rainbow trout captured from Lake Ogallala by night electrofishing during June and September 1999 and were implanted with transmitters that were 45 mm in length, 14 mm in diameter, weighed approximately 12-14 g and had a battery life of 12 months.

Surgical procedures were similar to those used by Hart and Summerfelt (1975) and Barrow (1998). Fish were anesthetized for surgery in a bath of 50-100 mg tricaine/L of water. Upon total loss of equilibrium (3-5 minutes), each fish was held with its head and gills immersed in a tub of fresh water and its abdomen out of water for surgery. A 1-2 cm incision was made through the peritoneum just to the side of the midventral line, approximately 1 cm anterior to the pelvic girdle. The transmitter was disinfected in alcohol, inserted into the body cavity, and two or three individually knotted nylon sutures were used to close the incision. Fish were placed into a cage or tank of fresh water to complete recovery. All smaller hatchery trout were released into section A one day to two weeks after surgery along with several thousand other trout. Larger resident trout were released immediately after complete recovery from anesthesia to minimize undue stress from being confined during potentially fluctuating water levels or periods of poor water quality.

Each fish was located three to five days per week from May through 8 August in 1999 and weekly to biweekly the rest of the year using a Sonotronics model USR-5W receiver and directional hydrophone attached to a 2.5-cm PVC pipe. An outboard motor-propelled boat was used to search for fish by stopping every 100-300 m along longitudinal transects to listen for signals. Searches for fish that had been previously located were begun near their last location to minimize time spent searching. Fish were located primarily by passing over them until the signal was equally strong in all directions or strongest straight below the boat. Fish locations were documented on a map and/or using a global positioning system. Transmitters did not allow location of trout vertically in the water column so water column depth was measured to the nearest 0.1 m at each location using a sonar unit. Dissolved oxygen and temperature readings were taken weekly at the surface and each meter to the bottom in each lake section using a YSI model 85 meter. Fish were located either in the morning or evening depending on other scheduled field sampling, equipment availability, and weather conditions.

**Phase 2.**

Resident rainbow and brown trout were captured by electrofishing the entire shoreline of each lake section in March and monthly from May through September 2000.

Catch per unit effort was the number of trout caught per 100 m sampled. Up to ten trout of each species from each site were kept and preserved for stomach content analyses. All other captured trout were identified and measured for weight and total length. Some trout were anesthetized with carbon dioxide gas, but due to a violent increase in activity during the first 30 seconds and difficulty in controlling the level of anesthesia, it was not used consistently. All captured trout over 180 g in weight were assumed to have been present in the lake for at least two weeks and were marked with numbered T-bar anchor tags with colors specific to each section and immediately released. All hatchery trout were released into section A so including these in the survey was not only logistically impossible at times but also likely would have overshadowed the movement of resident trout. A creel survey implemented by the NGPC was utilized to gather information from angler catches of tagged fish, and drop boxes were used to gather voluntary catch information. Rewards were offered by the NGPC and advertised at the drop boxes to facilitate tag return and submission of catch information. Recaptures of tagged fish were also recorded during subsequent electrofishing.

Tag/recapture data were analyzed using a generalized logits model to determine significant ($\alpha \leq 0.05$) trends in trout movement between sections (Stokes et al. 2000). Analysis of variance was performed on the electrofishing data using the Statistical Analysis System® (SAS, SAS Institute 1989) to detect differences in trout relative abundance between months and/or between sections. Due to the lack of section replication within months, variance of trout density was estimated assuming a Poisson distribution using the formula: $s^2_{\mathrm{DST}} = n/(2wL)^2$, where $n$ = number of trout captured, $w$ = width of transect sampled, and $L$ = length of the transect sampled (Young and Young

1998). Data were also grouped into bimonthly periods: March/May; June/July; and August/September; as well as March/May/June and July/August/September to provide some replication and to test for seasonal differences in catch per unit effort between sections and time periods.

I attempted to implant three resident rainbow and/or brown trout from each section every other month with ultrasonic transmitters. From March through August, 39 resident rainbow trout were implanted and immediately released into the section where they were captured. In March and May, 16 newly stocked trout were also implanted with 30-60 day transmitters before release into section A, along with several thousand other trout. Water depth was documented at each fish location and dissolved oxygen and temperature profiles were taken weekly in each section. These fish were located once or twice weekly and the section they inhabited was documented. New fish were implanted each month to maintain approximately ten active transmitters in the lake.

Rainbow trout locations were subdivided into three time periods: 1) sunrise to 1300 hours, 2) 1300 hours to sunset, and 3) sunset to sunrise, to determine diel selection of water column depths. The sun was at its zenith at approximately 1300 hours at the study site. Analysis of variance was performed to detect differences in diel use of water column depth using SAS.

Locations of resident and newly stocked rainbow trout were analyzed using a likelihood ratio chi-square analysis to determine if annual or seasonal selection of lake sections took place (Manly et al. 1993). If chi-square tests were significant ($\alpha=0.05$) then a selection ratio was calculated at a 95% confidence interval for all population parameters using the formula $(1-\alpha/n)*100\%$ at $\alpha=0.05$ (Manly et al. 1993). Chi-square tests were performed and selection ratios were calculated using both proportions of total surface area and of total volume of each lake section as available habitat resources. Significance for selection ratio analyses was defined as $P \leq 0.05$ for all categories. Section surface area and volume (Table 1) were calculated from a digital orthophoto using Arcview® 3.2 software (Environmental Systems Research Institute 1999) and from a bathymetric map (CNPPID 1992) from which cross-sectional areas of depth contours were calculated using a planimeter. Volume between successive depth contours was calculated using the formula: $V=((A_1+A_2)/2)*h$ where $A_i$ = cross-sectional area of depth contour, and $h$ = height of the water column between contours.

From May through September 2000, one or more trout in each lake section were located each month at approximately three-hour intervals over a 24-hour period to identify diel movement patterns. An electric motor was used to position the boat over or near the fish with minimal disturbance. Locations were recorded with a global positioning unit and documented on a site map. Initial locations were marked with a buoy and distance and direction from buoys were estimated for subsequent locations. Water column depth was documented at each location and temperature and dissolved oxygen readings were taken at various times to identify changes in water quality. The straight-line distance between successive locations of each trout was measured using Arcview (Environmental Systems Research Institute 1999) and was standardized (m/h) to provide a minimum estimate of movement. Movements were analyzed using SAS (UNIVARIATE) to determine whether they fit a normal distribution. Due to an apparent violation of the assumption of normality necessary to perform a standard parametric analysis, movements per hour were transformed by rank and analyzed for analysis of variance between time periods, sections, and months, with possible interactions between the three. This analysis was suggested as performing equal or optimal to a Kruskal-Wallis nonparametric analysis (Dowdy and Wearden 1991) and yielded similar results.

A fixed telemetry station was installed on the Sutherland Supply Canal to document fish that had left the lake. An ultrasonic receiver and directional hydrophone that were connected to a palmtop computer were used to record signals of tagged fish that passed by the unit. Data were stored, downloaded, and analyzed later to determine which, if any, individual fish had passed. The computer recorded possible signals approximately every 20 seconds so any fish that passed by should have been recorded many times in sequence.

A regular sampling protocol was performed semi-weekly from May to September 1999 and 2000 to survey habitat and food availability aspects at eight permanent sampling sites on the lake. One site was located in section A, three were located in sections B and C combined, and four were located in section D. Temperature and dissolved oxygen data were taken using a digital meter at the surface and at 1-m intervals to the bottom. Zooplankton were sampled at the surface and 1-m intervals to the bottom using a 10-L Schindler-Patalas trap equipped with a 53-μ mesh net. Benthic invertebrates were sampled using an Ekman grab and a core-type sampler. Maximum monthly temperature and minimum monthly dissolved oxygen values at three depth intervals were calculated for each section using data compiled from this study, as well as data from Central Nebraska Public Power and Irrigation District. The proportion of suitable habitat, defined as <19°C and >5 mg/L DO, by volume were also calculated for each section on a monthly basis to observe how available habitat changed seasonally.

Water discharge data supplied by CNPPID and the Nebraska Department of Natural Resources were adapted to calculate bimonthly estimates of water flowing into Lake Ogallala from Lake McConaughy and out into the North Platte River and Sutherland Supply Canal (Tables 2,3). Data supplied for hydroplant discharge were hourly readings in acre-feet and were summed and converted to $m^3$ while data for Lake Ogallala discharge were in hourly $ft^3/s$ and were converted to $m^3/s$ as well as $m^3$ for comparison with proximity to inflow estimates.

## RESULTS

### Water temperature and dissolved oxygen (DO)

Water temperature during daytime in section A during 1999 increased to 18.0°C at a depth of 7 m by 22 June and through 11 September temperature above 8 m ranged from 17.5- 20.7°C (Figure 2). By 20 July, DO had declined to below 6 mg/L at 5-m and during the first two weeks of August it had declined to below 6 mg/L from 1-m to the bottom (Figure 3). However, by the third week in August DO levels improved to over 6 mg/L from 7 m to the surface and for the most part remained that way through September.

In section B, water temperature generally remained below 16°C through mid-August before increasing to near 18°C by mid-September (Figure 4). DO in section B remained high until the first week of July when it chronically declined to <6 mg/L from 2 m to the bottom (Figure 5). In August, DO from 2 to 4 m occasionally dropped below 5 and even 4 mg/L, declining to < 3 mg/L near the bottom. Water temperature in section C was similar to B remaining below 16°C through mid-August before increasing to above

18°C through the entire water column by mid-September (Figure 6). DO in section C was highly influenced by releases from the hydroplant and whether the aeration valve was operating at the time readings were taken (Figure 7). DO readings taken at a 1 m depth at the buoy line below the hydroplant typically fluctuated from 3.9-5.5 mg/L daily during the summer in 1999 and 2000 (Figures 8,9). DO throughout most of the water column was consistently below 6 mg/L and chronically dropped below 5 mg/L from 9 July through September.

Temperature and DO in section D were also dependent on the releases from the hydroplant (Figures 10,11). However, due to the large surface area and spatial heterogeneity in section D, both temperature and dissolved oxygen varied significantly depending on the location and time of day. All 108 readings in 1999 were taken during the daytime, when photosynthesis and more than likely wind influenced dissolved oxygen. The lowest DO readings (≈ 3 mg/L) occurred in early morning and typically in September.

The summer of 2000 was much warmer and drier than 1999 and water temperature in section A rose to over 19°C throughout the water column by 7 July, and remained between 19 and 22°C through the first week of September (Figure 12). DO typically remained > 6 mg/L from 7 m to the surface through July before decreasing to <6 mg/L by the first week of August from 5 m to the bottom (Figure 13). This decline was short-lived as DO recovered by mid-August. Water temperature in section B in 2000 rose to over 19°C by 17 August and over 20.5°C by 9 September throughout the water column (Figure 14). DO in section B was typically lower than 6 mg/L from 3 m to the bottom by 14 August before improving by approximately 9 September (Figure 15). In the middle of the night on 11 August 2000, DO was ≤ 2.65 mg/L from 3 m to the bottom.

High discharge rates and apparent depletion of the hypolimnion in Lake McConaughy in 2000 led to an increase in average DO at the buoy line below the hydroplant of approximately 1 mg/L on 13 August (Figure 9). Water temperature also increased to near 20°C by the same time and remained near or above that through 22 September (Figure 16). Conditions in sections C and D approximated those of hydroplant releases and water temperatures (Figures 17,18) were very similar and even slightly higher than in section A during this time. DO was also generally higher in section A than in C or D by August and September (Figures 19,20).

DO readings taken at a 1 m depth approximately every 3 h in section D revealed declines from 12.8 mg/L at mid-day on 26 July to 2.24 mg/L just before sunrise on 27 July (Figure 21). Readings revealed a decline from 7.27 mg/L at 1440 hours on 10 August to 3.00 mg/L at 0400 hours on 11 August (Figure 22). These low DO levels at night contributed to several apparently minor trout kills of several hundred or less in the east end of section D during July through September 1999 and 2000.

The percentage of suitable rainbow trout habitat in each section was 100% from March through June and in October of 1999 and 2000 (Table 7). From July through September, water quality began to degrade in all lake sections. Sections A and B exhibited a greater decline in suitable habitat than sections C and D in 1999 and 2000. Section A showed severe declines in July and August 1999 and had no suitable habitat during July and August 2000. By August 2000, only 2.1% of the entire lake volume could be classified as suitable rainbow trout habitat.

Temporal variation in water quality within section D is illustrated in Figures 23 and 24. These data were recorded at the gates to the river on the lake side of the Keystone diversion dam (NGPC unpublished data). Several masses of warmer, more oxygenated water apparently moved in front of the gates and were released into the North Platte River at various times as temperature and DO fluctuated several units between 15 minute readings. Figure 25 supports the indicated diel fluctuation in DO and the 10 hour duration of levels less than 4 mg/L in the east end of section D.

## Trout diet and food availability

### Diet

Rainbow trout collected while night electrofishing Lake Ogallala preyed primarily on benthic invertebrates. Chironomidae, Gastropoda, and Corixidae were the most abundant taxa in rainbow trout stomachs during 1999 and 2000. Corixidae represented 73.2% of prey items eaten by rainbow trout in section A during July-September 1999 (Figure 26). Chironomids and gastropods were consumed the most in sections B and C in both May-June and July-September representing 61.3-63.5% and 34.3-34.9% of prey items respectively. Rainbow trout in section D appeared to partially shift from chironomids in May-June (90.6%) to gastropods during July-September (45.8%), but still preyed on chironomids heavily (52.3%).

In 2000 rainbow trout in section A appeared to shift prey from chironomids in May-June (84.9% by number) to gastropods in July-September (88.0%, Figure 27). Corixids also represented 8.0% and 4.0% of food items found in stomachs during May-June and July-September, respectively. Rainbow trout in sections B and C showed a similar shift from chironomids in May-June (69.4%) to gastropods in July-September

(61.5%). Corixids increased from 1.3 to 14.5% and amphipods remained constant from 3.4 to 4.7% of total food items between the two periods. Chironomids were the most common food item of rainbow trout in section D during the entire sampling period, 98.8% in May-June and 86.5% in July-September (Figure 27). Feeding on gastropods and odonates in section D increased respectively to 6.2% and 5.7% in July-September from 0.3% and 0.0% of prey consumed in May-June in 2000.

Prey found in stomachs of brown trout were not divided seasonally or by section due to the low number of brown trout sampled. The mean weights of 24 brown trout sampled in 1999 and 43 sampled in 2000 were 319 g and 329 g, respectively and ranged from 115-1003 g. As with rainbow trout, chironomids were the most common prey consumed by brown trout during June-October 1999 (59.1%) and May-September 2000 (88.2%, Figure 28). Gastropods were also selected in high proportions in 1999 (35.0%) with corixids next (1.4%). Odonates (3.3%), isopods (2.5%), gastropods (1.9%), and amphipods (1.8%) were eaten in the highest proportions after chironomids in 2000. Only one stomach from a 577 g brown trout contained an alewife, however two dead Wild Rose strain brown trout captured in gill nets in 2000 were noticed to have fish tails protruding from their gullets upon capture. Three 90-mm alewife were removed from a 360-g brown trout, and two 151-158-mm alewife were removed from a 730-g brown trout in May and August sampling respectively. Captures of larger brown trout were rare and in order to reduce stress and quickly return them to the lake alive, few were sampled for stomach contents.

## Benthic invertebrates

Chironomids, gastropods, and amphipods were all more abundant in section D than sections A, B, or C (Table 8). Mean densities of chironomids in section D were 18,058/m$^2$ and 11,786/m$^2$ compared to 1,455/m$^2$ and 2,205/m$^2$ in section A in 1999 and 2000 respectively. Mean densities of gastropods were 2,058/m$^2$ and 4,320/m$^2$ in section D and 212/m$^2$ and 646/m$^2$ in section A in 1999 and 2000 respectively.

Chironomid larvae were usually the most abundant benthic invertebrate sampled in all sections, typically comprising > 80% of all organisms that appeared to be important in the diet of trout. Gastropods appeared in the highest proportions at the inner (shore) station of section A during May-June 1999 (58.2%) and 2000 (40.5%) before declining in July-September 1999 (20.8%) and 2000 (31.0%, Figures 29,30). The proportion of chironomids in samples from the shoreline station in section A increased from May-June to July-September, from 52.9% to 67.6% in 1999 and from 38.8% to 78.2% in 2000.

Benthic samples for sections B and C were combined because sample sites in individual sections did not adequately represent each. In 1999 chironomids dominated benthic samples (> 82.6%) followed by gastropods (2.0-5.6%) and amphipods (0-7.6%, Figure 31). Gastropods and amphipods were both at highest proportions during July-September at the shoreline station. In 2000, gastropods increased during July-September and represented 23.0 and 38.7% of the sample at the middle and outer stations respectively (Figure 32).

In section D, chironomids and gastropods were found in somewhat constant proportions throughout the summer of 1999 (77.6-90.1% and 7.0-14.6% respectively), while amphipods represented a higher proportion of organisms sampled during July-

September (Figure 33). Amphipods were also sampled in higher proportions in section D during July-September 2000 (9.8-13.3%) than in May-June (Figure 34). In 2000, gastropods were sampled in high proportions (28.6-37.6%) from May through September at the middle and outer stations in section D, while chironomids were sampled in lower proportions (55.2-61.2%).

Oligochaetes were found in only two rainbow trout stomachs in May-June 1999 and none in 2000. Oligochaetes were common and abundant in most benthos samples, but due to their small size and rare appearance in rainbow trout stomachs they are assumed a minor prey item and were not included in estimates of available prey. Oligochaetes were most abundant at the inner station in section A in May-June (> 50,000/m$^2$), making up > 89% of all organisms sampled in both 1999 and 2000. No fish or zooplankton were found in the stomachs of the 165 rainbow trout sampled.

### Zooplankton

Copepods and bosminids were the most common and abundant macrozooplankton present in Lake Ogallala during 1999-2000. In 1999, cyclopoid copepods reached a maximum length of 1.5 mm and averaged 0.6 mm, and in 2000 they reached a maximum length of 1.7 mm and averaged 0.7 mm (Table 9). In 1999, bosminids reached a maximum total length of 0.7 mm and averaged 0.3 mm, and in 2000 reached a maximum length of 1.0 mm and averaged 3.0 mm.

The largest daphnid sampled in sections A and B during 1999 was 1.2 mm long and during 2000 was 1.5 mm long. No daphnids were found before July in samples collected in sections A and B during 1999. The two largest daphnids collected in 1999-2000 were 1.7 and 1.9 mm long, were sampled in section D and were likely discharged into Lake Ogallala from Lake McConaughy. They were considerably larger than most other daphnids, which were commonly <1.2 mm total length. Mean daphnid length in 1999 was 0.8 mm and in 2000 was 1.0 mm. Rotifer species were also abundant in most samples but have minimal importance in the diet of rainbow trout and were not included in analyses.

## Ultrasonic Telemetry

### Rainbow trout

From March through December 1999, 27 rainbow trout (two resident and 25 newly stocked) were surgically implanted with ultrasonic transmitters. Newly stocked and resident rainbow trout had mean weights of 213 g and 860 g, respectively. Nine of the newly stocked trout were either removed from the lake by anglers or predaceous birds, died and/or expelled the transmitter, had their transmitter fail, or simply left the lake into the canal or river. The remaining 18 trout were located for 409 observations (43 on resident and 366 on newly stocked trout) from March through December 1999 (Table 10, Appendix 1). Newly stocked trout were given one week to disperse within or out of the lake before locations were included in analyses.

From March through September 2000, 54 rainbow trout were surgically implanted with ultrasonic transmitters. Of those, 38 were resident, and 16 were newly stocked, and 467 locations were observed (71 on newly stocked and 396 on resident trout; Table 11, Appendix 2). Newly stocked and resident rainbow trout had mean weights of 302 g and 560 g, respectively. Seven of the eight newly stocked trout that were released in March were not located after two weeks. The one trout that remained was located in section A through April before moving into section B, where it remained until mid-May when the transmitter likely expired. Only one of the eight newly stocked trout released in May was not located after the first week. Of the remaining seven, six moved out of A into B, C, or D within one week after release and the other one was caught by an angler in section B after three weeks (Appendix 2).

Seven of the 12 resident rainbow trout implanted in March 2000 and three of the 11 implanted in May 2000 were not located within the lake after two weeks. One trout implanted in March was caught in section A 11 days after it was released into section D, and one trout from May was caught approximately 25 km downstream in the canal 17 days after it was released into section B. Only one of the remaining 15 resident rainbow trout implanted in July and August was not located within the lake after two weeks, however two died or expelled the transmitter shortly after release. Anglers caught four rainbow trout from within the lake in 1999, and eight rainbow trout, including four from the canal and four from within the lake, in 2000.

Most observations of rainbow trout in 1999 were in sections C (N=152) and D (N=194), while few were in section B (N=16, Table 10, Figures 37,38). Frequency of use of sections A and B in 1999 by sonic tagged rainbow trout was just 4% and 12% compared to 37% and 47% for sections C and D, respectively. No rainbow trout were observed from June through September in section A and from July through September in section B, while 287 and 193 locations were recorded in the rest of the lake during the same periods. The selection ratio analysis of all 1999 rainbow trout observations indicated that section B was selected against while A, C, and D were selected in proportion to both lake surface area and volume (Table 12). This can be primarily attributed to the significant negative selection of sections A and B by newly stocked rainbow trout from July through September. Positive or negative selection of lake sections was by both volume and surface area unless otherwise specified.

Most rainbow trout observations in 2000 were in sections C (N=114) and D (N=264) and very few (N=19) were in section A (Table 11, Figures 39,40). Frequency of use of section A by sonic tagged rainbow trout was 4% compared to 24% and 57% for sections C and D, respectively. From June through September only six rainbow trout locations were recorded in section A, while 321 locations were recorded in the rest of the lake. The selection ratio analysis of all 2000 rainbow trout observations indicated that section A was selected against while B, C, and D were selected in proportion to lake surface area (Table 12). When analysis was performed using lake volume, section A was still selected against, but B was also marginally selected against ($P > 0.05$) and D was selected for. This can be primarily attributed to the significant selection against section A by newly stocked and resident rainbow trout in May and June, and selection against A and B, and for D in proportion to lake volume by resident trout from July through September.

In 1999 and 2000, of 608 observations of newly stocked and resident ultrasonically tagged rainbow trout from June through September, only 6 occurred in section A (Tables 10,11). Of the 365 observations from July through September, only 6 occurred in section B. Rainbow trout selected against section A and selected for D in May and June in proportion to lake volume. They selected against both A and B in proportion to surface area and volume and selected for D in proportion to volume from July through September (Table 12). All positive selections of section D occurred only when the proportional volume of each section to the lake was used to calculate the selection ratio index.

### Brown trout

From March through October 1999, 11 brown trout, 10 new and 1 resident, were implanted with ultrasonic transmitters (Appendix 3). Three of the five newly stocked brown trout released in March and one of the five released in October were not located within the lake after just two weeks. The two remaining brown trout released in March moved into B in mid-April just before they disappeared. The four remaining brown trout released in October all moved into sections B and C shortly after release only to return to section A by mid-November when they were last located.

Three resident brown trout were implanted in June and July 2000 and located 46 times collectively (Table 13, Appendix 4). All three moved from sections B, C, and D into A by August and September when they were last located. Frequency of use of sections A and B by brown trout was 86% for 1999 and 2000 combined. Selection ratio analyses for 1999 and 2000 brown trout locations indicated a positive selection of section A and a negative selection of D in proportion to both surface area and volume (Table 14). Due to the low number of observations, a seasonal analysis was not performed, and resident brown trout were only located from June through September in 2000. All ultrasonically tagged brown trout in 2000 moved to section A in August and September where they were last located.

### Telemetry station

Only one trout was recorded to have passed by the telemetry station on the canal during 1999 and 2000. Rainbow trout 368 appeared to pass by the station on 22 August

2000, 13 days after it was implanted and released into section C. Technical problems hindered the performance of the station during both years. Low water levels, cold temperatures, and unit failure in March and April, unfortunately when most transmitters disappeared from the lake, were the source of most problems. The moving water in the canal and clumps of aquatic plants catching on the hydrophone during summer and autumn created excessive interference that may have blocked some signals. However, a test of the station indicated that it was successful at recording a transmitter that was lowered into the water near it. Another transmitter was identified, however it was located in the lake several times after it was recorded in the canal and was likely an erroneous reading.

### Depth selection

Analysis of variance indicated a significant time, section, and type (new, resident) interaction effect on the water column depth used by rainbow trout (F = 4.72, df = 11, $P <$ 0.0001). A mean comparison test identified significant differences between variables in the interaction (Table 15). Resident rainbow trout appeared to use significantly deeper water during both daytime periods, sunrise to 1300 hours and 1300 hours to sunset, than during the night in both sections B and C ($P \leq 0.0022$). Resident and newly stocked rainbow trout used significantly deeper water (2.8 to 7.6 m deeper) in sections A, B, and C than in section D during both daytime periods ($P \leq 0.0207$). However, during the night, water column depths used by resident rainbow trout in sections B, C, and D were not significantly different (0.6 to 1.7 m deeper, $P \geq 0.1581$). Newly stocked rainbow trout appeared to use significantly deeper water than resident trout in both sections A and C from sunrise to 1300 hours ($P \leq 0.0607$) and from 1300 hours to sunset ($P \leq 0.0012$).

Newly stocked rainbow trout were only located during the night in section D and showed no significant difference in use of water depth between time periods ($P \geq 0.6536$).

### 24-hour telemetry

Intensive 24-hour tracking indicated that rainbow trout underwent significant movement within and between lake sections from May through September 2000. Rainbow trout 444 moved a total distance of 3,046 m over a 23.3-hour period in section D in July, averaging over 131 m/h (Table 16, Figure 41). Rainbow trout 589 in section C in May and rainbow trout 788 in section B in June moved more than 2,000 m in approximately 24 hours. These two were also the only trout that moved between different sections within the 24-hour period (Figures 42,43). Movement between sections occurred between 0200 to 0800 hours and between 1100 to 1700 hours (Table 16). Figures 44-47 illustrate 24-hour movements of other rainbow and brown trout in May, June, and July 2000.

Straight-line movements ranged from 1 to 296 m/h and were highest between 0500-1400 hours (Figure 48). Analysis of variance of ranked movements indicated a significant difference between 3-hour periods ($P = 0.0456$). Typically, only one trout was followed in each section during each month; therefore, differences and interactions involving month and section parameters were not analyzed. Median movement was highest from 0500-0800 hours at 51 m/h, and lowest from 1400-1700 hours and 2300-0200 hours at 12 and 12.5 m/h respectively (Figure 48). A mean comparison test based on the rank transformed data indicated that movement from 1400 to 1700 hours was less than during all other periods and significantly less than all except 2000 to 2300 and 2300 to 0200 hours ($P \leq 0.05$). Movement from 0500 to 0800 and 0800 to 1100 hours was significantly higher than during 1400 to 1700 and 2300 to 0200 hours ($P \leq 0.0312$). Movement between periods was not significant from 1100 to 1400 hours, and 1700 to 0500 hours ($P \geq 0.062$), although the difference between 1100 to 1400 and 2300 to 0200 hours (+20.4 m/h) was approaching significance.

### Electrofishing

Lake Ogallala was surveyed in March and monthly from May through September 2000 resulting in the capture of 950 rainbow trout and 277 brown trout over 180 g in weight (Table 17). The highest rainbow catch per 100-m (CPUE) sampled occurred in sections A and D in March, and section B in May (Figure 49). The highest catch rates for the entire lake occurred in March and May respectively, accounting for 62% of the electrofishing catch of rainbow trout for the year (Figure 50). Catch rate in A declined from 4.50 to 0.19 per 100 m from March to June and in B declined from 5.45 to 0.44 per 100 m from May to June. Catch rate in section D rose from 1.18 to 1.58 per 100 m from May to June, while in section C peaked and was highest in the lake in July at 2.06 per 100 m. Only one rainbow trout was captured in sections A and B in July and only 15 were captured there in June. In August, most of the 31 rainbow trout captured in sections A and B were located in the toe drain seepages from Lake McConaughy.

ANOVA procedures using a variance of estimated density assuming a Poisson distribution (Young and Young 1998) indicated a significant difference between months ($P = 0.0486$) but not between sections ($P = 0.4047$). A lack of degrees of freedom did not allow a comparison of interaction between month and section using this method. A test for differences between means indicated that March sampling resulted in a significantly higher CPUE, or relative abundance, of rainbow trout than all months except May ($P \leq 0.045$). Grouping data into two- and three-month periods to attain replication provided results similar to the previous test. There were significant differences between month groups ($P = 0.0095$, $P = 0.0462$) but not between sections ($P \geq 0.9005$). Grouping the data allowed for a test of interaction between month and section and both indicated interaction to be insignificant ($P \geq 0.2906$). Results of the bimonthly test indicated CPUE was significantly higher in March/May than both June/July (-1.82/100-m, $P = 0.005$) and August/September (-2.05/100-m, $P = 0.0103$). Grouping into three-month periods indicated that March/May/June sampling resulted in significantly higher (+1.27/100-m) CPUE than July/August/September ($P = 0.0462$).

Of the 277 brown trout captured, 167 were Seeforellen, 81 were Wild Rose, and 29 were unidentified to strain. Most Seeforellen brown trout were captured in sections C (67) and D (44) while most Wild Rose were captured in sections A (31) and B (22; Table 17). In 2000, 33% of all brown trout captured were caught in May, and 43% of those were caught in section C. The three highest catches of brown trout for the year occurred in section C during May, July, and June respectively and ranged from 1.00-2.50/100-m (Figure 51). Highest catches of brown trout in August and September were recorded in sections A and B while only seven were caught in C and D combined in September. There was no significant interaction between section and month variables ($P \geq 0.4594$) and no significant difference between months ($P \geq 0.3554$) or sections ($P \geq 0.1006$).

### Tag/recapture

During electrofishing from March through August 2000, 740 rainbow trout and 188 brown trout were tagged with numbered T-bar anchor tags and released into the section where they were caught. Nine rainbow trout, or 1.2%, were recaptured during electrofishing and 205, or 27.7%, were caught by anglers through April 2000 for a 28.9% total return (Table 18). Of all rainbow trout returns, 3.7% did not specify which lake section the trout was caught in and 0.9% did not specify any catch location. Five rainbow trout or 0.7% of returns were misidentified as brown trout and eight brown trout or 34.8% of returns were misidentified as rainbow trout by anglers. Return rates of tags from each section ranged from 23.1% in C to 30.6% in D. Most rainbow trout were caught in the same section where they were tagged except those tagged in section A which were recaptured at higher rates in sections B, C, and D (Table 18). Rainbow trout tagged in each section were recaptured in every other section of the lake as well as in the canal and river except no trout tagged in section C were caught in the canal. Overall, 31.3% of recaptured rainbow trout were caught in section D, 18.7% in section B, 17.3% in section C, 9.3% in section A, and 8.9% and 9.8% in the river and canal respectively (Figure 52).

Trends in rainbow trout movement over time fit the design of the generalized logits model well ($P = 0.9744$, non-significant = good fit). The model indicated that the probability that a rainbow trout moved one section increased by a factor of 1.0067 each day after release compared to the probability that it remained in the same section ($X^2 = 6.24$, $P \leq 0.0121$, df = 1). The probability of moving two or three sections was not significantly affected by the number of days after release ($X^2 \leq 0.85$, $P \geq 0.3566$, df = 1).

Six brown trout, or 3.2% of all tagged, were recaptured during electrofishing and 23, 12.2% of all tagged, were caught by anglers for a 15.4% return through April 2001 (Table 18). Seeforellen brown trout accounted for 16 angler returns and Wild Rose for seven. Recapture rates for brown trout tagged in each section were highest for D at

23.1% and C at 17.4%. Conversely, recapture rates of brown trout were highest at 4.8% in section B and 2.7% in both A and C, while only 1.1 % were recaptured in D. Brown trout that were caught in the river and canal accounted for 13.8% and 10.3% of recaptures, respectively (Figure 53). Only one brown trout of the 39 tagged in section D was recaptured in D, while two were recaptured in each of sections B and C, in the river, and in the canal. The generalized logits model indicated that the number of days after release did not significantly affect the probability that a brown trout would move one or more sections ($X^2 = 2.22$, $P = 0.3297$, df = 2). The low number of brown trout tag returns were likely insufficient to establish significant trends in movement.

## DISCUSSION

### Section use and movement between sections

Ultrasonic telemetry of newly stocked and resident rainbow trout indicated similar avoidance of sections A and B during July through September, 1999-2000. The highest electrofishing catches of rainbow trout in section A occurred in March and May, before the date the aeration unit was in operation. During aeration from June through September the few rainbow trout caught in sections A and B were located in front of small inflows of cool, oxygen-poor water seeping through Kingsley Dam from Lake McConaughy. Catch rates increased and were the highest in the lake in sections D and C during June and July respectively, indicating movement from A and B. Most rainbow trout that were captured and tagged in section A appeared to move into other sections rather than remain there, as more were recaptured in sections B, C, and D than they were in A.

Operation of the aeration system in section A appeared to improve dissolved oxygen levels significantly deeper in the water column during most of the summer. However, it also appeared to increase the temperature throughout the water column to a level not optimal for rainbow trout growth (See Table 6). Peters et al. (1999) found that water temperatures near the bottom increased approximately 5°C to 18-19°C during July 1998 as compared to July 1997, before aerators were installed. By August 1999, water temperatures increased to greater than 19°C throughout most of the water column and by August 2000, water column temperatures ranged from 20.8°C near the bottom to 21.9°C at the surface.

Movement of rainbow trout from section A also may be related to interspecific or intraspecific competition between the trout that are there and the thousands that are released monthly. Juvenile salmonids often show increased territoriality and aggressive behavior at high densities (Crisp 1993; Symons and Heland 1978). Jenkins (1971) found that stocked rainbow trout were more likely to make significant movements if they were in larger schools. Brown and Brown (1993) found that rainbow trout formed aggregations of related individuals and would be more aggressive towards other trout. Heggenes (1988) increased densities of adult brown trout in a stream reach, but found no effects on the amount of movement of resident trout. However, introduced trout usually occupied less preferred habitats than larger resident trout, likely due to intraspecific competition. Grossman and Boule (1991) tested intraspecific competition in rainbow trout and only one behavioral variable, the percent of time spent near another trout, showed an effect.

Aeration and the resultant warming of section A may be improving conditions for cool- and warm-water fish species in Lake Ogallala. Walleye (*Stizostedion vitreum*), yellow perch (*Perca flavescens*), channel catfish (*Ictalurus punctatus*), bullheads (*Ameiurus* spp.), longnose (*Catostomus catostomus*) and white suckers, and common carp may outcompete trout for food and/or habitat or even prey on the trout themselves (Fraser 1978; Yule et al. 2000).

Newly stocked and resident rainbow trout appeared to prefer sections C and D in 1999 and 2000. There were losses of suitable rainbow trout habitat due to combinations of temperature and dissolved oxygen conditions from July through September in both years, and extreme losses throughout the lake occurred in 2000. Tag return results suggest that trout moved freely between sections of the lake, however nearly one-third of the rainbow trout tagged in section D were recaptured by anglers and nearly half of those were caught in section D. This indicates that the probability of a rainbow trout staying in its section of residence is best in section D, at least until August, when only four of the 25 rainbow trout that had been tagged in D were recaptured in D. The recapture of seven in the North Platte River and six in section A indicates movement from D in both directions by August. These trout may have been searching for better conditions and DO may have been better in section A, but temperature was higher than optimal. Increases in temperature may have overridden benefits of aeration in section A which led rainbow trout to select the typically cooler, more productive section D. In 1998, Barrow (1998) also found that during aeration the majority of sonic-tagged newly stocked rainbow trout observations were in section D.

## Food items and availability

Benthic macroinvertebrates were the primary source of food for both rainbow and brown trout in 1999 and 2000. Chironomids and gastropods typically represented > 90% of all organisms eaten by both species. Alewife were not found in any rainbow trout stomachs and in only one brown trout stomach sampled during night electrofishing. Two brown trout, 360 g and 730 g, captured in gill nets in section C had each consumed two to three 90-158 mm alewife. Due to the importance of benthic invertebrates as prey, rainbow trout preference for section D, which was almost entirely covered by submergent macrophytes was expected.

Very few zooplankton captured in Lake Ogallala were large enough to be consumed and retained by rainbow trout during 1999-2000. Daphnids, bosminids, and cyclopoid copepods were the primary zooplankton found in Lake Ogallala and all had mean lengths of less than 1.0 mm. Rainbow trout will typically prey on large *Daphnia* spp. when they are available (Beauchamp 1990), however they must usually be >1.3-1.5 mm in length before they are selected by rainbow trout (Galbraith 1967; Schneidervin and Hubert 1987; Tabor et al. 1996). The absence of *Daphnia* in section A before June 1999 and July 2000 indicates that they may be removed completely by planktivores in winter and early spring until alternate food sources and more turbid water reduce predation pressure.

Rainbow trout in Flaming Gorge Reservoir, Wyoming showed negative selectivity for daphnids <1.2 mm long (Schneidervin and Hubert 1987). The Lake DeSmet stock of rainbow trout in Viva Naughton Reservoir, Wyoming, one of the strains stocked into Lake Ogallala, fed primarily on *Daphnia pulex* (86.5% by number, 59.5% by volume, 81% occurrence) and Chironomidae larvae and pupae (11.3% by number, 46% by weight, King 1980). However, most *Daphnia* consumed by all lengths of rainbow trout were > 2.0 mm. Redside shiners (*Richardsonius balteatus*) and mountain whitefish (*Prosopium williamsoni*) between 2.6 and 9.1 cm TL entered the diet when trout reached lengths of approximately 30 cm but comprised only 8.6% of the diet by weight. Similar to Lake Ogallala, benthic invertebrates, mainly chironomids, were preferred while they were available, from May through August, even though a large zooplankton population was available in the limnetic zone. Zooplankton became more prominent in the diet from September through December after insect emergences ended. Benthic invertebrates were also the most important food source of rainbow trout during the summer in Castle Lake, California (Wurtsbaugh et al. 1975).

The absence of larger cladocerans and copepods in Lake Ogallala can be attributed to the large alewife population that became established since 1989 (Madsen et al. 1992; Laux et al. 1996). The complete chemical renovation in 1997 apparently had an extremely short-term effect on the alewife population, which is continuously supplemented by eggs and adults discharged in water from Lake McConaughy (Laux et al. 1996). Alewife abundance had recovered and appeared to be higher within a year after the renovation than it had been before (Peters et al. 1999). Introductions of alewife into other freshwater lakes has led to similar results, altering zooplankton populations from large daphnids and copepods to smaller bosminids and rotifers (Brooks and Dodson 1965; Lackey 1969; Wells 1970; Brown 1972; Hutchinson 1975; Kohler and Ney 1981; Mills et al. 1992).

Food selection by large rainbow and brown trout (> 2 kg) is probably not adequately represented in these results as most were implanted with a transmitter or immediately returned to the lake to avoid undue stress and mortality. Since very few large trout were caught, their value alive and in the lake seemed to be greater than dead and a source of diet information. The amounts of information collected and labor required during electrofishing and tagging precluded the time and effort to anesthetize large trout and process stomach contents. A better method of assessing food item selection of these large trout might be hook-and-line sampling or integrated with a creel survey of angler catches (King 1980).

Tag and recapture data from electrofishing and angler returns indicated that some rainbow trout moved out of the lake into the canal and river. Harvest of tagged trout in the river and canal of only 5.4 % of those tagged or 18.7 % of the total return indicates that most rainbow trout remained in the lake long enough to be harvested. This is a primary management goal after the 1997 renovation and appears to have been successful (Madsen and Eichner 1996).

High rates of discharge into Lake Ogallala from the Kingsley Hydroelectric Plant and into the North Platte River and Sutherland Supply Canal likely influenced fish movement and habitat selection. High flows combined with chronically lethal dissolved oxygen likely magnified the movement of trout from section D into other lake sections or the river and canal during August and September, as indicated in tag return results. Rainbow trout typically move upstream or laterally into slower velocity refugia during discharge events (Niemela 1989; Pert and Erman 1994; Simpkins et al. 2000). However, I hypothesize that poor dissolved oxygen during the night in Lake Ogallala may prevent trout from moving into refugia or be able to resist the current and be carried out of the lake with the 110 to 125 $m^3/s$ average flow. Trout that use backwater areas around dense macrophyte beds may become trapped in suboptimal habitat when water levels drop up to 1.5 m in a matter of hours. Declining dissolved oxygen in these areas and the inability of trout to escape may have led to the observed fish kills.

The spatial and temporal variation of habitat within section D is difficult to quantify with the present study. Fluctuations in water temperature and dissolved oxygen related to photosynthesis and respiration were further influenced by changes in the amount and quality of water discharged from the hydroplant. Most of the water discharged from Lake Ogallala into the river and canal traveled through channels between islands of submergent macrophytes and flowed almost directly from release at the hydroplant. Water discharged from Lake McConaughy in late summer was a white, milky color and was easily distinguished from the clear water that was located off the channels of section D.

Only through analysis by water volume did rainbow trout positively select section D. Analysis by volume showed little effect on results that showed negative selection, but did increase the significance for such avoidance of A and B. Since rainbow trout habitat is water, the assumption of trout habitat as a volume should be applicable if the entire water column of the lake is available habitat.

## Depth selection and movement within sections

### Rainbow trout

Rainbow trout appeared to perform greater movement an hour or two before sunrise to approximately noon and again around sunset. Movement was lowest during the middle of the afternoon and the middle of the night. Increased movement may have been related to feeding and decreased movement to resting and conservation of energy. Fluctuating water levels of up to 1.5 m per day and temporal variation in water quality may have influenced movement patterns, especially in section D. However, the limited number of trout observed and high variation in the response of individual trout restricted analysis of temporal and spatial variations in water quality within sections and thus were not evaluated.

Larger resident rainbow trout within sections A, B, and C appeared to remain primarily in shallow, littoral zone areas during day and night while smaller newly stocked trout moved from deeper water column depths during the day into the littoral zone at night. Movement into or residing in littoral habitats is probably a result of feeding on benthic chironomids, gastropods, and corixids, the major prey items of rainbow trout in Lake Ogallala.

Smaller newly stocked trout may have utilized deeper water during the day to avoid predation by birds or other fish or antagonism from larger trout (Freeman and Stouder 1989). Jonsson and Gravem (1985) hypothesized that smaller brown trout used habitat that minimized predation and competition, while larger trout selected habitats that would maximize feeding and growth, leading to habitat segregation. Since large zooplankton were rare in Lake Ogallala, remaining in the littoral zone where benthic macroinvertebrates were abundant should maximize growth. The movement of small trout out of the littoral zone during the day is an indication that they were avoiding it even though it offered a better food source. Avoidance of competition or predation is hypothesized for diel changes in water column depth by smaller newly stocked rainbow trout in Lake Ogallala. They may also have been attempting to feed on zooplankton during the day as Warner and Quinn (1985) and Beauchamp (1990) found of rainbow trout in Lake Washington.

The lack of diel change in depth selection in section D was likely due to the dominance of shallow littoral habitat, however the spatial heterogeneity of this area may have allowed larger resident and smaller newly stocked trout to avoid negative interactions. Symons and Heland (1978) found that the addition of complex habitat to an artificial stream reduced intraspecific competition between two size classes of Atlantic salmon (*Salmo salar*).

### Brown trout

In contrast to rainbow trout, brown trout appeared to avoid section D in 1999 and 2000 and prefer section A, primarily from June through September 2000. Movement into section A by August and September may have been in response to poor water quality conditions in lake sections influence more by discharge from Lake McConaughy and to partial stratification of section B. Brown trout movement may also be attributed to a search for cooler water, also in response to the discharge of water from Lake McConaughy that rose to near or greater than 20°C in 1999 and 2000. Garrett and Bennett (1995) found that all radio-tagged adult brown trout in a Washington reservoir moved into cooler 16°C tributary streams when temperatures exceeded 19°C in the reservoir. Brown trout remained in the reservoir the following year when reservoir temperatures were cooler. McMichael and Kaya (1991) recommended preventing water temperatures from exceeding 19°C as a management objective for waters supporting brown trout.

More Wild Rose strain brown trout were captured while electrofishing and appeared to prefer sections A and B, while more of the Seeforellen strain were captured in sections C and D. Brown trout relative abundance appeared to be highest during May, as 33% of all brown trout captured in 2000 were caught in May. Brown trout relative abundance was highest in section C during May, June, and July, and in sections A and B in August and September, supporting data obtained with sonic tagged fish.

Tag return data indicated that most brown trout captured in section D apparently did not stay there long, moving quickly out into the North Platte River or Sutherland Canal or back into sections B and C. Overall, movement of brown trout into the canal and river appears to be higher than that by rainbow trout and may be a concern for establishing a sizeable population in Lake Ogallala.

No telemetry information was collected on brown trout prior to the renovation and aeration, so while it is difficult to attribute increased use of section A by brown trout to aeration, it appears likely. Since very few brown trout were implanted due to a focus on rainbow trout, further research would be helpful in identifying movement patterns and related water quality or food related influences.

### Transmitter disappearance

The poor success at retaining rainbow and brown trout in Lake Ogallala in March and April is discouraging. Most trout implanted in March simply disappeared with only a few observations. A more intensive daily or semi-daily tracking would be required to ascertain the cause for these disappearances and still may not be successful. Large populations of double-crested cormorants (*Phalacrocorax auritus*), American white pelicans (*Pelicanus erythrorhynchos*), and great blue herons (*Ardea herodias*) were present, primarily in section A during March and April of both years. Instantaneous counts of 9 blue herons, 17 pelicans and 20 cormorants on 31 March 2000 and of 65 cormorants on 21 April 2000 indicated that predation losses of newly stocked trout were probably high in section A. Subadult rainbow and cutthroat (*Oncorhynchus clarkii*) trout in a southern Utah reservoir made up 75% of the diet biomass of double-crested cormorants sampled (Modde et al. 1996). They estimated consumption of subadult trout by cormorants from 2 March through 2 October to be 32,970 fish, more than the estimated catch by anglers during the entire year. Daily consumption of subadult trout per cormorant was estimated at 348.8 g, which is equivalent to two newly stocked trout per day in Lake Ogallala. Newly stocked trout that recently underwent surgical implantation of a transmitter may have been more susceptible to predation than a normal trout, however, it is likely that these efficient predators removed significant numbers of all trout stocked in March and April. Several herons and a group of approximately 10 to 15 common mergansers (*Mergus merganser*) remained at the lake throughout the summer, but most cormorants and pelicans left by early May.

Several transmitters had pin-sized or larger holes in the epoxy capsule in which they were cast, apparently the result of air bubbles in the mold upon encapsulation. The manufacturer assured me that any holes in the epoxy resin were tested for conductivity into the capsule before shipment. However, 3-4 of the transmitters returned by anglers showed considerable corrosion inside the battery compartment and a small hole was apparent in the wall of each failed transmitter. Several transmitters were returned to the company because of defects including being cemented to the plastic wrap, being unfinished, and failure due to internal corrosion. At least one of the replacements was documented to have failed prior to the 60-day life. I speculate that premature transmitter failure led to the early disappearance of an unknown number of implanted trout in Lake Ogallala. The added possibility of removal by avian piscivores or anglers brings little confidence to an assumption that failure to locate the transmitter within Lake Ogallala meant they had left the lake into the canal or river.

Since more rainbow trout were implanted with transmitters in sections C and D, a potential bias toward selection of these areas may have resulted. However, the inability to catch rainbow trout in sections A and B to implant and the small probability that they remained there led to no other solution. Only 16 resident rainbow trout were caught in sections A and B in June and July 2000.

Since anglers caught 12 of the 91 ultrasonically tagged trout, transmitters were apparently not negatively effecting trout behavior and allowed them to feed in a manner assumed to be similar to other trout. Considering that the telemetry study was not advertised to the public, more ultrasonically tagged trout were probably caught and transmitters were discarded. Rewards offered in the tag/recapture study probably influenced the high return of transmitters. Contacts with anglers who returned transmitters indicated the trout were healthy and had well-healed incisions. A large brown trout recaptured while electrofishing also had a well-healed incision, unfortunately the transmitter it was carrying had failed within two weeks after release.

### Electrofishing

Catch rates for the entire lake declined through July before recovering slightly in August and September, ~~and~~ indicating that trout had left the lake through the canal or river or through angler harvest and/or were not using shoreline habitat. Data from electrofishing were pooled for each section primarily to simplify the sampling process. However, establishing consistent shoreline transects within each section would have likely resulted in a stronger statistical analysis. Electrofishing CPUE was highly variable between months and sections and may not have been the most effective method of assessing trout relative abundance. Whitworth (1986) found that purse seine and trap net CPUE were valid estimators of rainbow trout relative abundance in small Wyoming reservoirs. However, purse seine CPUE was better than trap net CPUE in reservoirs with large non-trout populations, such as Lake Ogallala.

### Dissolved oxygen

Hypolimnion aeration using compressed air and a special tower was successful at reducing destratification in a eutrophic lake in Michigan (Fast 1973). Rainbow trout that were limited to shallow depths before aeration occupied the entire water column during aeration. Design flaws in the tower led to a slow deterioration of the hypolimnion, but could be easily overcome. The aeration systems in sections A and B could be modified to reduce or possibly prevent destratification of the hypolimnion.

Water quality standards or at least enforcement of those standards is not sufficient to provide suitable conditions for rainbow trout in Lake Ogallala throughout the year. Missouri has a minimum dissolved oxygen standard of 6.0 mg/L for trout supporting waters (Weithman and Haas 1984). Davis (1975) found that freshwater salmonids showed symptoms of low-oxygen stress at an average oxygen concentration of 6.00 mg/L at average temperature of 15°C. He advised that at an average oxygen concentration of 4.16 mg/L, a large proportion of the fish population may be affected, possibly severely if exposed beyond a few hours, and that this level should be applied only to populations of marginal significance or marginal economic importance, and are dispensable. This classification does not fit Lake Ogallala's designation as the most important trout fishery in Nebraska and certainly should not apply to a fishery that has trophy potential.

Low dissolved oxygen concentrations resulting from hypolimnetic (depth of 43 m) releases of water from a hydroelectric facility below Table Rock Dam, Missouri, were believed to have a direct linear effect on angler success at levels between 2.4 and 6.0 mg/L (Weithman and Haas 1984). Harvest rates were significantly lower in the fall than in the spring and were attributed to a reduced metabolic rate and activity due to low DO concentrations.

In addition to being low in DO, hydrogen sulfide, ammonia, and total dissolved gases have recently been identified to be at high and possibly lethal concentrations in the water released from Lake McConaughy (K. Hoagland, University of Nebraska at Lincoln, personal communication). The combined effects of these gases with low dissolved oxygen may be influencing trout mortalities in section D and movement of trout out of Lake Ogallala.

## Conclusions and Recommendations

Telemetry, electrofishing, and tag return results indicate that rainbow trout in Lake Ogallala selected sections C and D and avoided section A from July through September, while the aeration system in section A was operating. Temperature increases in section A early in the summer due to mixing and contact with the air as well as isolation from hydroplant releases appeared to contribute to rainbow trout avoidance. Rainbow trout still occupied sections C and D at higher than or equal to expected numbers even though they were being supplied oxygen deficient water from Lake McConaughy from July through September. High discharge rates of this poor quality water through sections C and D did appear to increase the number of trout that left the lake.

Barrow (1998) attributed dissolved oxygen, temperature, and time of year to be the most important variables affecting movement in the lake and my data support these as probable conclusions. The aeration system in section A did not meet its objective of improving dissolved oxygen to 6 mg/L one meter from the bottom and these data indicate that it is not effective at providing preferable rainbow trout habitat. Improving dissolved oxygen levels in sections C and D from July through September would likely be more effective at preventing trout from leaving the lake and improving growth than the continued aeration of section A. A method of aeration that does not break stratification and reduces warming of the hypolimnion is an alternative that may also improve trout habitat in sections A and B.

Water quality standards set by the Nebraska Department of Environmental Quality appear to be inadequate to prevent trout mortalities in section D. CNPPID appears to be meeting minimum water quality standards at the buoy line below the hydro discharge. Spatial and temporal heterogeneity of water quality in section D appear to contribute to chronic declines in dissolved oxygen below that required for rainbow trout to live. Diel fluctuations of DO, apparently due to respiration at night, lead the already oxygen deficient water to drop below 3 and even 2 mg/L in areas of section D for most of the night.

These low standards set by the State of Nebraska need to be improved for Lake Ogallala to reach its full potential and become a more sustainable, cost-effective trout fishery. According to Davis (1975), the standards set for Lake Ogallala would indicate its trout populations to be of "marginal significance or marginal economic importance, and are dispensable". The Nebraska Department of Environmental Quality, Central Nebraska Public Power and Irrigation District, and the Nebraska Game & Parks Commission need to determine the importance of Lake Ogallala trout to the citizens of Nebraska. If it is truly considered important, the current management and regulation of water quality in Lake Ogallala must be improved.

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Table 1. Surface area and volume of sections of Lake Ogallala based on a mean surface elevation of 3124.7 ft above mean sea level.

| Elevation | Depth | Cross-sectional surface area ($m^2$) | | | | |
|---|---|---|---|---|---|---|
| (ft) | (m) | A | B | C | D | Total lake |
| 3,084 | 12.41 | 0 | | 0 | | 0 |
| 3,085 | 12.10 | 1,289 | 0 | 9,766 | | 11,055 |
| 3,090 | 10.58 | 27,160 | 21,510 | 117,606 | | 166,276 |
| 3,095 | 9.05 | 129,654 | 133,222 | 200,670 | | 463,547 |
| 3,100 | 7.53 | 189,624 | 237,699 | 222,773 | | 650,095 |
| 3,105 | 6.00 | 223,326 | 269,418 | 239,838 | | 732,582 |
| 3,110 | 4.48 | 239,285 | 292,217 | 249,913 | 0 | 781,414 |
| 3,115 | 2.96 | 262,281 | 310,356 | 284,609 | 76,240 | 933,487 |
| 3,122 | 0.82 | 288,549 | 335,831 | 316,066 | 1,102,260 | 2,042,706 |
| 3,124.7 | 0 | 328,412 | 375,335 | 325,541 | 1,258,256 | 2,287,544 |
| Mean Depth (m) | | 6.93 | 7.12 | 8.30 | 1.71 | 4.3 |

| | | Approximate incremental storage | | | | |
|---|---|---|---|---|---|---|
| Elevation | Depth | Volume ($m^3$) | | | | |
| (ft) | (m) | A | B | C | D | Total lake |
| 3,084 | 12.41 | 0 | 0 | 0 | 0 | 0 |
| 3,085 | 12.10 | 196 | 0 | 1,488 | 0 | 1,685 |
| 3,090 | 10.58 | 21,874 | 16,391 | 98,546 | 0 | 136,811 |
| 3,095 | 9.05 | 141,366 | 134,296 | 341,073 | 0 | 616,735 |
| 3,100 | 7.53 | 384,656 | 416,938 | 663,737 | 0 | 1,465,331 |
| 3,105 | 6.00 | 699,323 | 803,361 | 1,016,247 | 0 | 2,518,931 |
| 3,110 | 4.48 | 1,051,832 | 1,231,327 | 1,389,437 | 0 | 3,672,596 |
| 3,115 | 2.96 | 1,434,026 | 1,690,488 | 1,796,742 | 58,095 | 4,979,351 |
| 3,122 | 0.82 | 2,021,652 | 2,379,841 | 2,437,542 | 1,181,118 | 8,020,153 |
| 3,124.7 | 0 | 2,275,519 | 2,672,472 | 2,701,551 | 2,152,423 | 9,801,964 |

Table 2. Simple water budget for Lake Ogallala and estimated time for complete water storage turnover, March-October 1999.

| | Lake McConaughy Release | | | | Lake Ogallala Release | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Source:** | **CNPPID** | | | | **Nebraska DNR** | | | | | |
| | **$m^3*10^3$** | | | | **Avg cms** | | **$m^3*10^3$** | | | |
| **Date** | **Plant** | **Bypass Valve** | **Seepage** (5 cfs) | **Total In** | **Canal** | **River** | **Canal** | **River** | **Total Out** | **Turnover** (Days) |
| **1999** | | | | | | | | | | |
| 3/1-3/15 | 33,054 | 0 | 183 | 33,238 | 26.5 | 0.0 | 34,290 | 0 | 34,290 | 4.3 |
| 3/16-3/31 | 36,741 | 6,960 | 196 | 43,896 | 33.0 | 0.0 | 42,811 | 0 | 42,811 | 3.7 |
| 4/1-4/15 | 27,590 | 18,508 | 183 | 46,281 | 37.4 | 0.0 | 48,470 | 0 | 48,470 | 3.0 |
| 4/16-4/30 | 46,413 | 0 | 183 | 46,596 | 41.1 | 0.0 | 53,328 | 0 | 53,328 | 2.8 |
| 5/1-5/15 | 24,305 | 0 | 183 | 24,488 | 21.2 | 0.8 | 27,416 | 1,080 | 28,496 | 5.2 |
| 5/16-5/31 | 36,212 | 0 | 196 | 36,408 | 22.4 | 4.9 | 28,969 | 6,387 | 35,357 | 4.4 |
| 6/1-6/15 | 43,024 | 1,564 | 183 | 44,772 | 29.2 | 7.8 | 37,896 | 10,099 | 47,995 | 3.1 |
| 6/16-6/30 | 44,309 | 9,648 | 183 | 54,140 | 32.5 | 11.5 | 42,078 | 14,896 | 56,974 | 2.6 |
| 7/1-7/15 | 96,330 | 12,613 | 183 | 109,127 | 42.1 | 44.6 | 54,607 | 57,743 | 112,350 | 1.3 |
| 7/16-7/31 | 132,715 | 21,507 | 196 | 154,418 | 49.0 | 67.0 | 63,557 | 86,795 | 150,351 | 1.0 |
| 8/1-8/15 | 78,590 | 17,705 | 183 | 96,478 | 47.7 | 26.7 | 61,781 | 34,661 | 96,443 | 1.5 |
| 8/16-8/31 | 72,266 | 25,850 | 196 | 98,311 | 48.3 | 22.9 | 62,551 | 29,708 | 92,259 | 1.7 |
| 9/1-9/15 | 54,290 | 24,163 | 183 | 78,636 | 43.5 | 17.7 | 56,424 | 22,963 | 79,387 | 1.9 |
| 9/16-9/30 | 77,775 | 25,058 | 183 | 103,016 | 45.0 | 32.5 | 58,332 | 42,177 | 100,509 | 1.5 |
| 10/1-10/15 | 54,612 | 8,182 | 183 | 62,977 | 45.9 | 4.1 | 59,506 | 5,297 | 64,803 | 2.3 |
| 10/16-10/31 | 64,887 | 0 | 196 | 65,083 | 46.6 | 2.8 | 60,424 | 3,573 | 63,997 | 2.5 |
| | | | Total | 1,097,866 | | | | Total | 1,107,823 | |

Table 3. Simple water budget for Lake Ogallala and estimated time for complete water storage turnover, March-October 2000.

| | Lake McConaughy Release | | | | Lake Ogallala Release | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Source:** | **CNPPID** | | | | **Nebraska DNR** | | | | | |
| | $m^3*10^3$ | | | | Avg cms | | $m^3*10^3$ | | | |
| **Date** | **Plant** | **Bypass Valve** | **Seepage** (5 cfs) | **Total In** | **Canal** | **River** | **Canal** | **River** | **Total Out** | **Turnover** (Days) |
| **2000** | | | | | | | | | | |
| 3/1-3/15 | 31,596 | 0 | 183 | 31,780 | 27.6 | 0.7 | 35,779 | 851 | 36,629 | 4.0 |
| 3/15-3/31 | 41,993 | 0 | 196 | 42,189 | 32.9 | 0.7 | 42,582 | 856 | 43,438 | 3.6 |
| 4/1-4/15 | 55,082 | 0 | 183 | 55,265 | 41.6 | 4.7 | 53,969 | 6,080 | 60,049 | 2.4 |
| 4/16-4/30 | 58,718 | 0 | 183 | 58,902 | 48.5 | 6.5 | 62,867 | 8,460 | 71,327 | 2.1 |
| 5/1-5/15 | 65,499 | 0 | 183 | 65,682 | 42.6 | 12.0 | 55,241 | 15,557 | 70,798 | 2.1 |
| 5/16-5/31 | 75,604 | 0 | 196 | 75,799 | 44.5 | 14.6 | 57,695 | 18,984 | 76,679 | 2.0 |
| 6/1-6/15 | 97,435 | 7,057 | 183 | 104,676 | 49.8 | 35.2 | 64,519 | 45,664 | 110,182 | 1.3 |
| 6/16-6/30 | 133,966 | 20,335 | 183 | 154,484 | 50.7 | 73.5 | 65,728 | 95,279 | 161,007 | 0.9 |
| 7/1-7/15 | 120,196 | 12,248 | 183 | 132,628 | 42.4 | 54.8 | 55,011 | 71,035 | 126,045 | 1.2 |
| 7/16-7/31 | 128,288 | 29,362 | 196 | 157,845 | 50.9 | 66.5 | 66,014 | 86,240 | 152,254 | 1.0 |
| 8/1-8/15 | 105,818 | 39,569 | 183 | 145,571 | 42.3 | 64.3 | 54,787 | 83,270 | 138,057 | 1.1 |
| 8/16-8/31 | 64,609 | 40,426 | 196 | 105,232 | 41.3 | 34.4 | 53,466 | 44,590 | 98,055 | 1.6 |
| 9/1-9/15 | 9,325 | 33,564 | 183 | 43,073 | 27.4 | 7.0 | 35,448 | 9,054 | 44,503 | 3.3 |
| 9/16-9/30 | 20,451 | 8,434 | 183 | 29,069 | 22.5 | 0.7 | 29,177 | 862 | 30,039 | 4.9 |
| 10/1-10/15 | 23,688 | 162 | 183 | 24,033 | 17.5 | 0.8 | 22,631 | 975 | 23,605 | 6.2 |
| 10/16-10/31 | 19,345 | 0 | 196 | 19,541 | 16.1 | 0.7 | 20,835 | 912 | 21,748 | 7.2 |
| | | | Total | 1,245,768 | | | | Total | 1,264,416 | |

Table 4. Summary of rainbow trout stocking in Lake Ogallala, 1999-2000.

| Date | Strain | Number |
|---|---|---|
| 03/03/1999 | Fish Lake DeSmet | 5000 |
| 03/16/1999 | Fish Lake DeSmet | 5000 |
| 04/07/1999 | Fish Lake DeSmet | 3081 |
| 04/19/1999 | Fish Lake DeSmet | 4000 |
| 04/27/1999 | Fish Lake DeSmet | 1000 |
| 04/27/1999 | Fish Lake DeSmet | 1919 |
| 05/04/1999 | Erwin | 3604 |
| 05/05/1999 | Erwin | 3624 |
| 05/25/1999 | Fish Lake DeSmet | 1000 |
| 05/25/1999 | Fish Lake DeSmet | 2128 |
| 06/02/1999 | Erwin | 4160 |
| 06/03/1999 | Erwin | 1600 |
| 06/14/1999 | Erwin | 3600 |
| 06/15/1999 | Erwin | 3660 |
| 07/21/1999 | Erwin | 6750 |
| 07/22/1999 | Erwin | 3040 |
| 07/27/1999 | Fish Lake DeSmet | 3600 |
| 10/07/1999 | Shasta | 4000 |
| 10/08/1999 | Shasta | 5000 |
| 1999 Total | | 65766 |
| | | |
| 03/15/2000 | Fish Lake DeSmet | 4114 |
| 03/17/2000 | Fish Lake DeSmet | 4766 |
| 04/12/2000 | Fish Lake DeSmet | 2800 |
| 04/14/2000 | Fish Lake DeSmet | 4204 |
| 04/20/2000 | Fish Lake DeSmet | 4116 |
| 05/19/2000 | Fish Lake DeSmet | 3864 |
| 05/22/2000 | Fish Lake DeSmet | 3523 |
| 05/22/2000 | Fish Lake DeSmet | 2600 |
| 06/12/2000 | Erwin | 5000 |
| 06/19/2000 | Erwin | 5000 |
| 07/06/2000 | Fish Lake DeSmet | 3200 |
| 07/13/2000 | Fish Lake DeSmet | 3100 |
| 09/21/2000 | Fall | 7835 |
| 10/10/2000 | Fall | 6512 |
| 11/14/2000 | Fall | 5608 |
| 12/07/2000 | Fall | 4892 |
| 2000 Total | | 71134 |

Table 5. Summary of brown trout stocking in Lake Ogallala, 1999-2000.

| Date | Strain | Number |
|---|---|---|
| 03/04/1999 | Seeforellen | 4393 |
| 03/15/1999 | Seeforellen | 4188 |
| 04/07/1999 | Seeforellen | 1440 |
| 10/06/1999 | Wild Rose | 1000 |
| 10/07/1999 | Wild Rose | 4020 |
| 10/12/1999 | Wild Rose | 3698 |
| 10/13/1999 | Wild Rose | 1435 |
| 1999 Total | | 20174 |
| | | |
| 3/16/2000 | Seeforellen | 4001 |
| 3/20/2000 | Seeforellen | 4758 |
| 4/12/2000 | Seeforellen | 1241 |
| 9/25/2000 | Wild Rose | 3550 |
| 9/26/2000 | Wild Rose | 3550 |
| 9/28/2000 | Wild Rose | 3110 |
| 2000 Total | | 20210 |

Table 6. Review of studies indicating selection by rainbow trout to water temperature.

| Age/Size Trout Studied | Optimal/Preferred Temperature (°C) | Lethal/Avoided Temperature (°C) | Reference and Location |
|---|---|---|---|
| Juvenile<br>30 mm | 17.2 | 25.6 | Hokanson et al. (1977)<br>Laboratory |
| Fingerling<br>40-90 mm TL | | 25-26 | Bidgood and Berst (1969)<br>Great Lakes |
| Fingerling | 18 | | Javaid and Anderson (1967), Laboratory |
| Fingerling<br>89 mm | 14.7 | | Peterson et al. (1979)<br>Laboratory |
| Fingerling | 18-19 | | Tabor et al. (1996)<br>Utah reservoir |
| Fingerling | 17-19 | ≥ 21 | McCauley and Pond (1971)<br>Laboratory |
| <1 kg | 14-19 | 23-24 | Spigarelli and Thommes |
| >1 kg | 13-15 | 20-21 | (1979), Lake Michigan |
| 1- 2 years | 13 (11-16) | | Garside and Tait (1958)<br>Laboratory |
| 15 month<br>205 g | 11.3 | | McCauley et al. (1977)<br>Laboratory |
| 15-20 cm TL | | 28.45 | Lee and Rinne (1980)<br>Southwest U.S. |
| 188 mm FL | 8-19 | ≥ 21 | Fast (1973)<br>Michigan lake |
| 200-250 mm TL, Yearling | 9.1-18.0 | | Barrow (1998)<br>Lake Ogallala, Nebraska |
| Adult | 15-18 | >20 avoided<br>25 lethal | Cherry et al. (1975)<br>Laboratory |
| Adult | 18.9-21.1 | | Horak and Tanner (1964)<br>Colorado reservoir |
| | 12-16 | | Jones (1982)<br>Kentucky lake |
| | | >18 | May (1973)<br>Lake Powell |
| | | >20 | Overholtz et al. (1977)<br>Ohio pond |
| | 10-16 | | Piper et al. (1989)<br>Hatchery |
| | 12-18 | >18<br>25 upper limit | Raleigh et al. (1984)<br>Habitat Suitability Criteria |

Table 7. Percent volume of suitable rainbow trout habitat in each section of Lake Ogallala, March through October 1999-2000 (>5 mg/L DO, < 19°C).

| | **Lake Section** | | | | |
|---|---|---|---|---|---|
| **1999** | **A** | **B** | **C** | **D** | **Lake** |
| March | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| April | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| May | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| June | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| July | 37.9 | 58.3 | 85.4 | 71.0 | 63.8 |
| August | 4.6 | 36.7 | 85.4 | 100.0 | 56.6 |
| September | 49.9 | 82.7 | 68.3 | 90.0 | 72.7 |
| October | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

| **2000** | **A** | **B** | **C** | **D** | **Lake** |
|---|---|---|---|---|---|
| March | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| April | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| May | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| June | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| July | 0.0 | 28.1 | 37.4 | 42.1 | 27.2 |
| August | 0.0 | 0.0 | 7.6 | 0.0 | 2.1 |
| September | 50.0 | 33.3 | 36.7 | 40.0 | 39.6 |
| October | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Table 8. Relative abundance of major benthic invertebrate taxa in Lake Ogallala, May through September 1999-2000.

| | Number per m$^2$ | | | | | |
|---|---|---|---|---|---|---|
| Lake Section(s) | A | | B and C | | D | |
| Taxon | 1999 | 2000 | 1999 | 2000 | 1999 | 2000 |
| Chironomidae | 2,205 | 1,455 | 4,648 | 7,934 | 11,786 | 18,058 |
| Gastropoda | 212 | 646 | 548 | 471 | 4,320 | 2,058 |
| Amphipoda | 22 | 2 | 411 | 217 | 1,516 | 754 |

Table 9. Mean total lengths of major zooplankton taxa in Lake Ogallala, May through September 1999-2000.

| | | Length (mm) | | | |
|---|---|---|---|---|---|
| | | 1999 | | 2000 | |
| Taxon | Month | Mean | SD | Mean | SD |
| Daphnids | May | N/A* | | N/A* | |
| | June | N/A* | | 0.88 | 0.27 |
| | July | 0.59 | 0.45 | 0.95 | 0.30 |
| | August | 0.74 | 0.23 | 1.00 | 0.21 |
| | Sept | 0.81 | 0.26 | 0.50 | 0.29 |
| | Year | 0.78 | 0.31 | 0.97 | 0.29 |
| Bosminids | May | 0.29 | 0.09 | 0.30 | 0.06 |
| | June | 0.35 | 0.08 | 0.30 | 0.07 |
| | July | 0.29 | 0.07 | 0.29 | 0.09 |
| | August | 0.36 | 0.13 | 0.32 | 0.14 |
| | Sept | 0.36 | 0.14 | 0.29 | 0.09 |
| | Year | 0.32 | 0.09 | 0.30 | 0.08 |
| Cyclopoids | May | 0.63 | 0.20 | 0.63 | 0.20 |
| | June | 0.65 | 0.18 | 0.60 | 0.19 |
| | July | 0.54 | 0.19 | 0.76 | 0.20 |
| | August | 0.65 | 0.23 | 0.70 | 0.15 |
| | Sept | 0.61 | 0.18 | 0.50 | 0.21 |
| | Year | 0.60 | 0.20 | 0.67 | 0.20 |

* Samples contained no daphnids

Table 10. Monthly summary of locations of ultrasonically tagged rainbow trout in Lake Ogallala, 1999.

**1999 All**

| Section | March | April | May | June | July | Aug | Sept | Oct-Dec | 1999 |
|---|---|---|---|---|---|---|---|---|---|
| A | 0 | 7 | 38 | 0 | 0 | 0 | 0 | 2 | 47 |
| B | 0 | 0 | 5 | 7 | 0 | 0 | 0 | 4 | 16 |
| C | 0 | 0 | 22 | 39 | 56 | 21 | 10 | 4 | 152 |
| D | 0 | 0 | 13 | 48 | 75 | 21 | 10 | 27 | 194 |
| Total | 0 | 7 | 78 | 94 | 131 | 42 | 20 | 37 | 409 |

**Resident**

| Section | March | April | May | June | July | Aug | Sept | Oct-Dec | 1999 |
|---|---|---|---|---|---|---|---|---|---|
| A | | | | 0 | 0 | 0 | 0 | 0 | 0 |
| B | | | | 0 | 0 | 0 | 0 | 0 | 0 |
| C | | | | 0 | 0 | 0 | 0 | 1 | 1 |
| D | | | | 5 | 15 | 6 | 7 | 9 | 42 |
| Total | | | | 5 | 15 | 6 | 7 | 10 | 43 |

**Newly stocked**

| Section | March | April | May | June | July | Aug | Sept | Oct-Dec | 1999 |
|---|---|---|---|---|---|---|---|---|---|
| A | 0 | 7 | 38 | 0 | 0 | 0 | 0 | 2 | 47 |
| B | 0 | 0 | 5 | 7 | 0 | 0 | 0 | 4 | 16 |
| C | 0 | 0 | 22 | 39 | 56 | 21 | 10 | 3 | 151 |
| D | 0 | 0 | 13 | 43 | 60 | 15 | 3 | 18 | 152 |
| Total | 0 | 7 | 78 | 89 | 116 | 36 | 13 | 27 | 366 |

Table 11. Monthly summary of locations of ultrasonically tagged rainbow trout in Lake Ogallala, 2000.

**2000 All**

| Section | March | April | May | June | July | Aug | Sept | Oct-Dec | 2000 |
|---|---|---|---|---|---|---|---|---|---|
| A | 5 | 4 | 4 | 0 | 0 | 6 | 0 | | 19 |
| B | 0 | 0 | 34 | 30 | 4 | 2 | 0 | | 70 |
| C | 0 | 0 | 20 | 41 | 25 | 28 | 0 | | 114 |
| D | 3 | 3 | 73 | 78 | 55 | 27 | 25 | | 264 |
| Total | 8 | 7 | 131 | 149 | 84 | 63 | 25 | | 467 |

**Resident**

| Section | March | April | May | June | July | Aug | Sept | Oct-Dec | 2000 |
|---|---|---|---|---|---|---|---|---|---|
| A | 4 | 3 | 3 | 0 | 0 | 6 | 0 | | 16 |
| B | 0 | 0 | 28 | 18 | 4 | 2 | 0 | | 52 |
| C | 0 | 0 | 20 | 37 | 25 | 28 | 0 | | 110 |
| D | 3 | 3 | 70 | 40 | 50 | 27 | 25 | | 218 |
| Total | 7 | 6 | 121 | 95 | 79 | 63 | 25 | | 396 |

**Newly stocked**

| Section | March | April | May | June | July | Aug | Sept | Oct-Dec | 2000 |
|---|---|---|---|---|---|---|---|---|---|
| A | 1 | 1 | 1 | 0 | 0 | | | | 3 |
| B | 0 | 0 | 6 | 12 | 0 | | | | 18 |
| C | 0 | 0 | 0 | 4 | 0 | | | | 4 |
| D | 0 | 0 | 3 | 38 | 5 | | | | 46 |
| Total | 1 | 1 | 10 | 54 | 5 | | | | 71 |

Table 12. Significant results ($P \leq 0.05$) of selection ratio analyses based on telemetry locations of rainbow trout in Lake Ogallala, March 1999 through September 2000. Variation in combination of data sets reveals importance of different groups of trout and/or time periods when they were observed (Parentheses = approaching significance, blank = selection according to availability).

| **Section**<br>**by Area** | 1999 All | 2000 All | 1999 New | 2000 New | 2000 Resident |
|---|---|---|---|---|---|
| **A** | | Negative | | Negative | Negative |
| **B** | Negative | | Negative | | |
| **C** | | | | | |
| **D** | | | | | |
| **by Volume** | | | | | |
| **A** | (Negative) | Negative | | Negative | Negative |
| **B** | Negative | (Negative) | Negative | | |
| **C** | | | | Negative | |
| **D** | | **Positive** | | | **Positive** |

| **Section**<br>**by Area** | 1999 New May-June | 1999 New July-Sept | 2000 New May-June | 2000 Resident May-June | 2000 Resident July-Sept | 99/00 Resident May-June | 99/00 Resident July-Sept | 99/00 New May-June | 99/00 New July-Sept |
|---|---|---|---|---|---|---|---|---|---|
| **A** | | Negative | Negative | Negative | Negative | Negative | Negative | | Negative |
| **B** | | Negative | | | Negative | | Negative | | Negative |
| **C** | | | | | | | | | |
| **D** | | | | | | | | | |
| **by Volume** | | | | | | | | | |
| **A** | | Negative | Negative | Negative | Negative | Negative | Negative | | Negative |
| **B** | Negative | Negative | | | Negative | | Negative | (Negative) | Negative |
| **C** | | | (Negative) | | | | | | |
| **D** | | | | | **Positive** | | **Positive** | | **Positive** |

Table 12 (continued).

| **Section** | | 99/00 All | 99/00 All | | 99/00 |
|---|---|---|---|---|---|
| **by Area** | 99/00 All | May-June | July-Sept | 99/00 New | Resident |
| **A** | Negative | | Negative | | Negative |
| **B** | | | Negative | (Negative) | |
| **C** | | | | | |
| **D** | | | | | |
| **by Volume** | | | | | |
| **A** | Negative | Negative | Negative | Negative | Negative |
| **B** | Negative | | Negative | Negative | (Negative) |
| **C** | | | | | |
| **D** | **Positive** | **Positive** | **Positive** | | **Positive** |

Table 13. Monthly summary of locations of ultrasonically tagged brown trout in Lake Ogallala, 1999-2000.

**1999**

| Section | March | April | May | June | July | Aug | Sept | Oct-Dec | 1999 |
|---|---|---|---|---|---|---|---|---|---|
| A | 0 | 4 | 0 | 1 | 0 | 0 | 0 | 9 | 14 |
| B | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 1 | 6 |
| C | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 4 |
| D | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| Total | 0 | 8 | 0 | 4 | 2 | 0 | 0 | 12 | 26 |

**2000**

| Section | March | April | May | June | July | Aug | Sept | Oct-Dec | 2000 |
|---|---|---|---|---|---|---|---|---|---|
| A | | | | 0 | 2 | 15 | 1 | | 18 |
| B | | | | 5 | 18 | 1 | 0 | | 24 |
| C | | | | 0 | 3 | 0 | 0 | | 3 |
| D | | | | 1 | 0 | 0 | 0 | | 1 |
| Total | | | | 6 | 23 | 16 | 1 | | 46 |

**1999-2000**

| Section | March | April | May | June | July | Aug | Sept | Oct-Dec | Total |
|---|---|---|---|---|---|---|---|---|---|
| A | 0 | 4 | 0 | 1 | 2 | 15 | 1 | 9 | 32 |
| B | 0 | 4 | 0 | 5 | 19 | 1 | 0 | 1 | 30 |
| C | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 2 | 7 |
| D | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 3 |
| Total | 0 | 8 | 0 | 10 | 25 | 16 | 1 | 12 | 72 |

Table 14. Significant results ($P \leq 0.05$) of selection ratio analyses based on telemetry locations of brown trout in Lake Ogallala, March 1999 through September 2000. Variation in combination of data sets reveals importance of different groups of trout and/or time periods when they were observed (Parentheses = approaching significance, blank = selection according to availability).

| **Section** | | | |
|---|---|---|---|
| **by Area** | 1999 All | 2000 All | 99/00 All |
| **A** | | **Positive** | **Positive** |
| **B** | | | |
| **C** | | | |
| **D** | Negative | Negative | Negative |
| **by Volume** | | | |
| **A** | | | **Positive** |
| **B** | | | |
| **C** | | | (Negative) |
| **D** | | | Negative |

Table 15. Mean comparison test of water column depth utilized in Lake Ogallala within a time*section*type interaction effect (df = 755). Time: 1 = sunrise to 1300 hours, 2 = 1300 hours to sunset, 3 = sunset to sunrise.

| Section 1 | Type 1 | Time 1 | Section 2 | Type 2 | Time 2 | Diff Estimate | SE | t-value | Pr > \|t\| | |
|---|---|---|---|---|---|---|---|---|---|---|
| A | New | 1 | A | New | 2 | -0.8729 | 0.3813 | -2.29 | 0.0223 | * |
| A | Resident | 1 | B | Resident | 1 | -2.4163 | 1.1904 | -2.03 | 0.0427 | * |
| A | Resident | 2 | B | Resident | 2 | -2.9429 | 0.9773 | -3.01 | 0.0027 | * |
| A | New | 1 | C | New | 1 | -2.3203 | 0.6582 | -3.53 | 0.0004 | * |
| A | New | 2 | C | New | 2 | -2.1507 | 0.6681 | -3.22 | 0.0013 | * |
| A | New | 1 | D | New | 1 | 4.6764 | 0.6144 | 7.61 | <.0001 | * |
| A | Resident | 1 | D | Resident | 1 | 2.8104 | 1.093 | 2.57 | 0.0103 | * |
| A | New | 2 | D | New | 2 | 5.4902 | 0.6241 | 8.8 | <.0001 | * |
| A | Resident | 2 | D | Resident | 2 | 2.8253 | 0.7495 | 3.77 | 0.0002 | * |
| A | New | 3 | D | New | 3 | 4.2367 | 1.8277 | 2.32 | 0.0207 | * |
| B | Resident | 1 | B | Resident | 3 | 3.3156 | 1.0683 | 3.1 | 0.002 | * |
| B | Resident | 2 | B | Resident | 3 | 4.0163 | 1.1246 | 3.57 | 0.0004 | * |
| B | New | 2 | C | New | 2 | -1.746 | 0.7439 | -2.35 | 0.0192 | * |
| B | Resident | 2 | C | Resident | 2 | 2.6781 | 0.8815 | 3.04 | 0.0025 | * |
| B | New | 1 | D | New | 1 | 5.7805 | 0.7116 | 8.12 | <.0001 | * |
| B | Resident | 1 | D | Resident | 1 | 5.2267 | 0.6646 | 7.86 | <.0001 | * |
| B | New | 2 | D | New | 2 | 5.8949 | 0.7318 | 8.06 | <.0001 | * |
| B | Resident | 2 | D | Resident | 2 | 5.7682 | 0.8219 | 7.02 | <.0001 | * |
| C | New | 1 | C | New | 2 | -0.7033 | 0.3177 | -2.21 | 0.0272 | * |
| C | Resident | 1 | C | Resident | 2 | 1.6973 | 0.4475 | 3.79 | 0.0002 | * |
| C | Resident | 1 | C | Resident | 3 | 3.6289 | 0.5678 | 6.39 | <.0001 | * |
| C | Resident | 2 | C | Resident | 3 | 1.9316 | 0.629 | 3.07 | 0.0022 | * |
| C | New | 1 | D | New | 1 | 6.9967 | 0.5934 | 11.79 | <.0001 | * |
| C | Resident | 1 | D | Resident | 1 | 4.9466 | 0.5705 | 8.67 | <.0001 | * |
| C | New | 2 | D | New | 2 | 7.6409 | 0.6036 | 12.66 | <.0001 | * |
| C | Resident | 2 | D | Resident | 2 | 3.0901 | 0.6376 | 4.85 | <.0001 | * |
| A | New | 1 | A | New | 3 | 1.1688 | 1.0961 | 1.07 | 0.2866 | |
| A | Resident | 1 | A | Resident | 2 | -0.1741 | 1.2435 | -0.14 | 0.8887 | |
| A | New | 2 | A | New | 3 | 2.0418 | 1.1032 | 1.85 | 0.0646 | |
| A | New | 1 | B | New | 1 | -1.1041 | 0.7297 | -1.51 | 0.1307 | |
| A | New | 2 | B | New | 2 | -0.4047 | 0.7603 | -0.53 | 0.5946 | |
| A | Resident | 1 | C | Resident | 1 | -2.1362 | 1.1378 | -1.88 | 0.0608 | |
| A | Resident | 2 | C | Resident | 2 | -0.2648 | 0.8627 | -0.31 | 0.759 | |
| B | New | 1 | B | New | 2 | -0.1736 | 0.6479 | -0.27 | 0.7888 | |
| B | Resident | 1 | B | Resident | 2 | -0.7007 | 0.6883 | -1.02 | 0.309 | |
| B | New | 1 | C | New | 1 | -1.2162 | 0.697 | -1.75 | 0.0814 | |
| B | Resident | 1 | C | Resident | 1 | 0.2801 | 0.7115 | 0.39 | 0.694 | |
| B | Resident | 3 | C | Resident | 3 | 0.5934 | 1.2855 | 0.46 | 0.6445 | |
| B | Resident | 3 | D | Resident | 3 | 1.7229 | 1.2407 | 1.39 | 0.1653 | |

Table 15. (continued).

| Section 1 | Type 1 | Time 1 | Section 2 | Type 2 | Time 2 | Diff Estimate | SE | t-value | Pr > \|t\| | |
|---|---|---|---|---|---|---|---|---|---|---|
| C | Resident | 3 | D | Resident | 3 | 1.1296 | 0.7995 | 1.41 | 0.1581 | |
| D | New | 1 | D | New | 2 | -0.05912 | 0.2953 | -0.2 | 0.8414 | |
| D | New | 1 | D | New | 3 | 0.7292 | 1.401 | 0.52 | 0.6029 | |
| D | Resident | 1 | D | Resident | 2 | -0.1592 | 0.2865 | -0.56 | 0.5787 | |
| D | Resident | 1 | D | Resident | 3 | -0.1881 | 0.416 | -0.45 | 0.6512 | |
| D | New | 2 | D | New | 3 | 0.7883 | 1.4171 | 0.56 | 0.5782 | |
| D | Resident | 2 | D | Resident | 3 | -0.02899 | 0.4456 | -0.07 | 0.9481 | |
| A | New | 2 | A | Resident | 2 | 2.8057 | 0.7594 | 3.69 | 0.0002 | * |
| C | New | 1 | C | Resident | 1 | 2.291 | 0.7037 | 3.26 | 0.0012 | * |
| C | New | 2 | C | Resident | 2 | 4.6917 | 0.7442 | 6.3 | <.0001 | * |
| A | New | 1 | A | Resident | 1 | 2.1068 | 1.1215 | 1.88 | 0.0607 | |
| B | New | 1 | B | Resident | 1 | 0.7947 | 0.7786 | 1.02 | 0.3078 | |
| B | New | 2 | B | Resident | 2 | 0.2676 | 0.9178 | 0.29 | 0.7707 | |
| D | New | 1 | D | Resident | 1 | 0.2409 | 0.535 | 0.45 | 0.6526 | |
| D | New | 2 | D | Resident | 2 | 0.1409 | 0.5554 | 0.25 | 0.7998 | |
| D | New | 3 | D | Resident | 3 | -0.6764 | 1.5065 | -0.45 | 0.6536 | |

Table 16. Diel movements of rainbow trout in Lake Ogallala sorted by transmitter number. MDT times are approximate; hyphen in section indicates movement between sections within observation period.

| Observation period | Transmitter number | Section | Month | Distance Moved | Distance Moved per hr | Water column depth @ begin |
|---|---|---|---|---|---|---|
| 0800-1100 | 456 | D | 5 | 121 | 44 | 1.5 |
| 1100-1400 | 456 | D | 5 | 189 | 67 | 1.9 |
| 1400-1700 | 456 | D | 5 | 6 | 2 | 2.0 |
| 1700-2000 | 456 | D | 5 | 304 | 99 | 2.1 |
| 2000-2300 | 456 | D | 5 | 168 | 52 | 2.1 |
| 2300-0200 | 456 | D | 5 | 37 | 10 | 2.1 |
| 0200-0500 | 456 | D | 5 | 325 | 163 | 1.4 |
| 0500-0800 | 456 | D | 5 | 295 | 89 | 1.1 |
|  |  |  | Total | 1445 |  |  |
| 0800-1100 | 589 | C | 5 | 375 | 125 | 2.3 |
| 1100-1400 | 589 | C-D | 5 | 113 | 40 | 1.6 |
| 1400-1700 | 589 | D | 5 | 518 | 145 | 1.4 |
| 1700-2000 | 589 | D | 5 | 581 | 183 | 1.1 |
| 2000-2300 | 589 | D | 5 | 3 | 1 | 1.4 |
| 2300-0200 | 589 | D | 5 | 21 | 6 | 1.3 |
| 0200-0500 | 589 | D-C | 5 | 359 | 144 | 1.2 |
| 0500-0800 | 589 | C-D | 5 | 458 | 137 | 1.3 |
|  |  |  | Total | 2428 |  |  |
| 0800-1100 | 788 | B | 5 | 32 | 12 | 7.1 |
| 1100-1400 | 788 | B | 5 | 36 | 12 | 7.7 |
| 1400-1700 | 788 | B | 5 | 26 | 9 | 7.6 |
| 1700-2000 | 788 | B | 5 | 177 | 56 | 7.7 |
| 2000-2300 | 788 | B | 5 | 68 | 22 | 8.1 |
| 2300-0200 | 788 | B | 5 | 42 | 13 | 1.7 |
| 0200-0500 | 788 | B | 5 | 81 | 31 | 1.2 |
| 0500-0800 | 788 | B | 5 | 89 | 26 | 3.5 |
|  |  |  | Total | 551 |  |  |
| 0800-1100 | 7614 | A | 5 | 82 | 30 | 3.9 |
| 1100-1400 | 7614 | A | 5 | 173 | 56 | 10.0 |
| 1400-1700 | 7614 | A | 5 | 53 | 18 | 8.7 |
| 1700-2000 | 7614 | A | 5 | 44 | 14 | 8.7 |
| 2000-2300 | 7614 | A | 5 | 27 | 10 | 7.4 |
| 2300-0200 | 7614 | A | 5 | 20 | 7 | 3.8 |
| 0200-0500 | 7614 | A | 5 | 20 | 7 | 2.8 |
| 0500-0800 | 7614 | A | 5 | 92 | 31 | 4.0 |
|  |  |  | Total | 511 |  |  |

Table 16 (continued).

| Observation period | Transmitter number | Section | Month | Distance Moved | Distance Moved per hr | Water column depth @ begin |
|---|---|---|---|---|---|---|
| 0800-1100 | 589 | C | 6 | 173 | 80 | 2.7 |
| 1100-1400 | 589 | C | 6 | 245 | 75 | 2.3 |
| 1400-1700 | 589 | C | 6 | 15 | 5 | 1.6 |
| 1700-2000 | 589 | C | 6 | 52 | 20 | 1.5 |
| 2000-2300 | 589 | C | 6 | 97 | 33 | 1.8 |
| 2300-0200 | 589 | C | 6 | 38 | 12 | 2.4 |
| 0200-0500 | 589 | C | 6 | 221 | 91 | 1.6 |
| 0500-0800 | 589 | C | 6 | 195 | 53 | 2.0 |
| | | | Total | 1036 | | |
| 0800-1100 | 788 | B | 6 | 80 | 36 | 8.5 |
| 1100-1400 | 788 | B | 6 | 163 | 59 | 9.2 |
| 1400-1700 | 788 | B-C | 6 | 486 | 124 | 7.8 |
| 1700-2000 | 788 | C | 6 | 340 | 136 | 9.7 |
| 2000-2300 | 788 | C | 6 | 189 | 63 | 11.0 |
| 2300-0200 | 788 | C | 6 | 236 | 75 | 10.5 |
| 0200-0500 | 788 | C | 6 | 409 | 129 | 8.5 |
| 0500-0800 | 788 | C-B | 6 | 158 | 53 | 9.7 |
| | | | Total | 2061 | | |
| 2000-2300 | 4610 | D | 6 | 82 | 23 | 2.6 |
| 2300-0200 | 4610 | D | 6 | 173 | 52 | 0.8 |
| 0200-0500 | 4610 | D | 6 | 53 | 18 | 0.8 |
| 0500-0800 | 4610 | D | 6 | 44 | 14 | 2.0 |
| | | | Total | 352 | | |
| 0800-1100 | 7713 | D | 6 | 66 | 24 | 1.6 |
| 1100-1400 | 7713 | D | 6 | 176 | 45 | 1.0 |
| 2000-2300 | 7713 | D | 6 | 45 | 15 | 1.8 |
| 2300-0200 | 7713 | D | 6 | 105 | 34 | 0.7 |
| 0200-0500 | 7713 | D | 6 | 75 | 27 | 0.7 |
| 0500-0800 | 7713 | D | 6 | 142 | 49 | 1.1 |
| | | | Total | 678 | | |

Table 16 (continued).

| Observation period | Transmitter number | Section | Month | Distance Moved | Distance Moved per hr | Water column depth @ begin |
|---|---|---|---|---|---|---|
| 0800-1100 | 39 | D | 7 | 41 | 22 | 2.3 |
| 1100-1400 | 39 | D | 7 | 127 | 38 | 2.4 |
| 1400-1700 | 39 | D | 7 | 50 | 15 | 1.4 |
| 1700-2000 | 39 | D | 7 | 238 | 71 | 1.3 |
| 2000-2300 | 39 | D | 7 | 69 | 28 | 2.8 |
| 2300-0200 | 39 | D | 7 | 135 | 49 | 2.6 |
| 0200-0500 | 39 | D | 7 | 128 | 40 | 2.5 |
| 0500-0800 | 39 | D | 7 | 157 | 47 | 1.4 |
| | | | Total | 945 | | |
| 0800-1100 | 252 | C | 7 | 80 | 26 | 1.0 |
| 1100-1400 | 252 | C | 7 | 163 | 24 | 10.5 |
| 1400-1700 | 252 | C | 7 | 486 | 13 | 1.7 |
| 1700-2000 | 252 | C | 7 | 340 | 20 | 1.0 |
| 2000-2300 | 252 | C | 7 | 189 | 5 | 1.8 |
| 2300-0200 | 252 | C | 7 | 236 | 7 | 2.1 |
| 0200-0500 | 252 | C | 7 | 409 | 286 | 1.0 |
| 0500-0800 | 252 | C | 7 | 158 | 286 | 1.2 |
| | | | Total | 2061 | 667 | |
| 0800-1100 | 589 | D | 7 | 92 | 46 | 1.2 |
| 1100-1400 | 589 | D | 7 | 162 | 50 | 1.3 |
| 1400-1700 | 589 | D | 7 | 17 | 5 | 1.4 |
| 1700-2000 | 589 | D | 7 | 19 | 6 | 1.3 |
| 2000-2300 | 589 | D | 7 | 59 | 24 | 2.0 |
| 2300-0200 | 589 | D | 7 | 18 | 6 | 2.1 |
| 0200-0500 | 589 | D | 7 | 19 | 6 | 2.0 |
| 0500-0800 | 589 | D | 7 | 40 | 11 | 1.8 |
| | | | Total | 426 | | |

Table 16 (continued).

| Observation period | Transmitter number | Section | Month | Distance Moved | Distance Moved per hr | Water column depth @ begin |
|---|---|---|---|---|---|---|
| 0800-1100 | 252 | C | 8 | 330 | 110 | 10.5 |
| 1100-1400 | 252 | C | 8 | 76 | 29 | 3.8 |
| 1400-1700 | 252 | C | 8 | 2 | 1 | 1.0 |
| 1700-2000 | 252 | C | 8 | 37 | 12 | 1.0 |
| 2000-2300 | 252 | C | 8 | 162 | 46 | 1.9 |
| 2300-0200 | 252 | C | 8 | 16 | 5 | 1.0 |
| 0200-0500 | 252 | C | 8 | 23 | 8 | 1.5 |
| 0500-0800 | 252 | C | 8 | 338 | 104 | 4.8 |
| | | | Total | 984 | | |
| 0800-1100 | 348 | C | 8 | 43 | 43 | 3.5 |
| 1100-1400 | 348 | C | 8 | 29 | 12 | 3.8 |
| 1400-1700 | 348 | C | 8 | 59 | 21 | 2.0 |
| 1700-2000 | 348 | C | 8 | 75 | 23 | 1.6 |
| 2000-2300 | 348 | C | 8 | 134 | 43 | 3.3 |
| 2300-0200 | 348 | C | 8 | 25 | 8 | 1.9 |
| 0200-0500 | 348 | C | 8 | 16 | 6 | 0.9 |
| 0500-0800 | 348 | C | 8 | 70 | 22 | 1.8 |
| | | | Total | 451 | | |
| 0800-1100 | 444 | D | 8 | 839 | 296 | 1.4 |
| 1100-1400 | 444 | D | 8 | 301 | 106 | 1.9 |
| 1400-1700 | 444 | D | 8 | 117 | 50 | 2.4 |
| 1700-2000 | 444 | D | 8 | 227 | 76 | 2.4 |
| 2000-2300 | 444 | D | 8 | 546 | 156 | 2.1 |
| 2300-0200 | 444 | D | 8 | 761 | 254 | 1.1 |
| 0200-0500 | 444 | D | 8 | 72 | 26 | 1.0 |
| 0500-0800 | 444 | D | 8 | 183 | 59 | 0.9 |
| | | | Total | 3046 | | |

Table 17. Catch of rainbow and brown trout during night electrofishing in each section of Lake Ogallala, March-September 2000.

| | | **Rainbow trout** | | **Brown trout** | |
|---|---|---|---|---|---|
| **Month** | **Section** | **Number caught** | **Number caught per 100 m** | **Number caught** | **Number caught per 100 m** |
| March | A | 116 | 4.50 | 15 | 0.58 |
| May | A | 73 | 2.83 | 8 | 0.31 |
| June | A | 5 | 0.19 | 0 | 0.00 |
| July | A | 1 | 0.04 | 2 | 0.08 |
| August | A | 22 | 0.85 | 16 | 0.62 |
| September | A | 8 | 0.31 | 22 | 0.85 |
| Total | | 225 | | 63 | |
| March | B | 36 | 1.60 | 15 | 0.66 |
| May | B | 123 | 5.45 | 19 | 0.84 |
| June | B | 10 | 0.44 | 3 | 0.13 |
| July | B | 0 | 0.00 | 5 | 0.22 |
| August | B | 9 | 0.40 | 14 | 0.62 |
| September | B | 26 | 1.15 | 10 | 0.44 |
| Total | | 204 | | 66 | |
| March | C | 20 | 1.25 | 4 | 0.25 |
| May | C | 9 | 0.56 | 40 | 2.50 |
| June | C | 15 | 0.94 | 16 | 1.00 |
| July | C | 33 | 2.06 | 21 | 1.31 |
| August | C | 13 | 0.81 | 8 | 0.50 |
| September | C | 24 | 1.50 | 4 | 0.25 |
| Total | | 114 | | 93 | |
| March | D | 157 | 4.66 | 1 | 0.03 |
| May | D | 53 | 1.18 | 25 | 0.56 |
| June | D | 70 | 1.56 | 15 | 0.33 |
| July | D | 17 | 0.38 | 3 | 0.07 |
| August | D | 52 | 1.16 | 8 | 0.18 |
| September | D | 58 | 1.29 | 3 | 0.07 |
| Total | | 407 | | 55 | |
| March | Lake | 329 | 3.36 | 35 | 0.36 |
| May | Lake | 258 | 2.36 | 92 | 0.84 |
| June | Lake | 100 | 0.91 | 34 | 0.31 |
| July | Lake | 51 | 0.47 | 31 | 0.28 |
| August | Lake | 96 | 0.88 | 46 | 0.42 |
| September | Lake | 116 | 1.06 | 39 | 0.36 |
| Total | | 950 | | 277 | |

Table 18. Number of rainbow and brown trout tagged and released into each lake section from March through August 2000, and subsequent percent recapture from within or below Lake Ogallala.

| Rainbow trout | | % recapture in each area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Lake section | Number Tagged | Section A | Section B | Section C | Section D | River | Canal | Lake Unk | Unk | % rec |
| A | 193 | 3.6 | **7.3** | 4.1 | 6.2 | 0.5 | 3.1 | 1.0 | 0.0 | 25.9 |
| B | 155 | 0.6 | **11.6** | 7.7 | 3.2 | 1.3 | 1.3 | 0.0 | 1.3 | 27.1 |
| C | 78 | 2.6 | 2.6 | **7.7** | 3.8 | 3.8 | 0.0 | 2.6 | 0.0 | 23.1 |
| D | 314 | 2.5 | 1.9 | 3.2 | **14.6** | 4.1 | 3.2 | 1.0 | 0.0 | 30.6 |
| Entire lake | 740 | 2.7 | 5.4 | 5.0 | 9.1 | 2.6 | 2.8 | 1.1 | 0.3 | 28.9 |
| % of all recaps | | **9.3** | 18.7 | 17.3 | **31.3** | 8.9 | 9.8 | 3.7 | 0.9 | 100.0 |

| Brown trout | | % recapture in each area | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Lake section | Number Tagged | Section A | Section B | Section C | Section D | River | Canal | Lake Unk | Unk | % rec |
| A | 30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.3 | 3.3 |
| B | 50 | 0.0 | 8.0 | 0.0 | 0.0 | 4.0 | 2.0 | 0.0 | 0.0 | 14.0 |
| C | 69 | 7.2 | 4.3 | 4.3 | 1.4 | 0.0 | 0.0 | 0.0 | 0.0 | 17.4 |
| D | 39 | 0.0 | **5.1** | **5.1** | **2.6** | **5.1** | **5.1** | 0.0 | 0.0 | 23.1 |
| Entire lake | 188 | 2.7 | 4.8 | 2.7 | 1.1 | 2.1 | 1.6 | 0.0 | 0.5 | 15.4 |
| % of all recaps | | 17.2 | **31.0** | 17.2 | **6.9** | 13.8 | 10.3 | 0.0 | 3.4 | 100.0 |

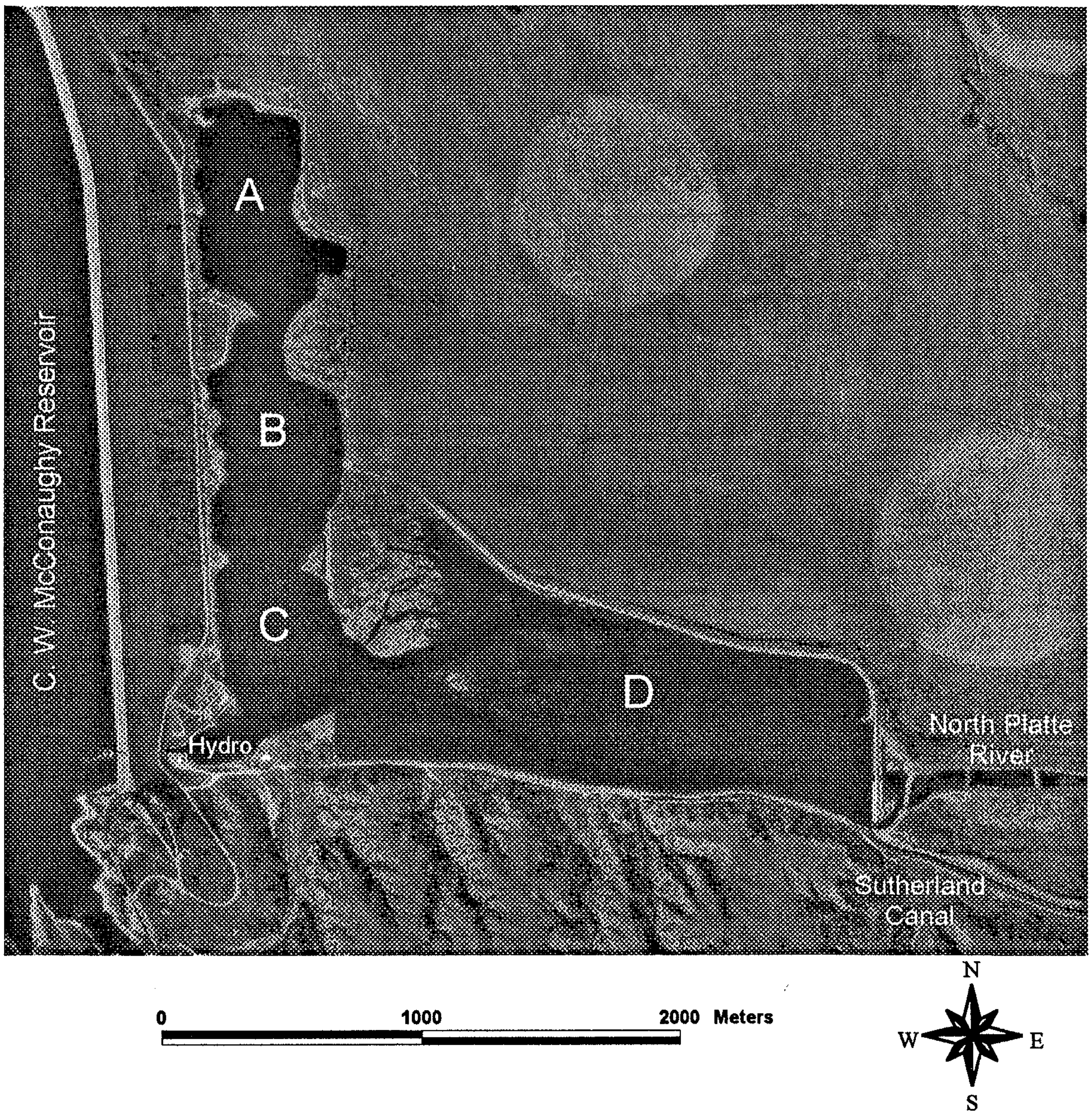

Figure 1. Lake Ogallala below C. W. McConaughy Reservoir on the North Platte River in western Nebraska. The lake was divided into sections to quantify movements of trout.

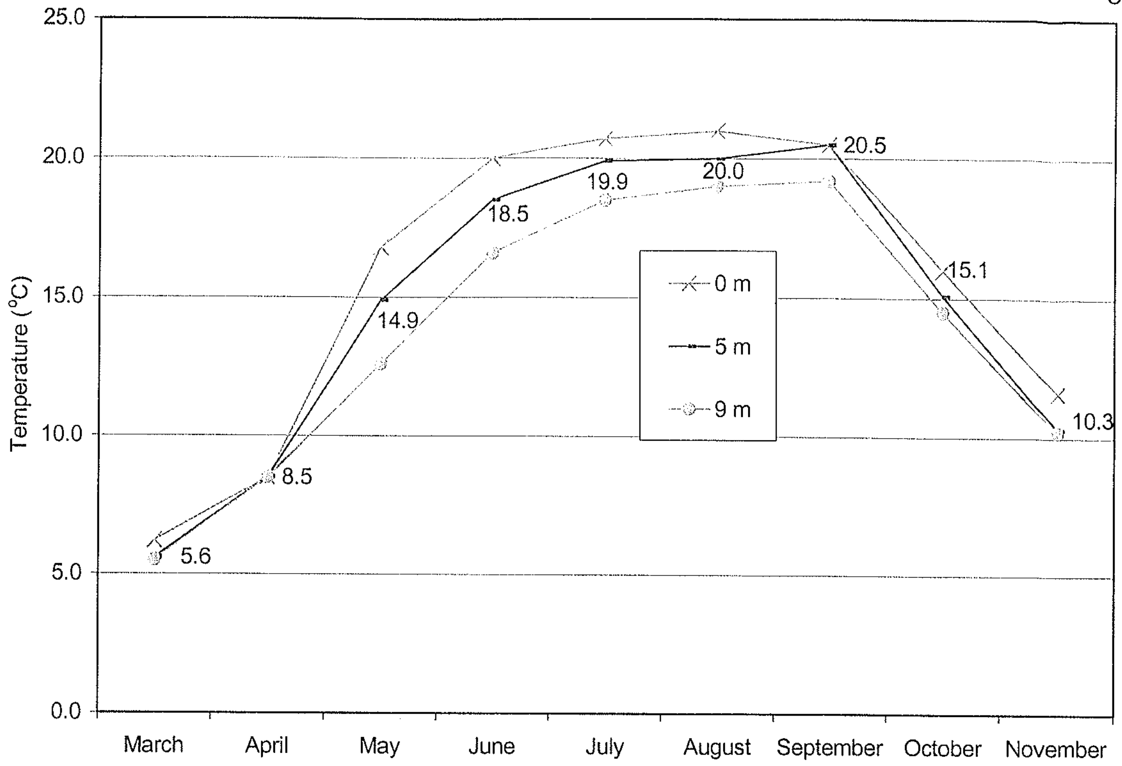

Figure 2. Maximum monthly temperature from the surface to 9 m in section A of Lake Ogallala, 1999.

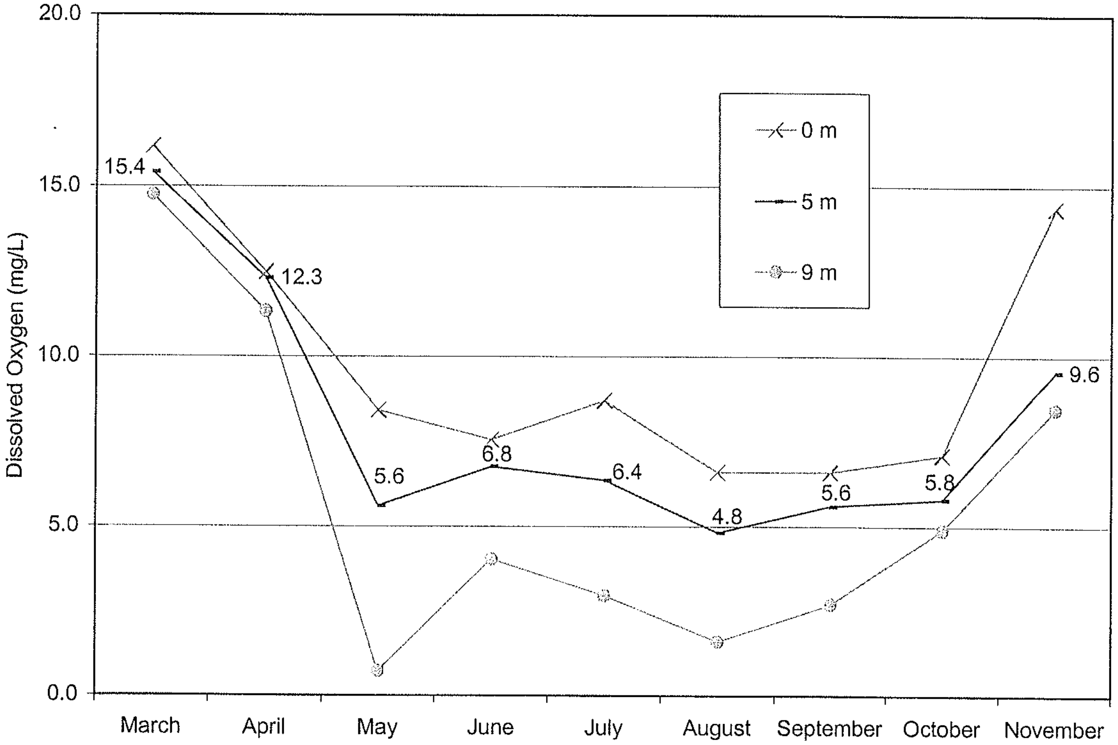

Figure 3. Minimum monthly dissolved oxygen from the surface to 9 m in section A of Lake Ogallala, 1999.

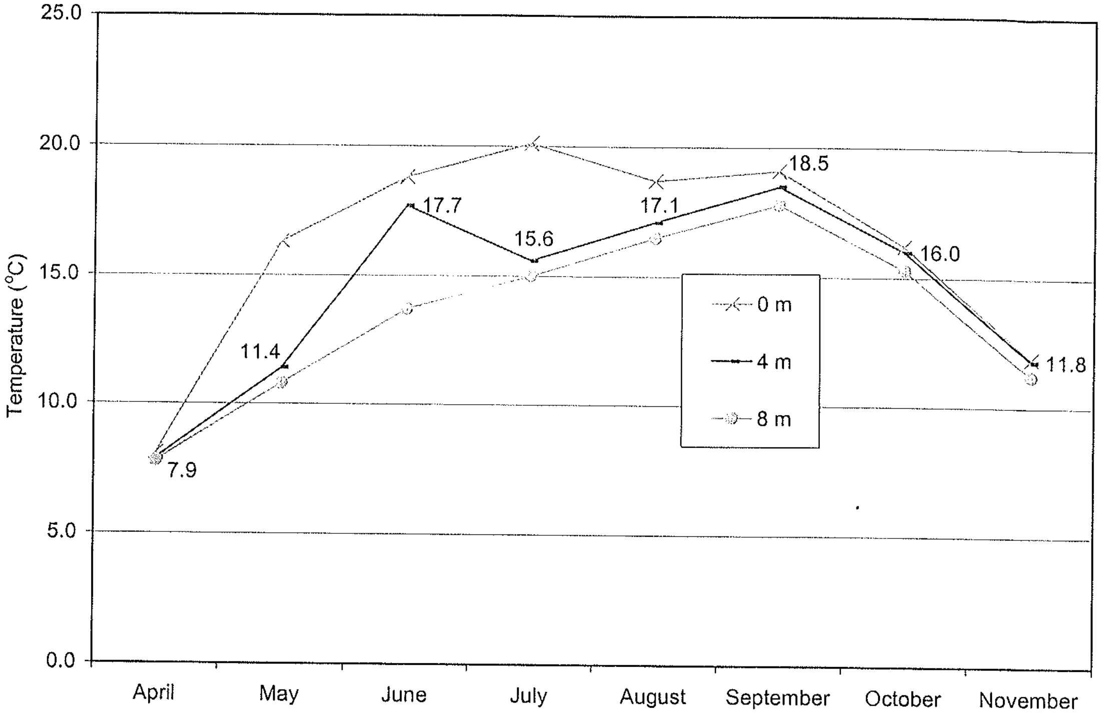

Figure 4. Maximum monthly temperature from the surface to 8 m in section B in Lake Ogallala, 1999.

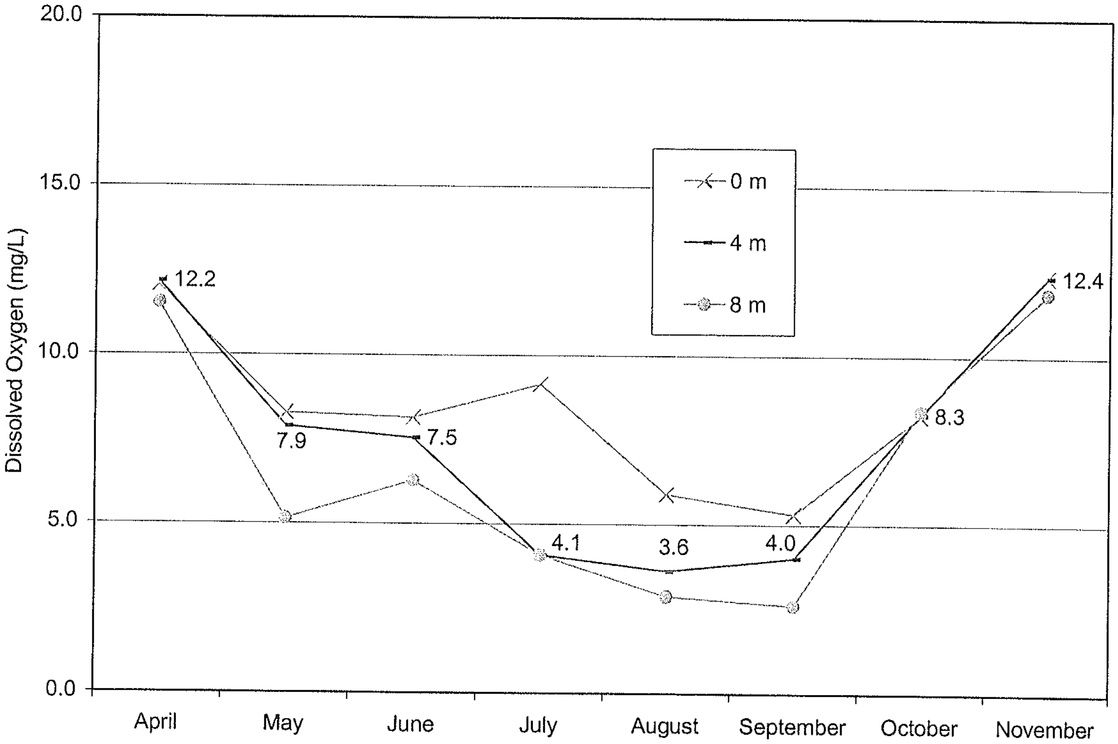

Figure 5. Minimum monthly dissolved oxygen from the surface to 8 m in section B of Lake Ogallala, 1999.

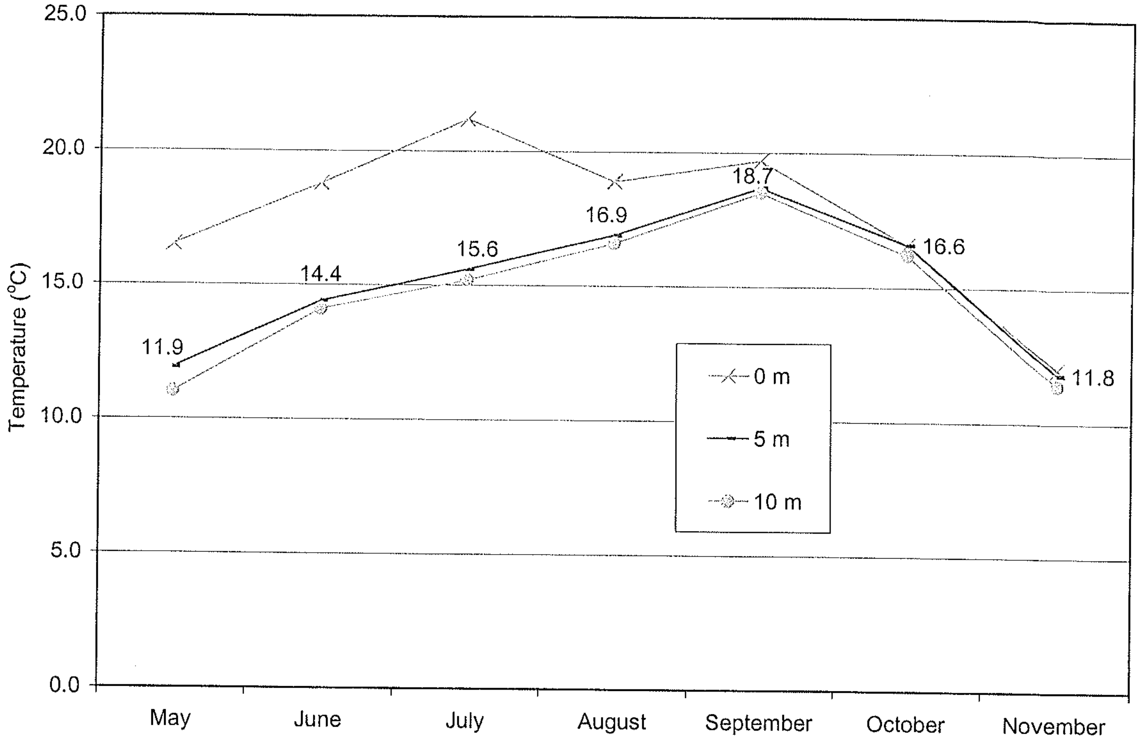

Figure 6. Maximum monthly temperature from the surface to 10 m in section C of Lake Ogallala, 1999.

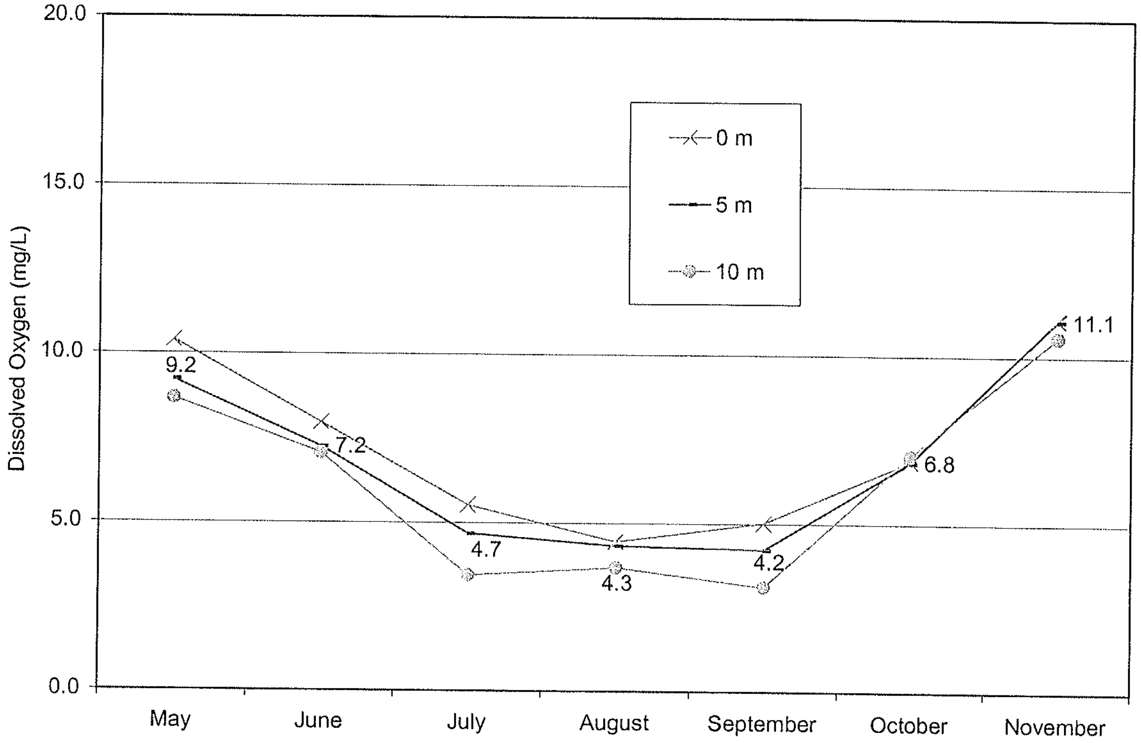

Figure 7. Minimum monthly dissolved oxygen from the surface to 10 m in section C of Lake Ogallala, 1999.

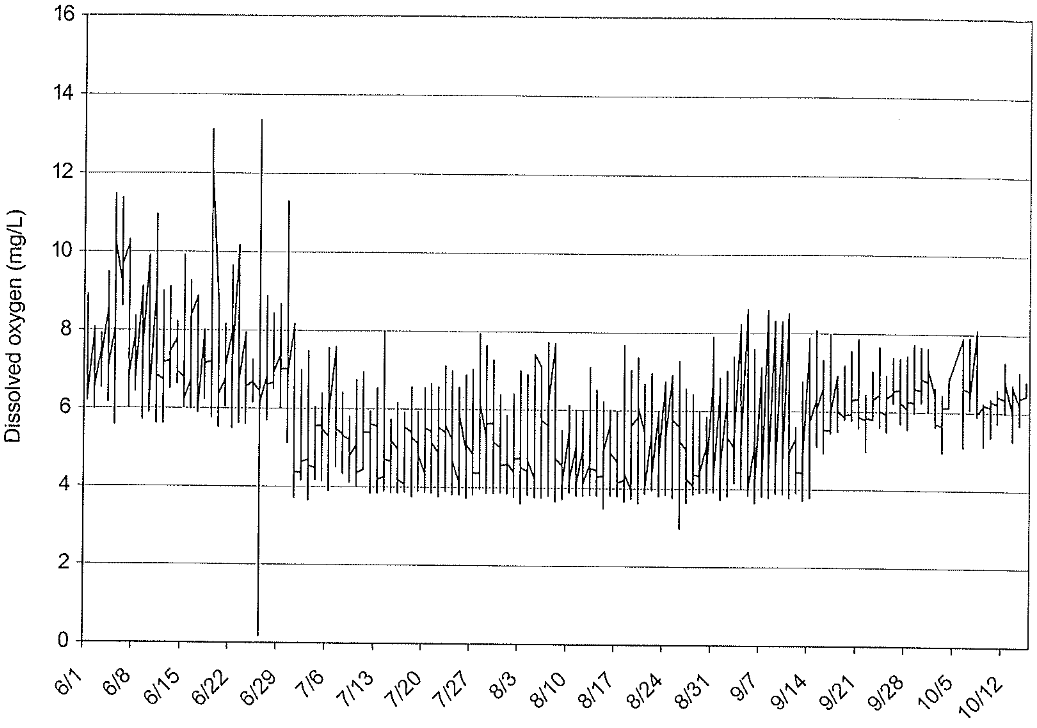

Figure 8. Daily range of dissolved oxygen at the buoy line below Kingsley hydroelectric discharge from readings taken at 10-min intervals, 1 June through 15 October 1999.

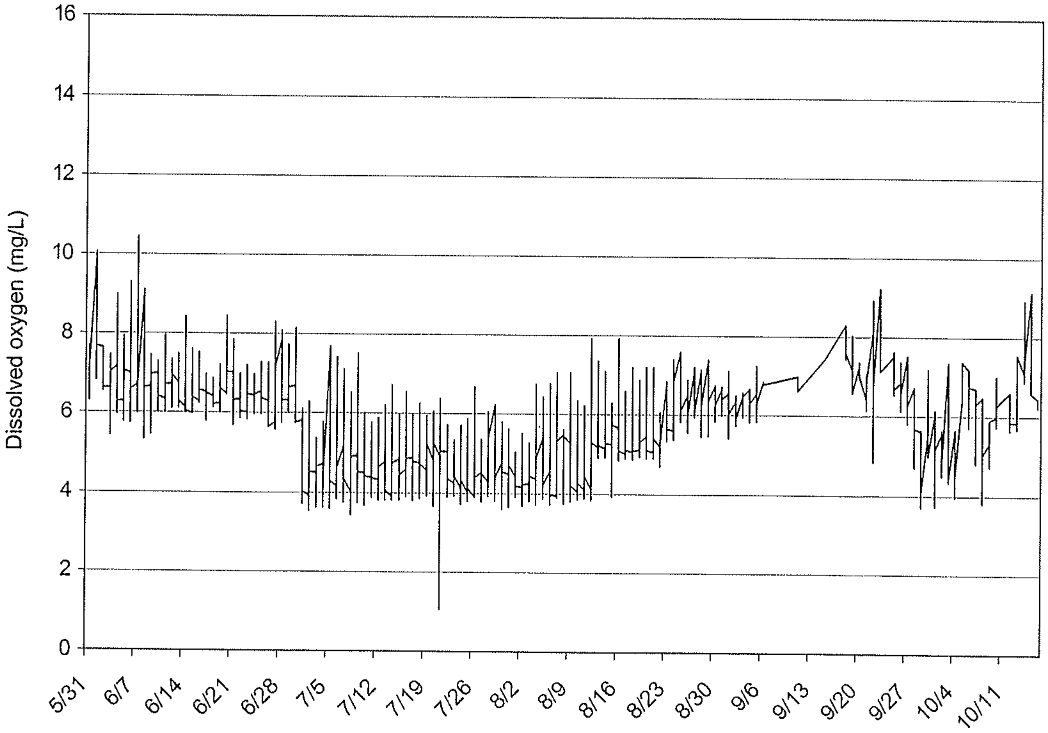

Figure 9. Daily range of dissolved oxygen at the buoy line below Kingsley hydroelectric discharge from readings taken at 10-min intervals, 31 May through 15 October 2000.

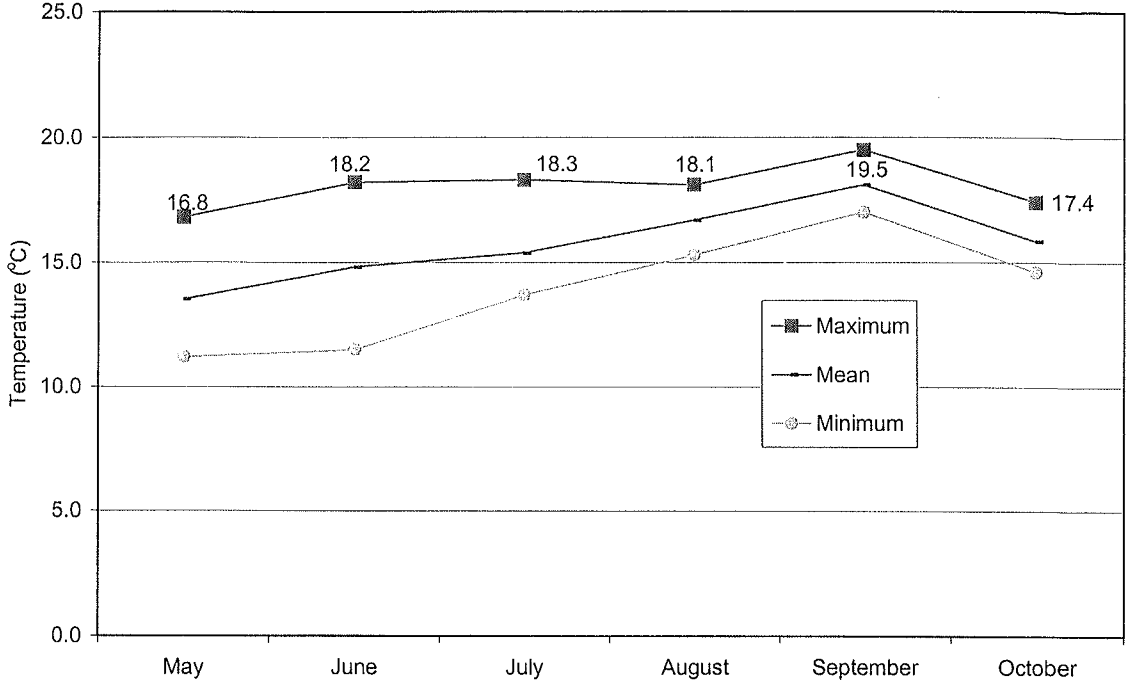

Figure 10. Minimum, mean, and maximum monthly temperature at 1 m depth in section D of Lake Ogallala, 1999.

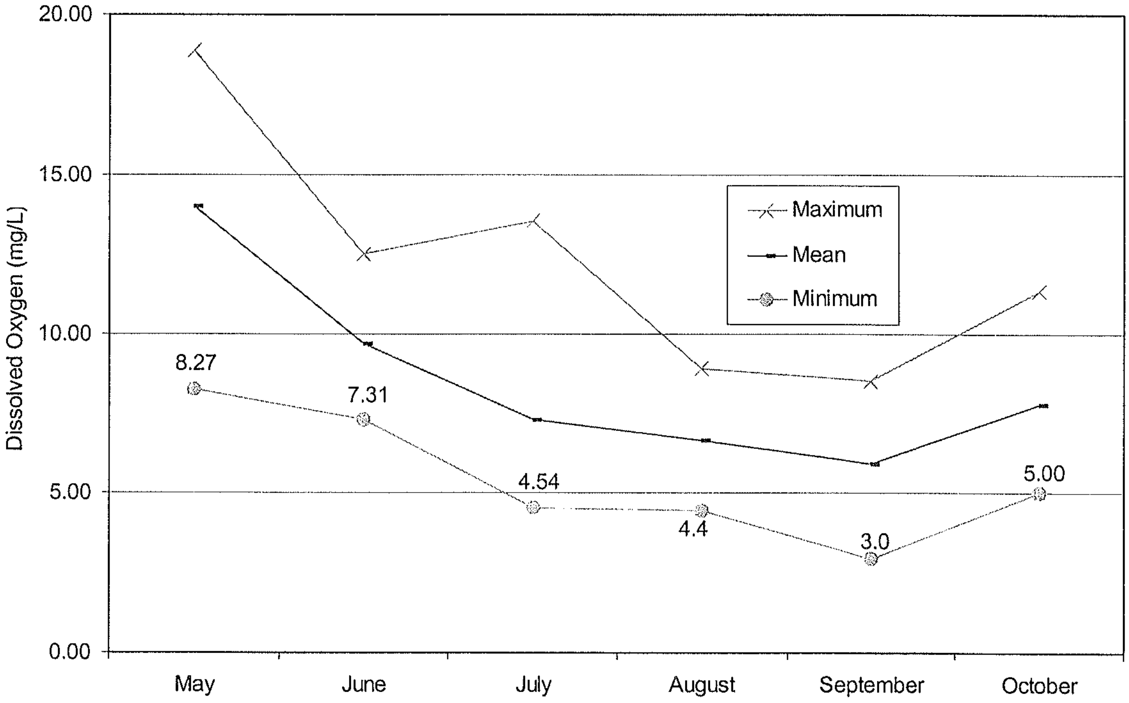

Figure 11. Minimum, mean ,and maximum monthly dissolved oxygen at 1 m depth in section D of Lake Ogallala, 1999.

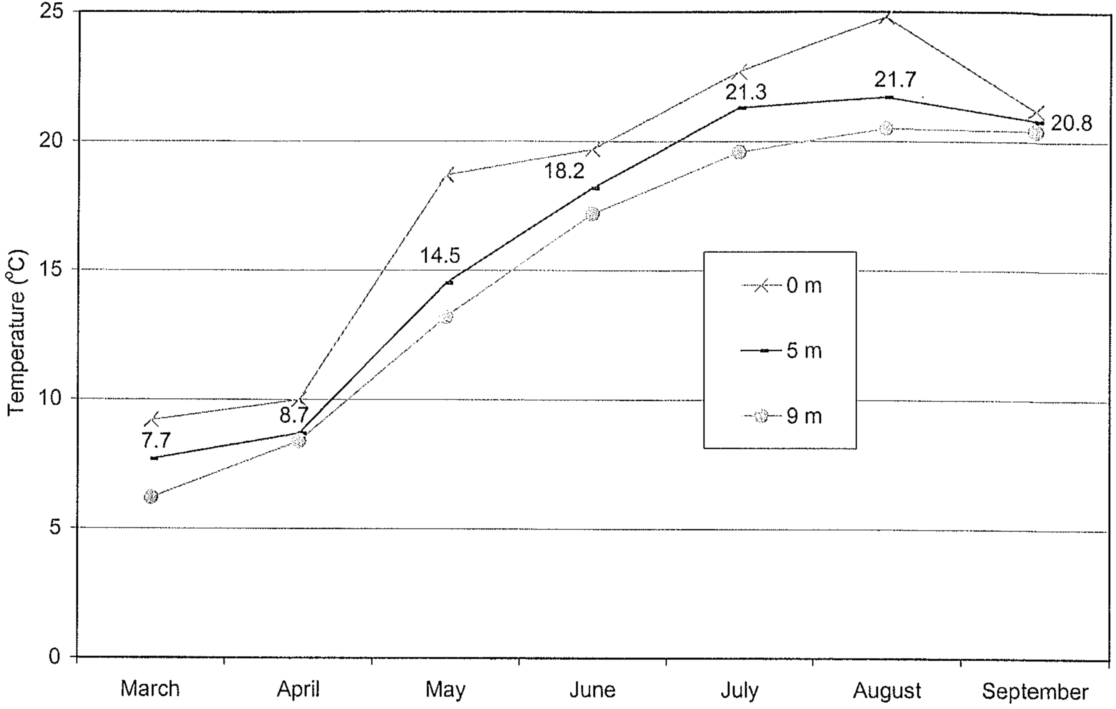

Figure 12. Maximum monthly temperature from the surface to 9 m in section A of Lake Ogallala, 2000.

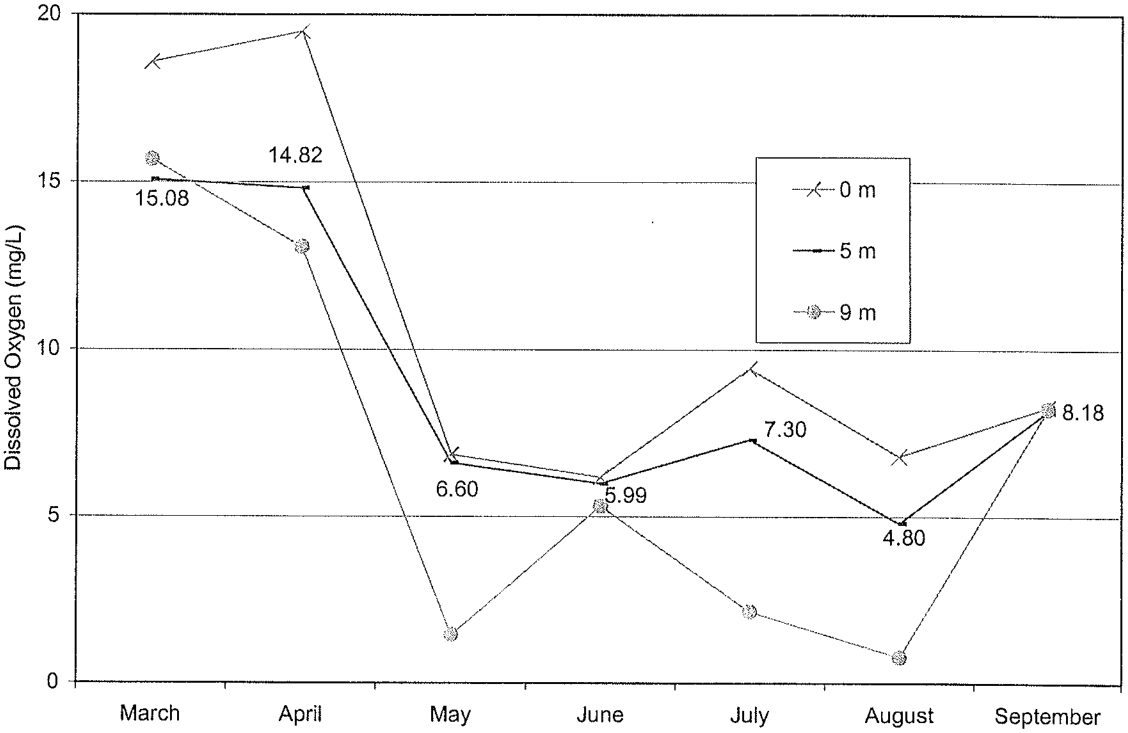

Figure 13. Minimum monthly dissolved oxygen from the surface to 9 m in section A of Lake Ogallala, 2000.

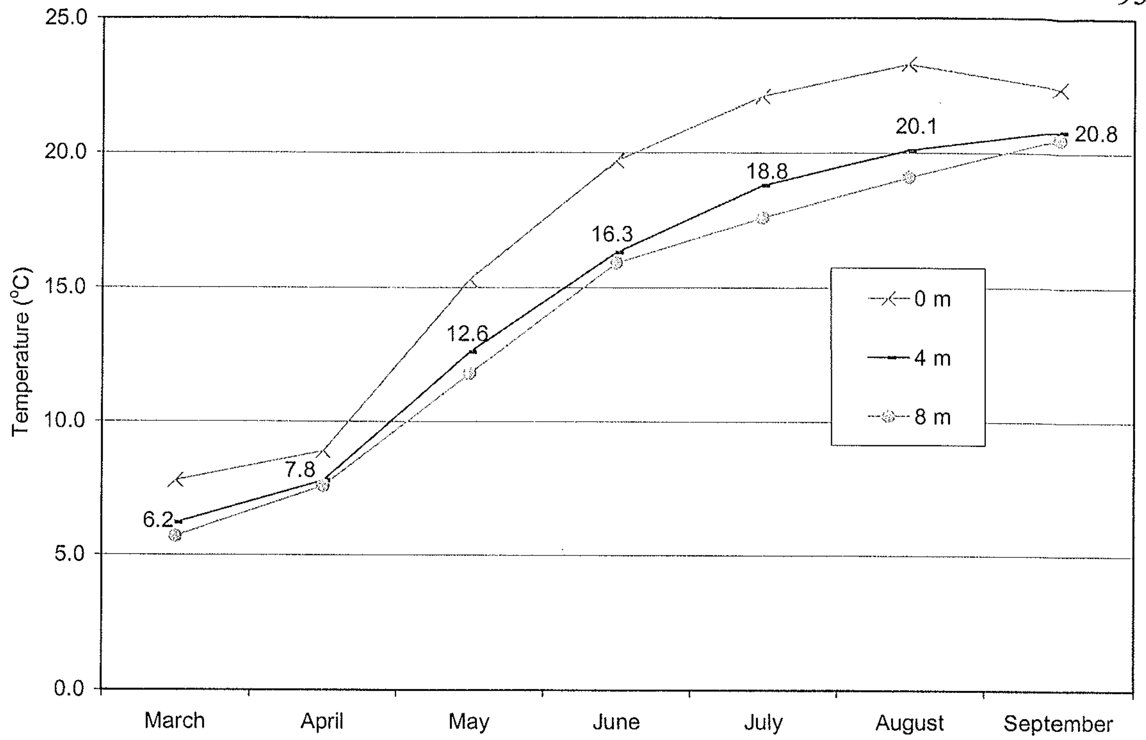

Figure 14. Maximum monthly temperature from the surface to 8 m in section B of Lake Ogallala, 2000.

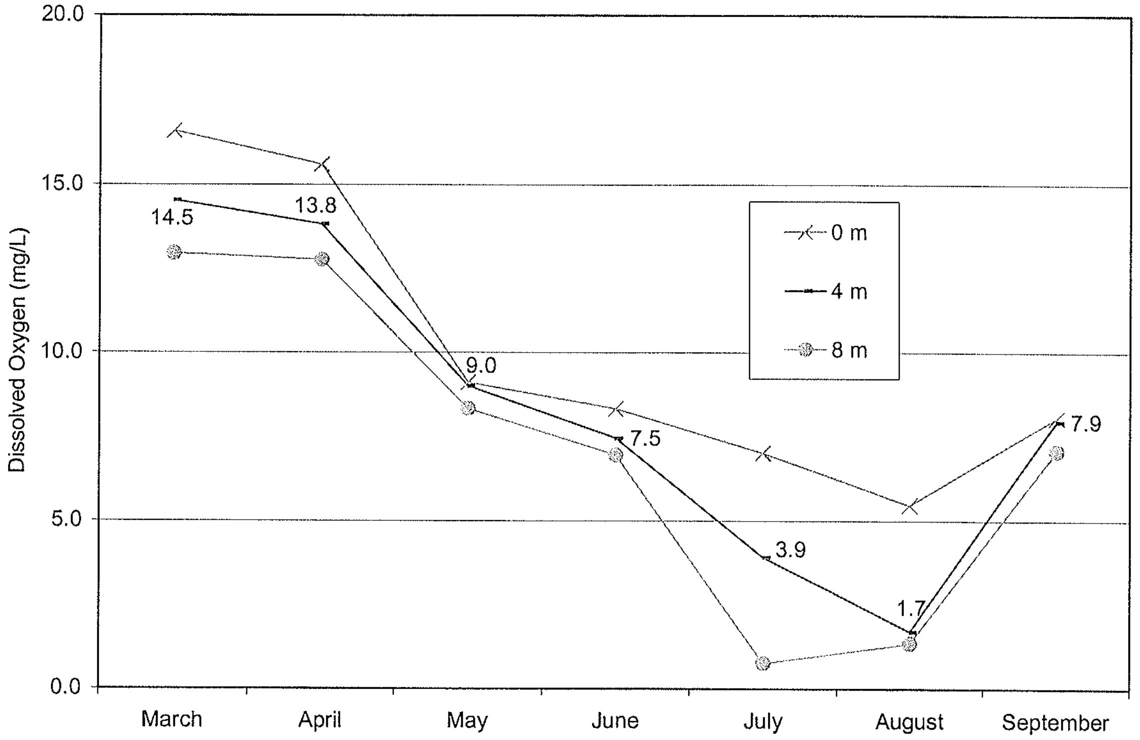

Figure 15. Minimum monthly dissolved oxygen from the surface to 8 m in section B of Lake Ogallala, 2000.

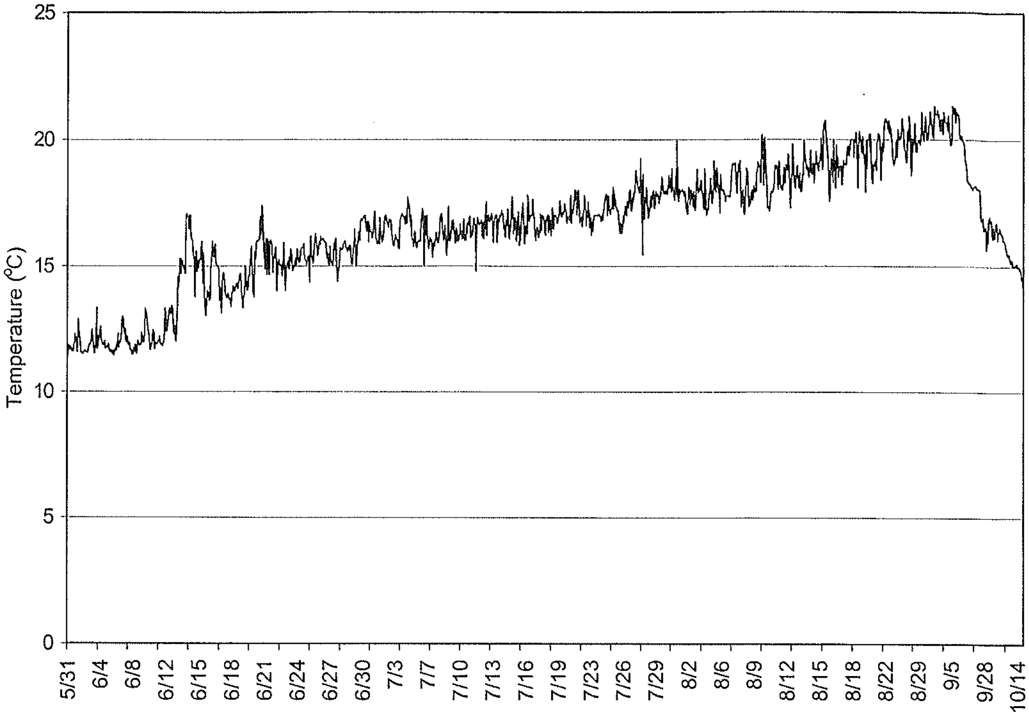

Figure 16. Hourly water temperature at the buoy line below the Kingsley hydroelectric discharge, 31 May through 15 October 2000.

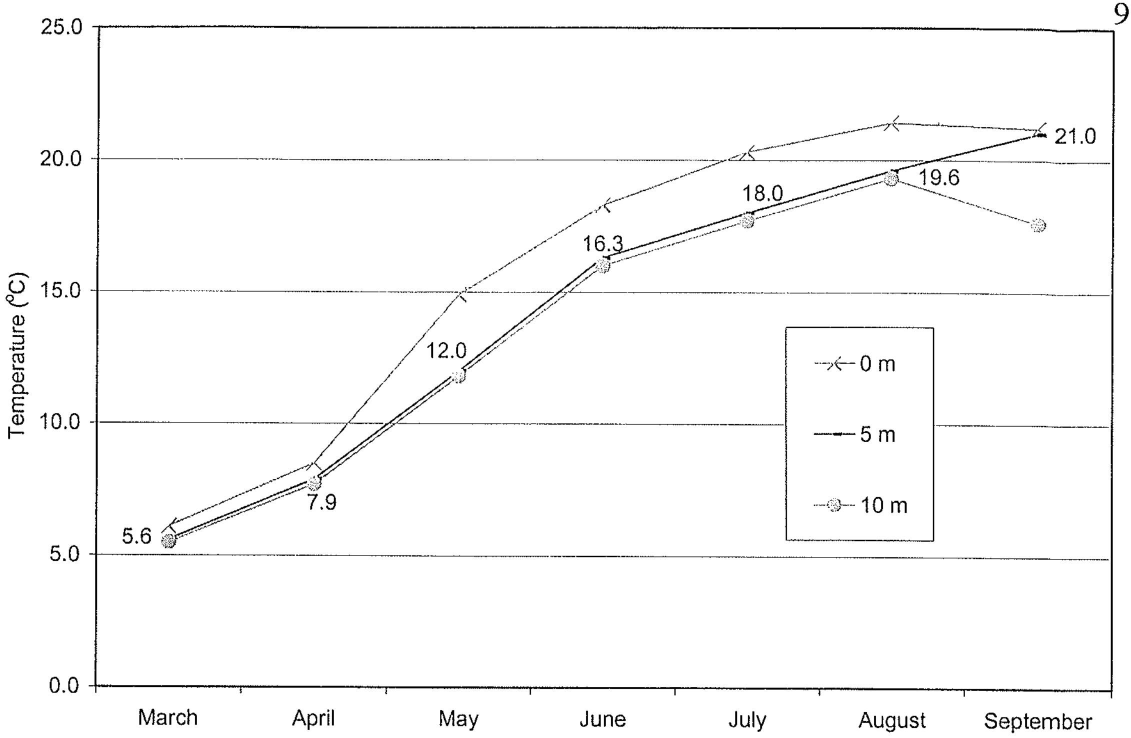

Figure 17. Maximum monthly temperature from the surface to 10 m in section C of Lake Ogallala, 2000.

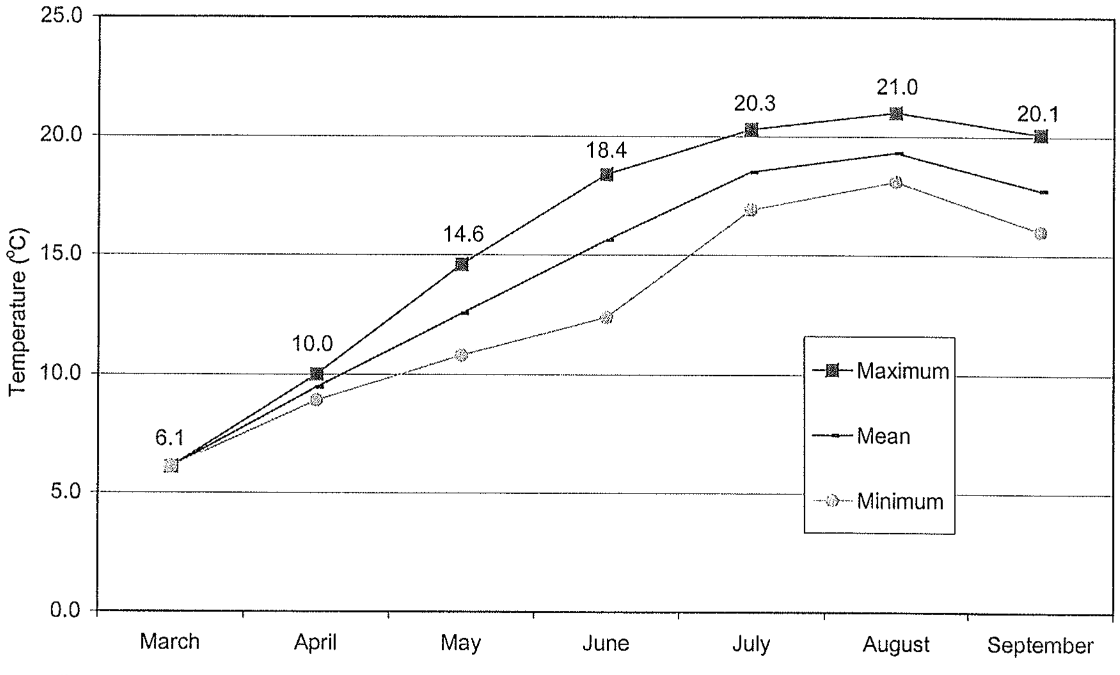

Figure 18. Minimum, mean, and maximum monthly temperature at 1 m depth in section D of Lake Ogallala, 2000.

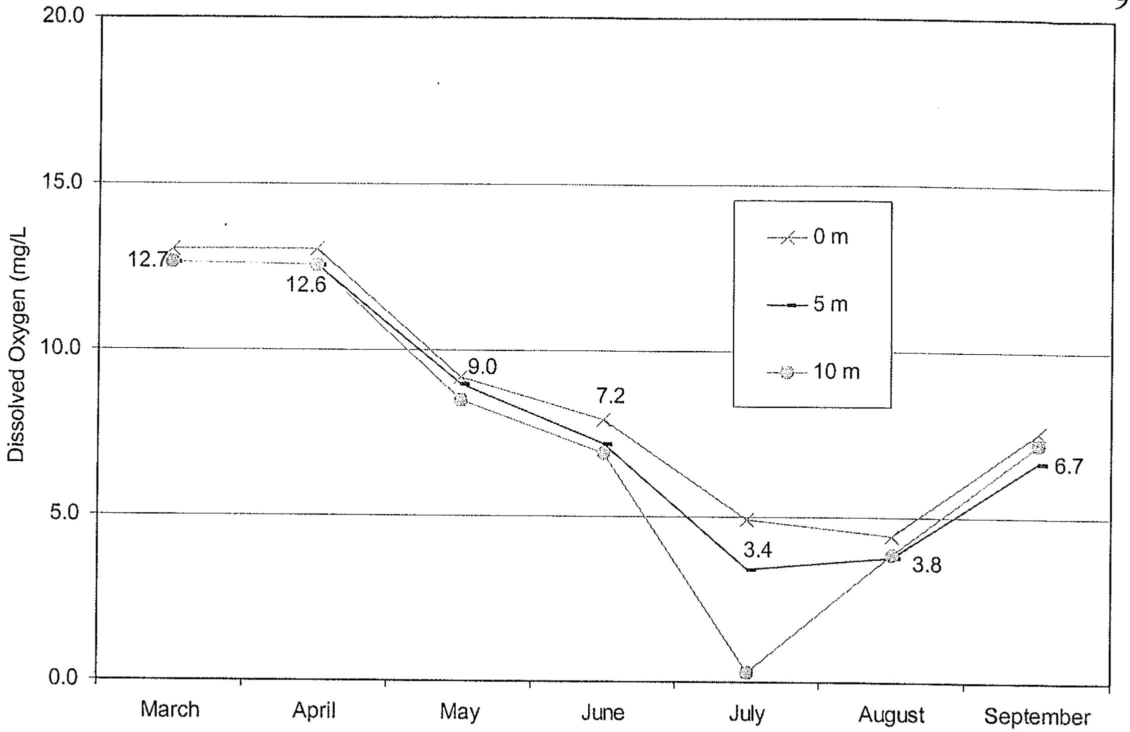

Figure 19. Minimum monthly dissolved oxygen from the surface to 10 m in section C of Lake Ogallala, 2000.

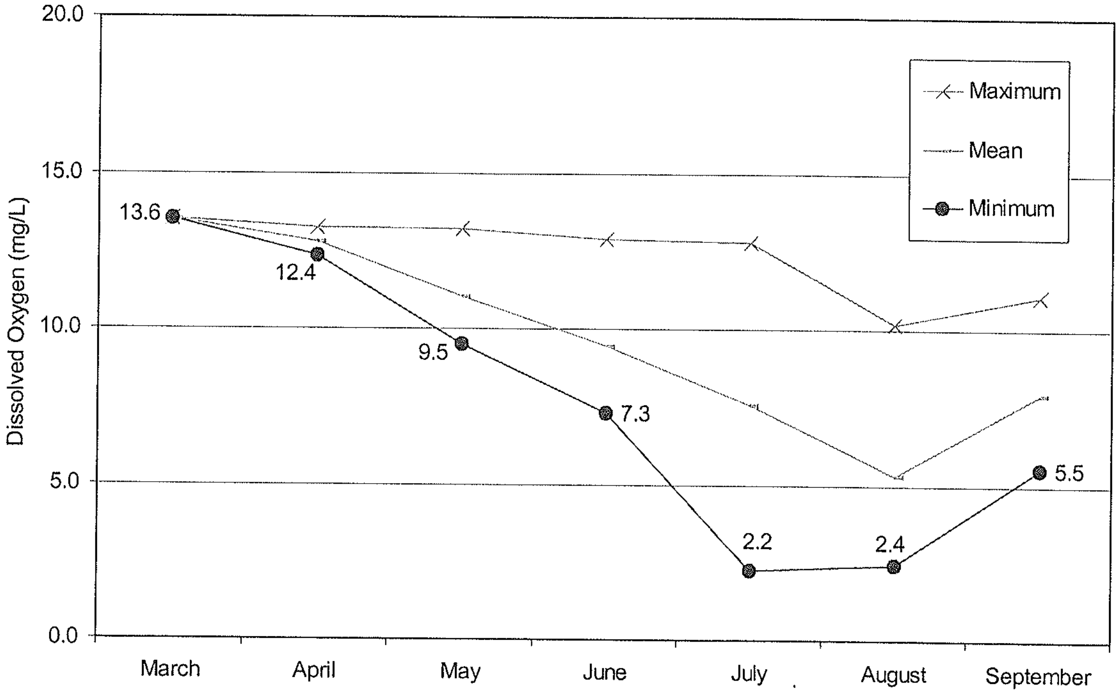

Figure 20. Minimum, mean, and maximum dissolved oxygen at a 1 m depth in section D of Lake Ogallala, 2000.

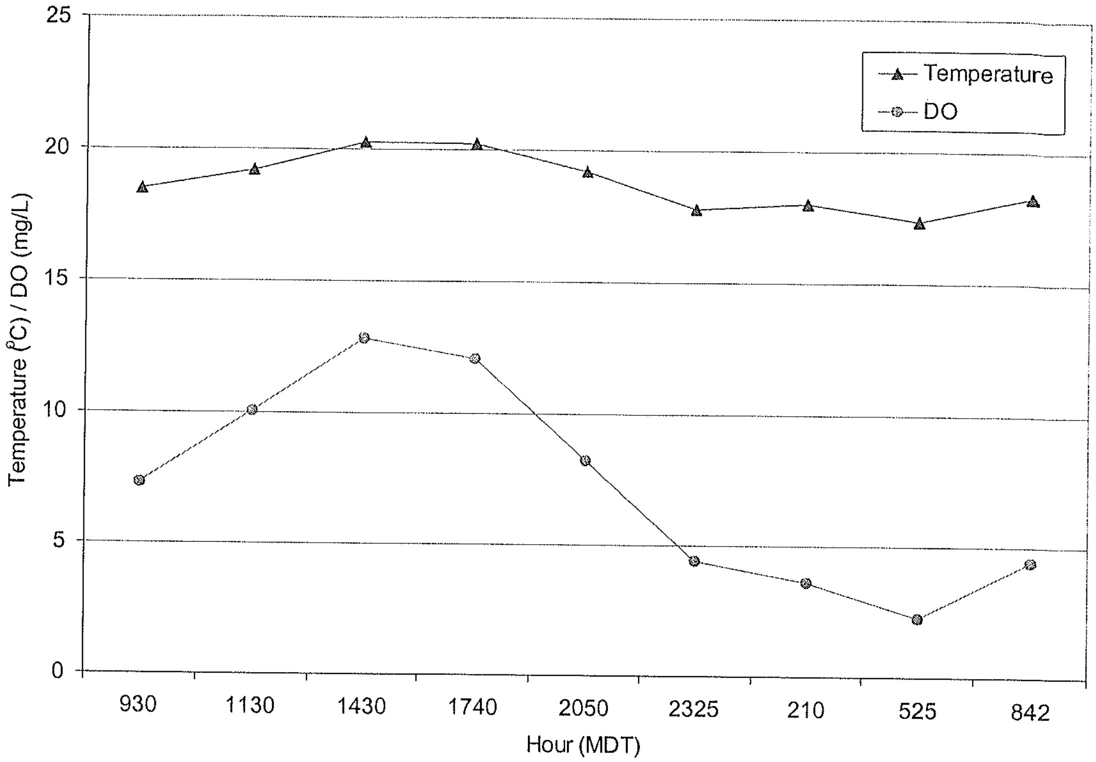

Figure 21. Temperature and dissolved oxygen at a 1 m depth at approximate 3-h intervals in the east end of section D of Lake Ogallala, 26-27July 2000.

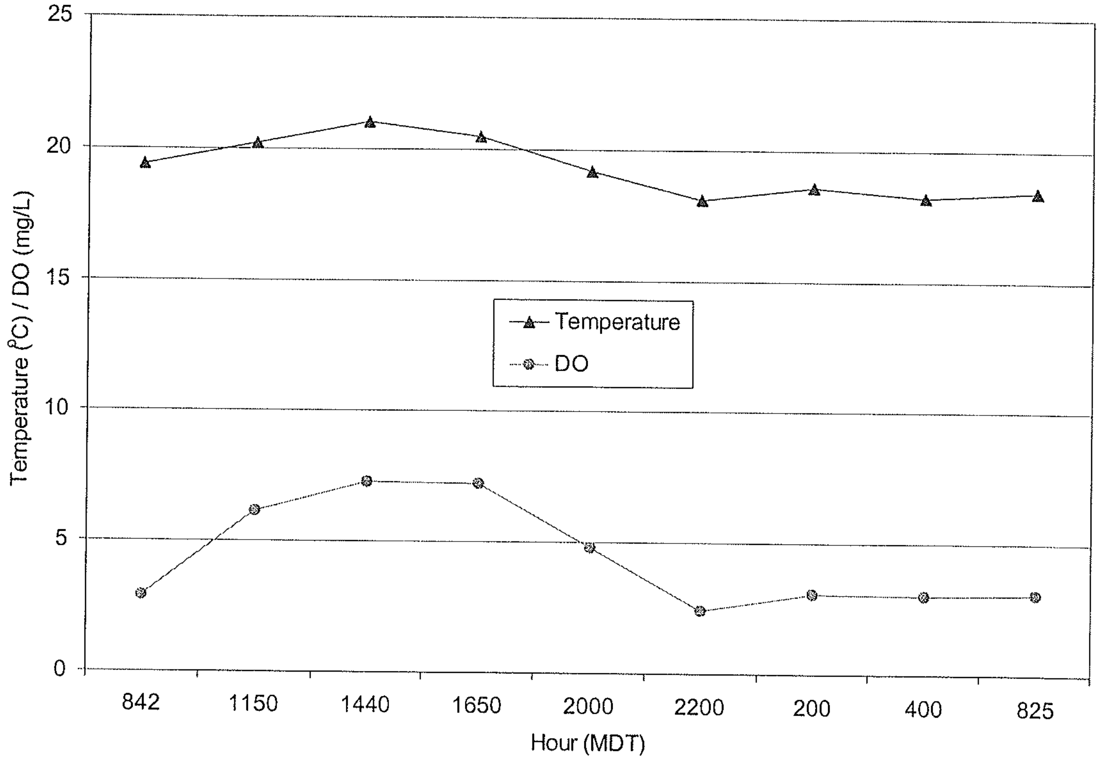

Figure 22. Temperature and dissolved oxygen at a 1 m depth at approximate 3-h intervals in the east end of section D of Lake Ogallala, 10-11 August 2000.

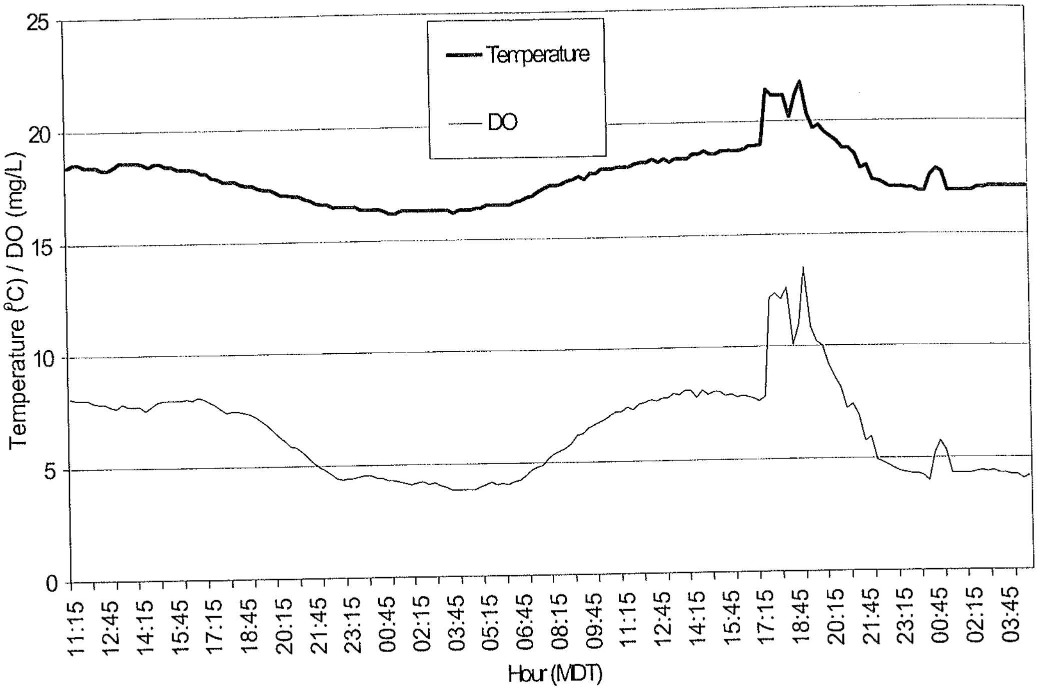

Figure 23. Temperature and dissolved oxygen of water leaving Lake Ogallala into the North Platte River, 7-9 July 2000 (NGPC unpublished data).

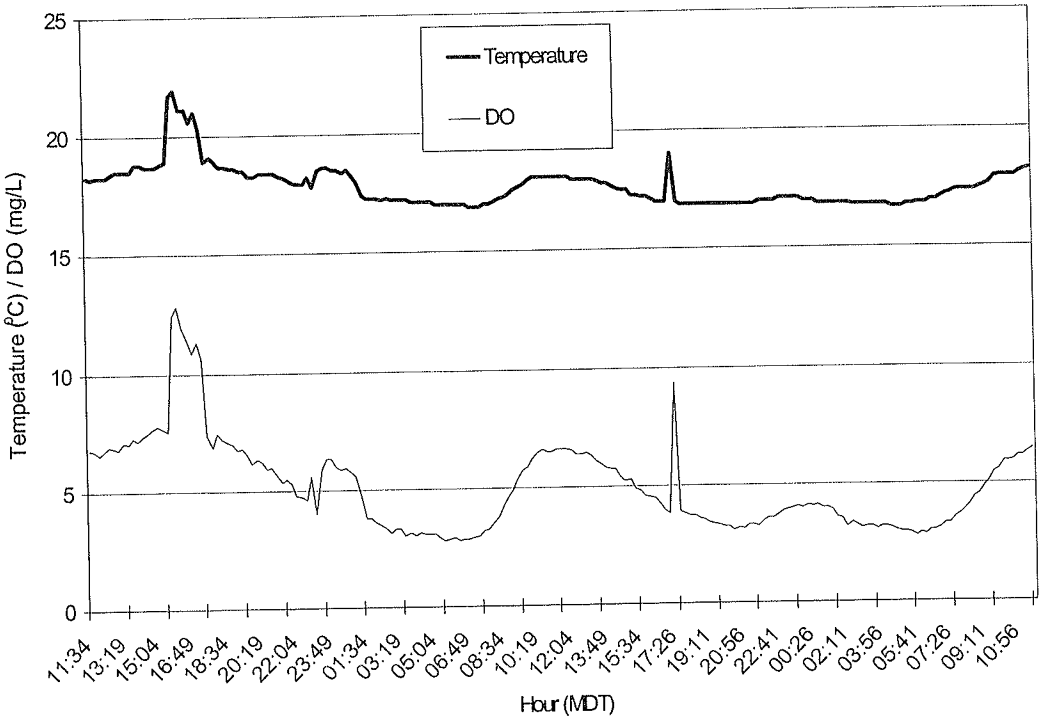

Figure 24. Temperature and dissolved oxygen of water leaving Lake Ogallala into the North Platte River, 11-13 July 2000 (NGPC unpublished data).

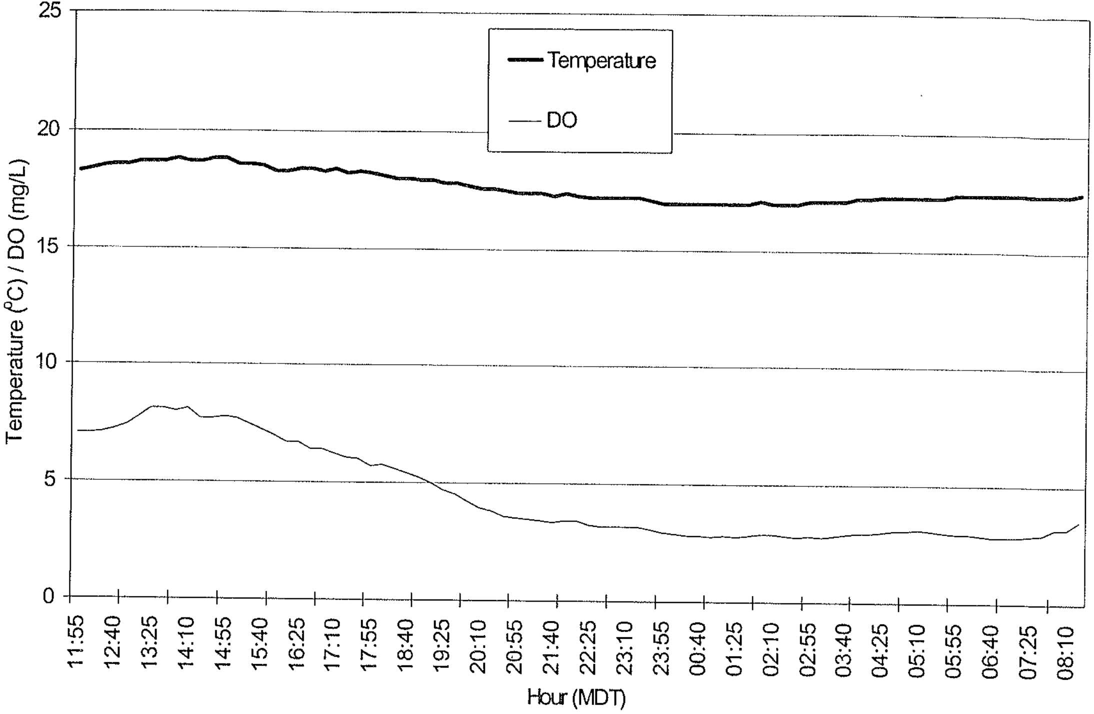

Figure 25. Temperature and dissolved oxygen of water leaving Lake Ogallala into the North Platte River, 19-20 July 2000 (NGPC unpublished data).

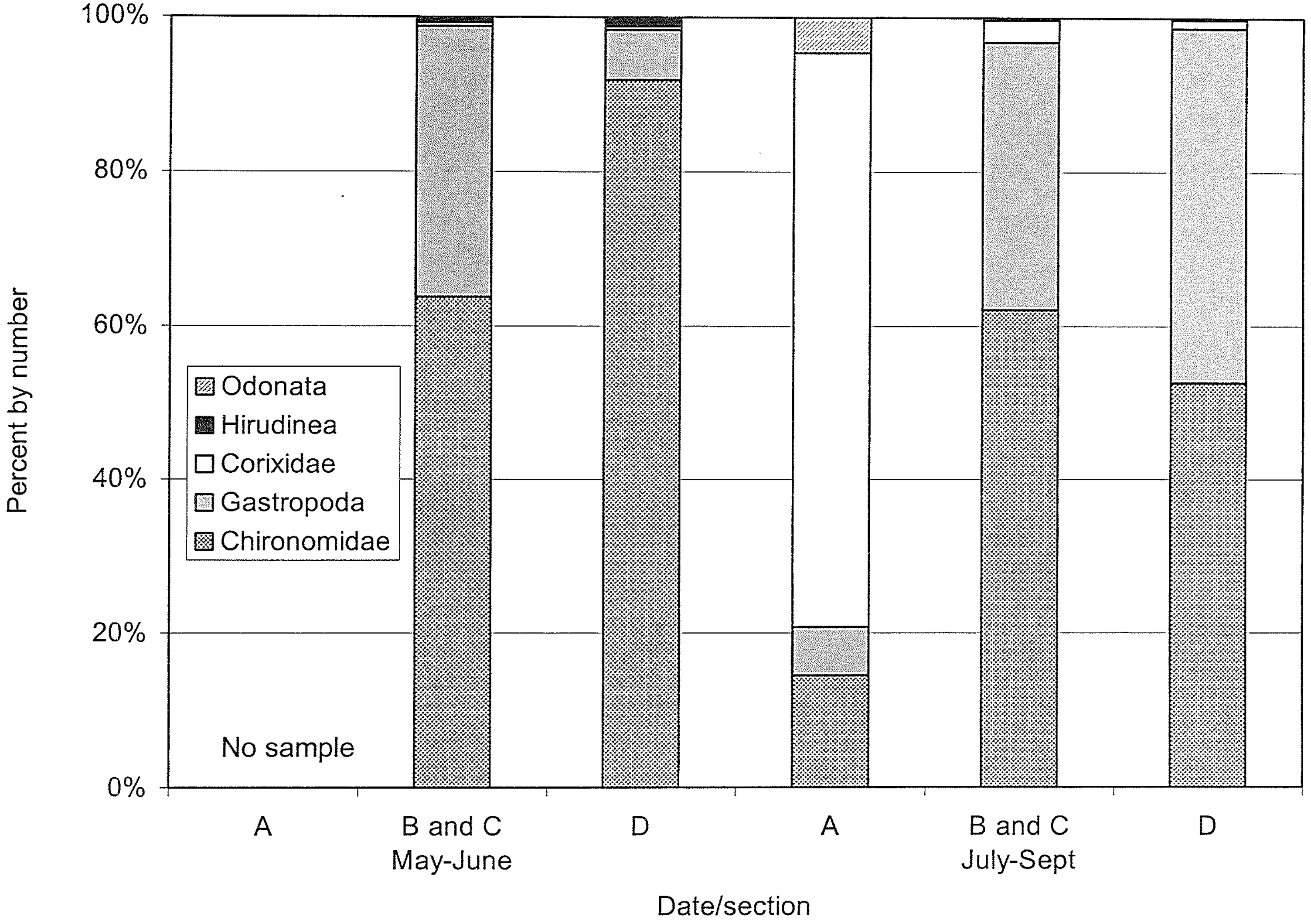

Figure 26. Food items found in the stomachs of 97 rainbow trout in sections of Lake Ogallala, Nebraska, May-September 1999.

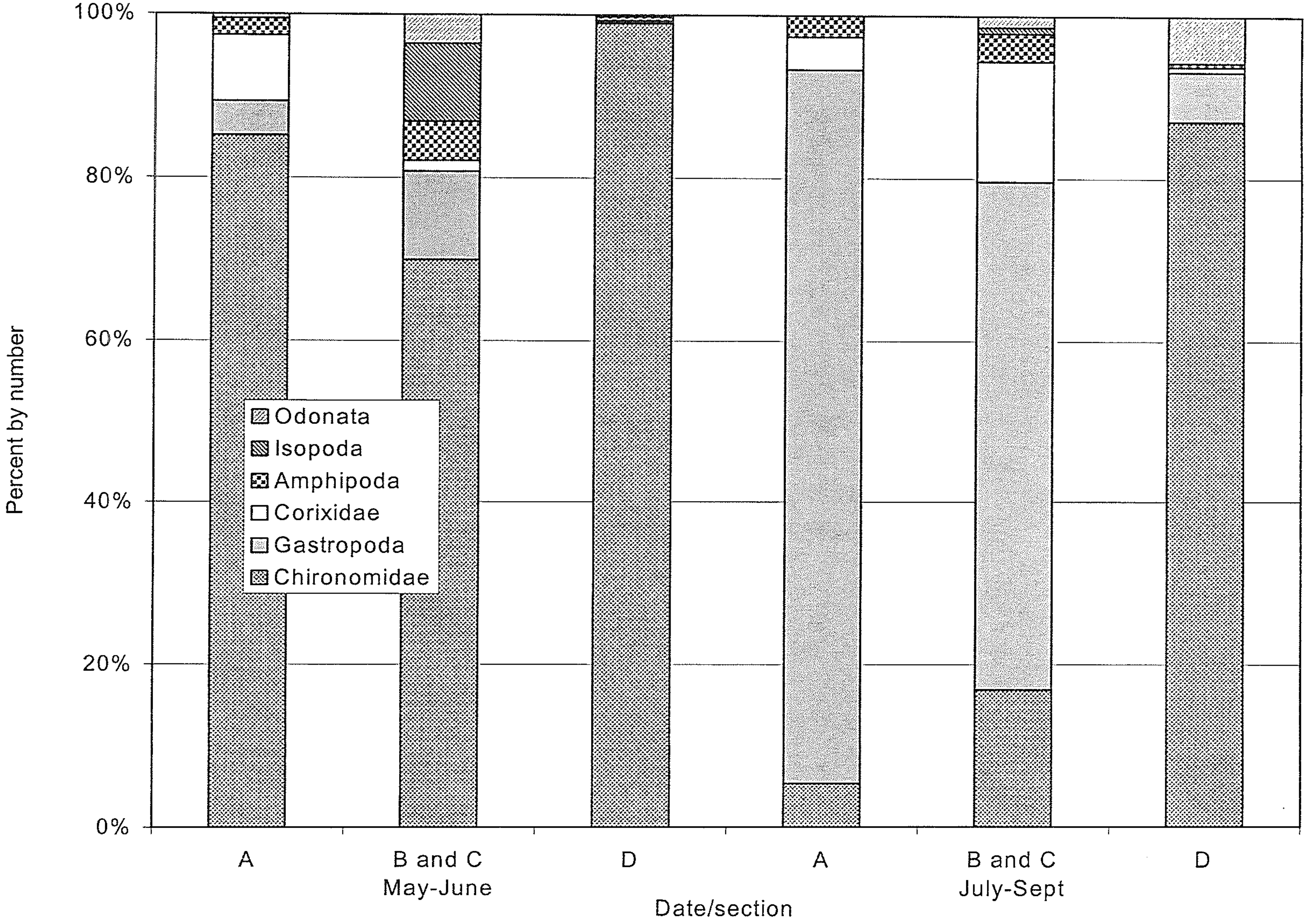

Figure 27. Food items found in the stomachs of 68 rainbow trout in sections of Lake Ogallala, Nebraska, May-September 2000.

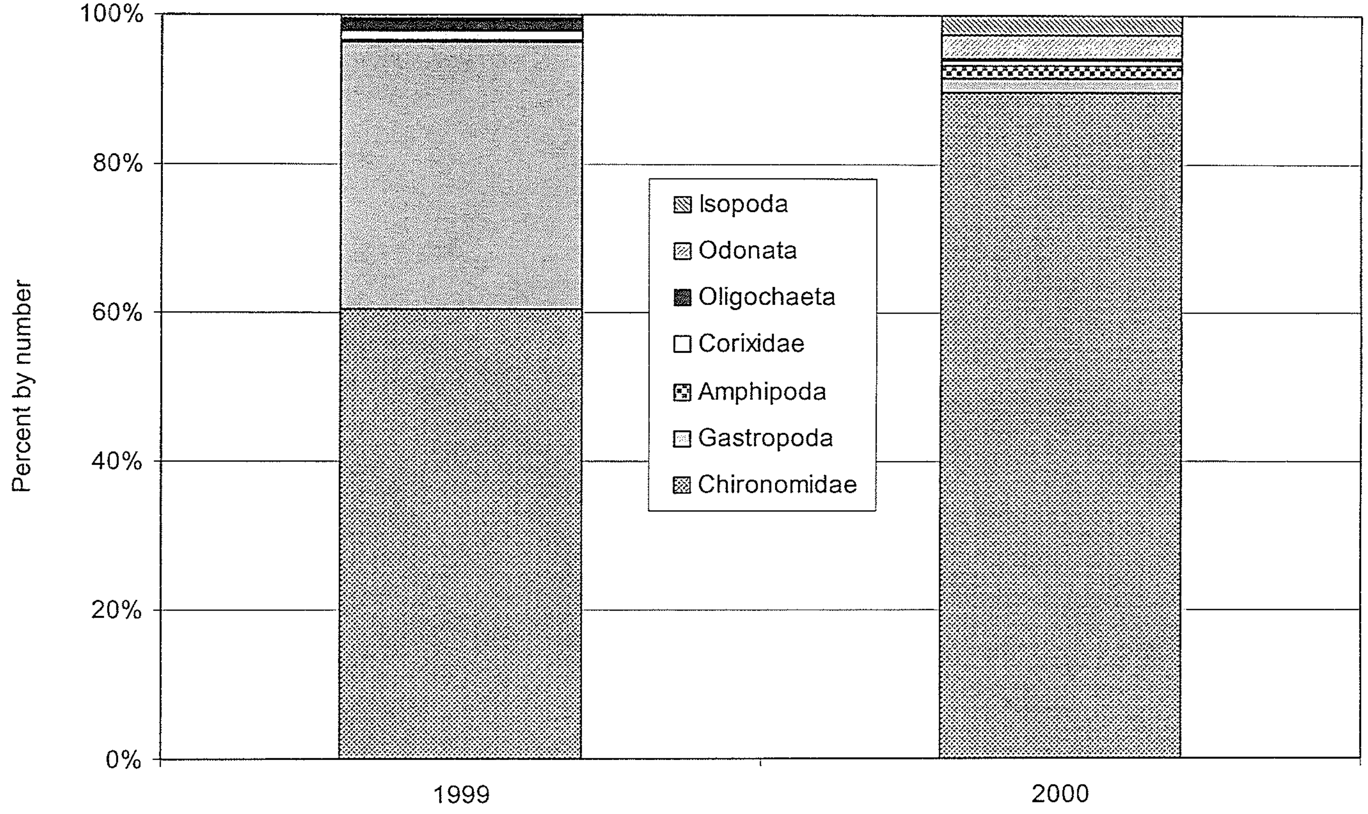

Figure 28. Food items found in the stomachs of 67 brown trout captured in Lake Ogallala, June-October 1999 and May-September 2000.

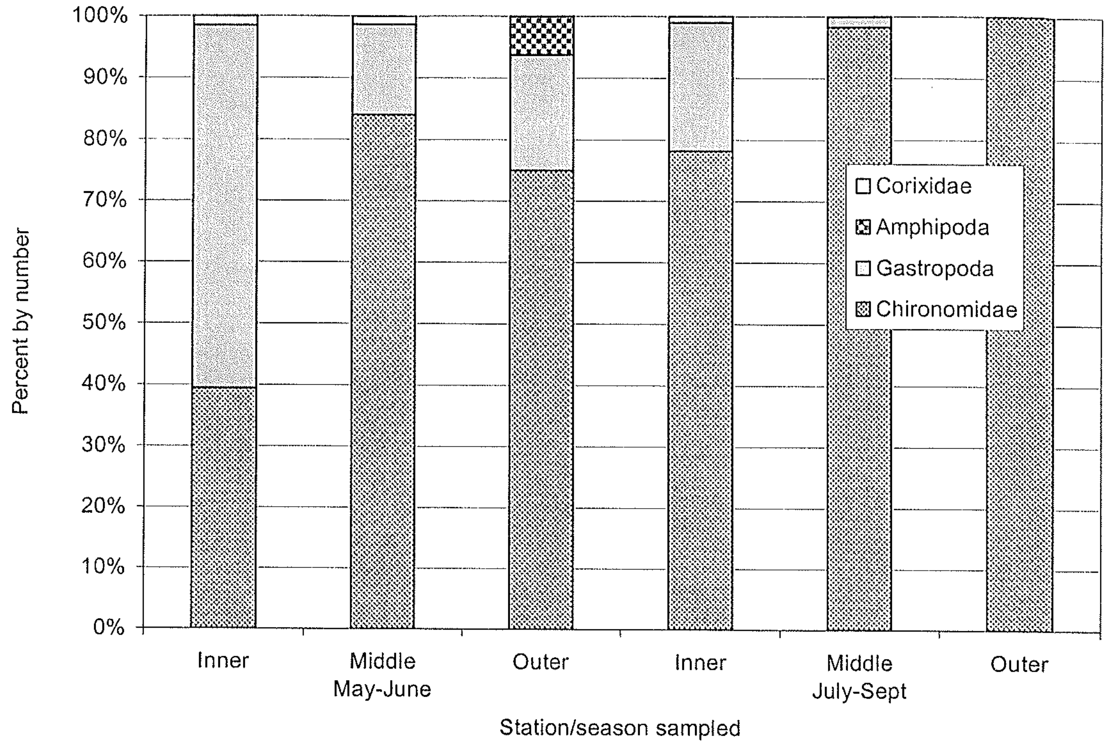

Figure 29. Percent by number of benthic invertebrates available as trout food, excluding oligochaetes, in section A of Lake Ogallala, May-September 1999.

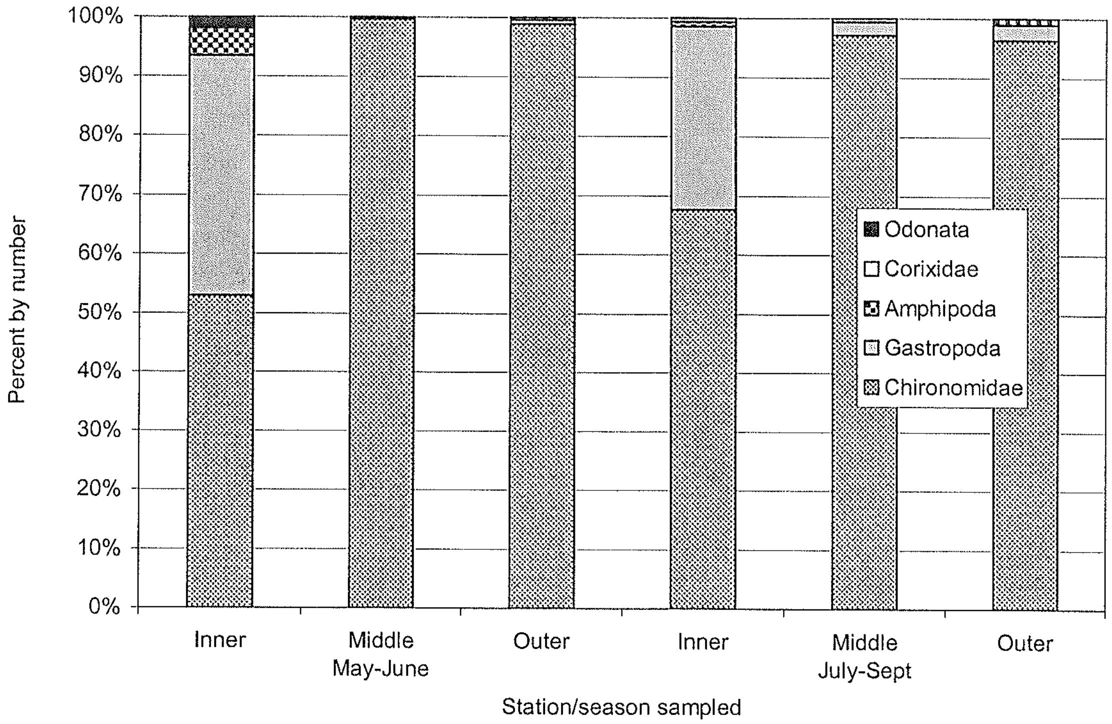

Figure 30. Percent by number of benthic invertebrates available as trout food, excluding oligochaetes, in section A of Lake Ogallala, May-September 2000.

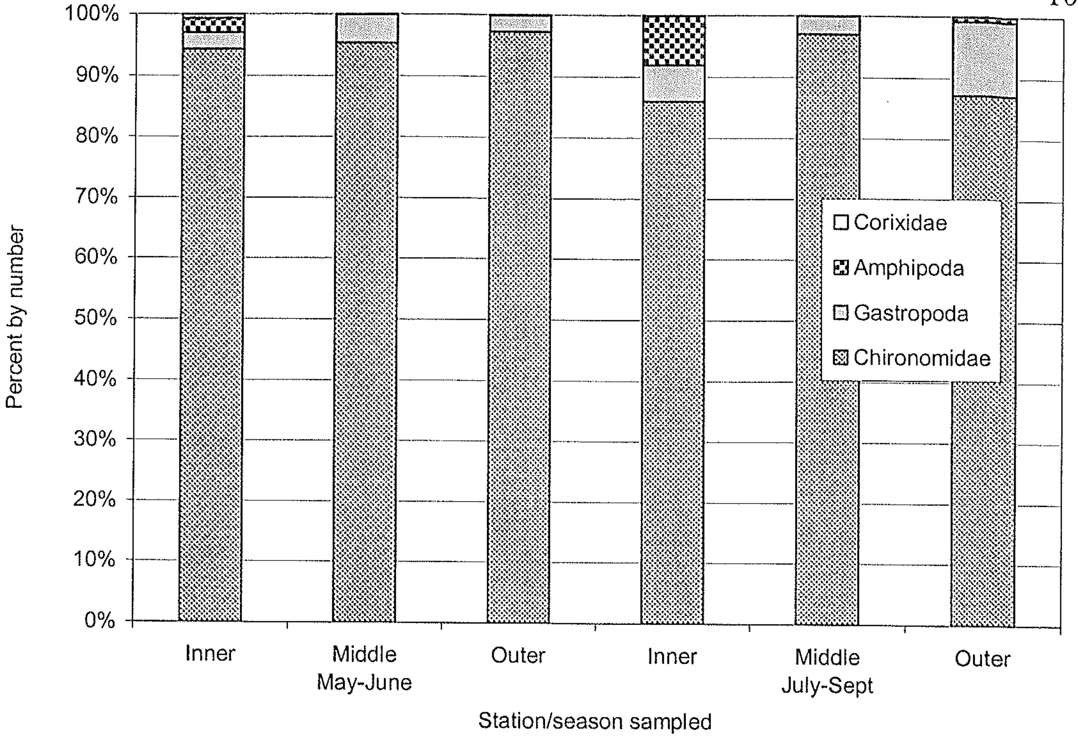

Figure 31. Percent by number of benthic invertebrates available as trout food, excluding oligochaetes, in sections B and C of Lake Ogallala, May-September 1999.

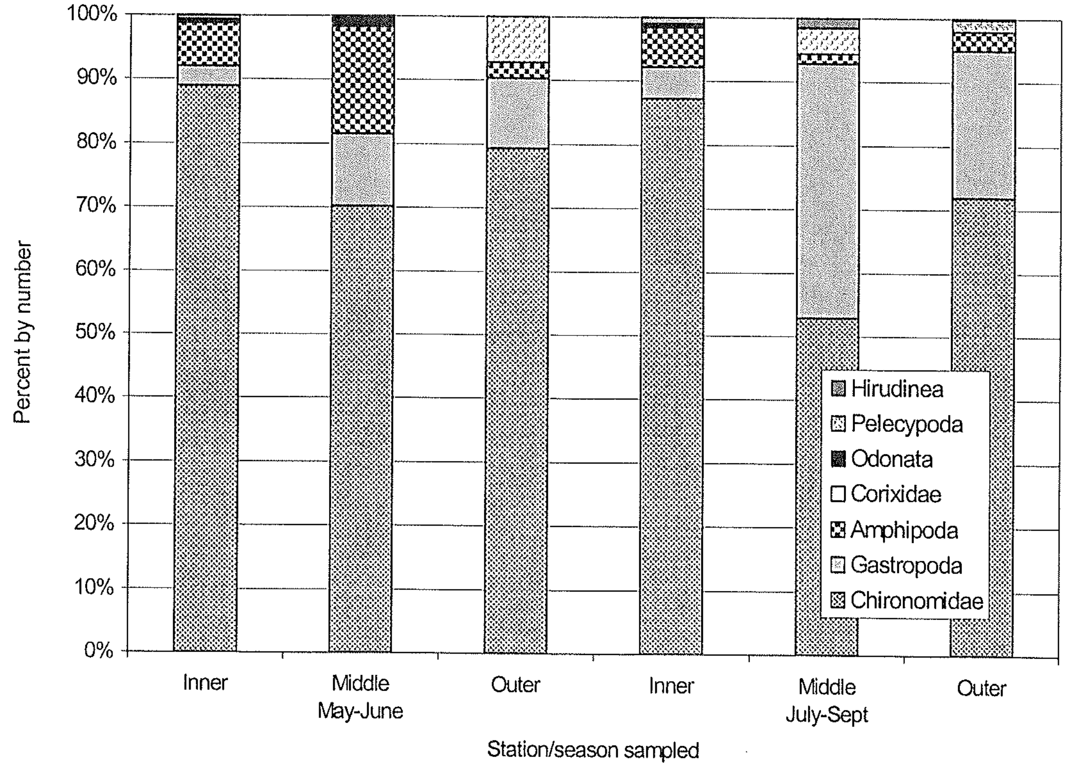

Figure 32. Percent by number of benthic invertebrates available as trout food, excluding oligochaetes, in sections B and C of Lake Ogallala, May-September 2000.

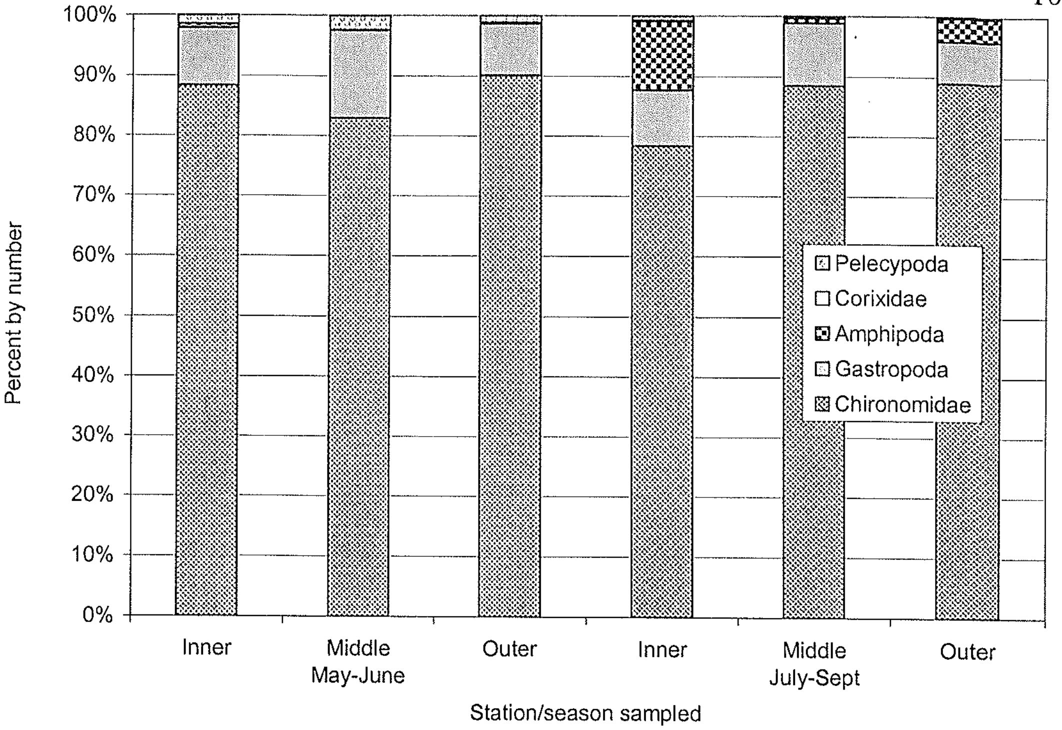

Figure 33. Percent by number of benthic invertebrates available as trout food, excluding oligochaetes, in section D of Lake Ogallala, May-September 1999.

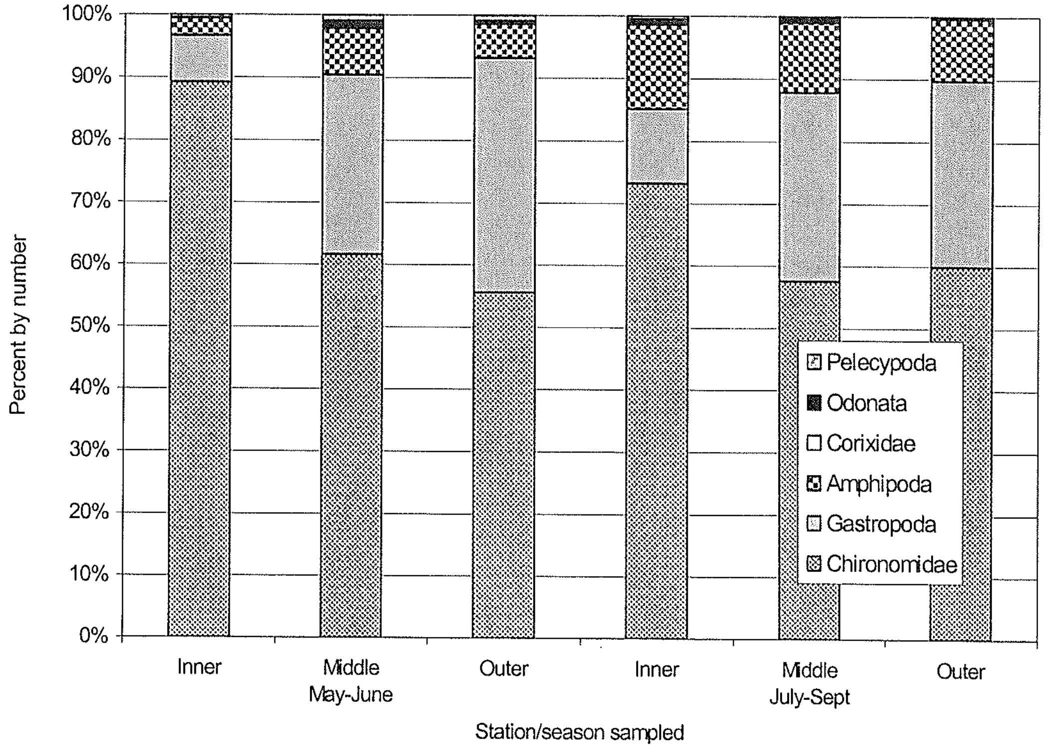

Figure 34. Percent by number of benthic invertebrates available as trout food, excluding oligochaetes, in section D of Lake Ogallala, May-September 2000.

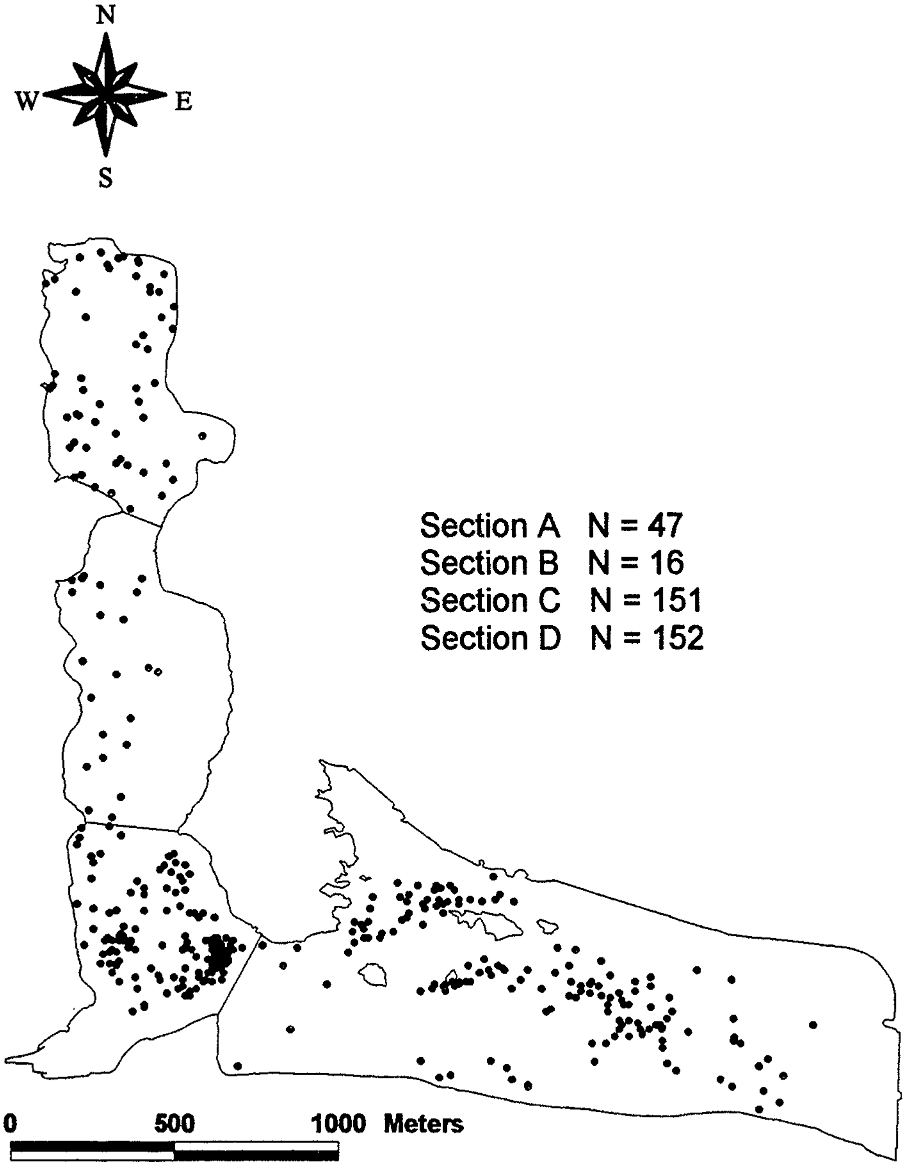

Figure 35. Locations of ultrasonically tagged newly stocked rainbow trout in Lake Ogallala, March-December 1999.

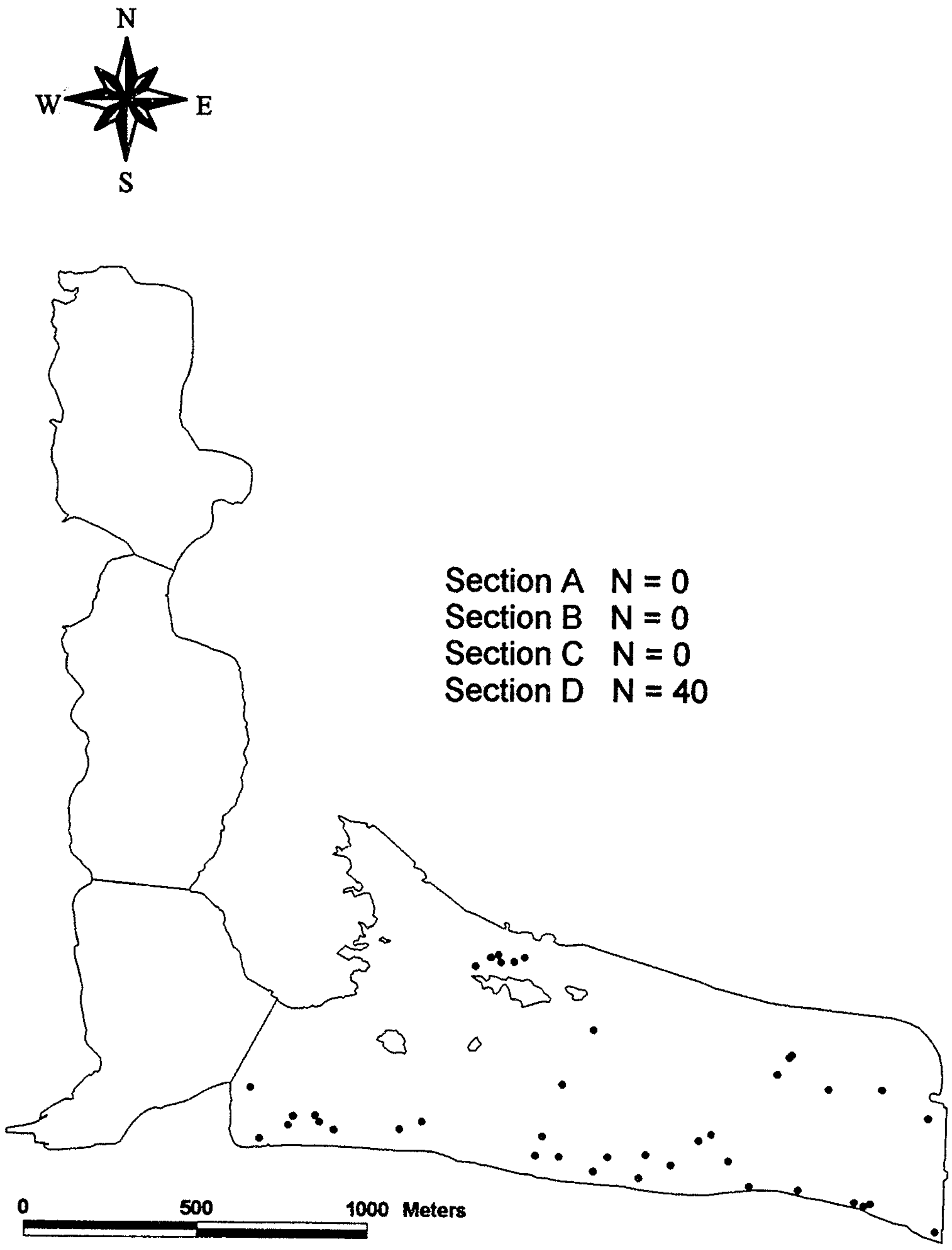

Figure 36. Locations of ultrasonically tagged resident rainbow trout in Lake Ogallala, June-December 1999.

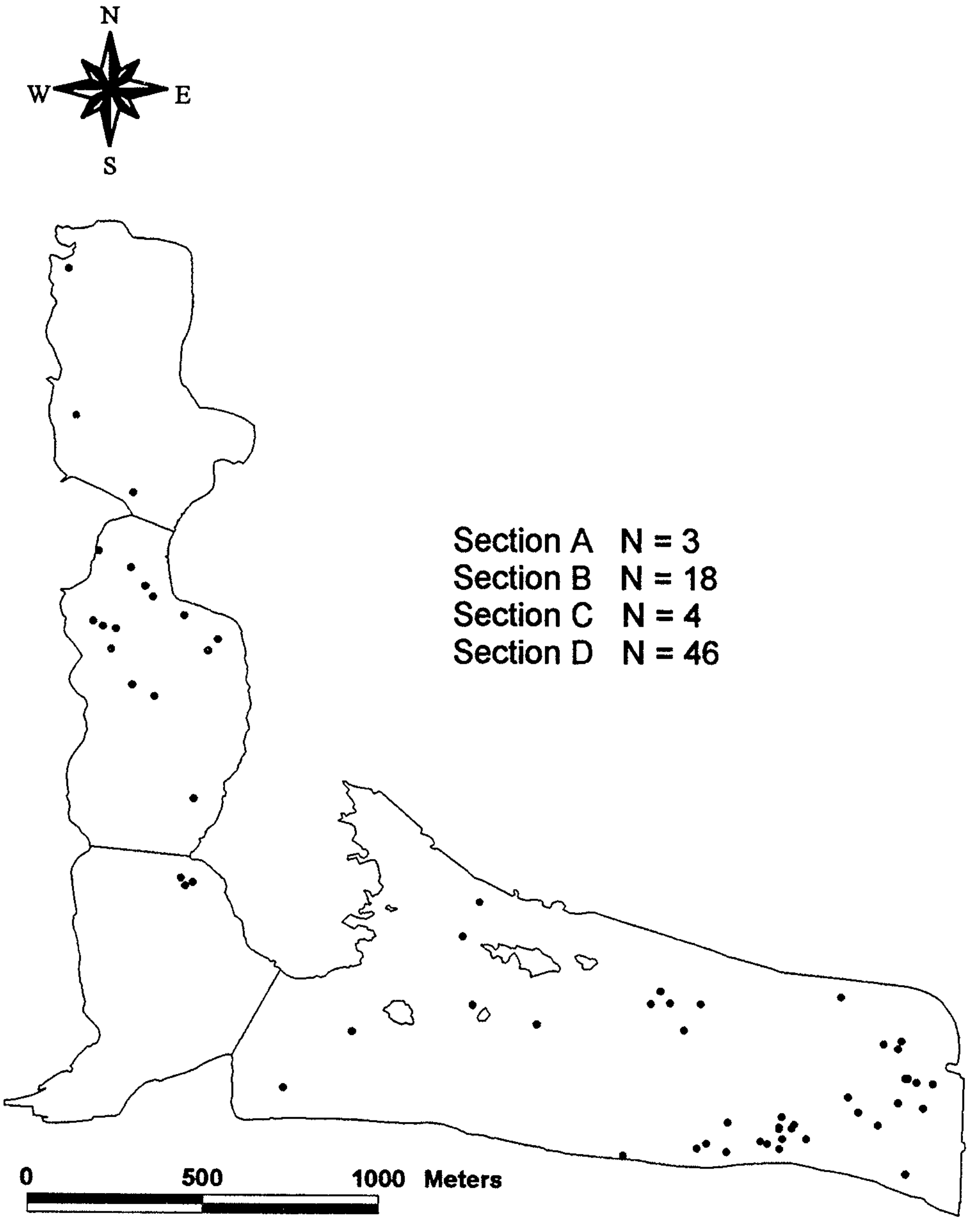

Figure 37. Locations of ultrasonicallly tagged newly stocked rainbow trout in Lake Ogallala, March-July 2000.

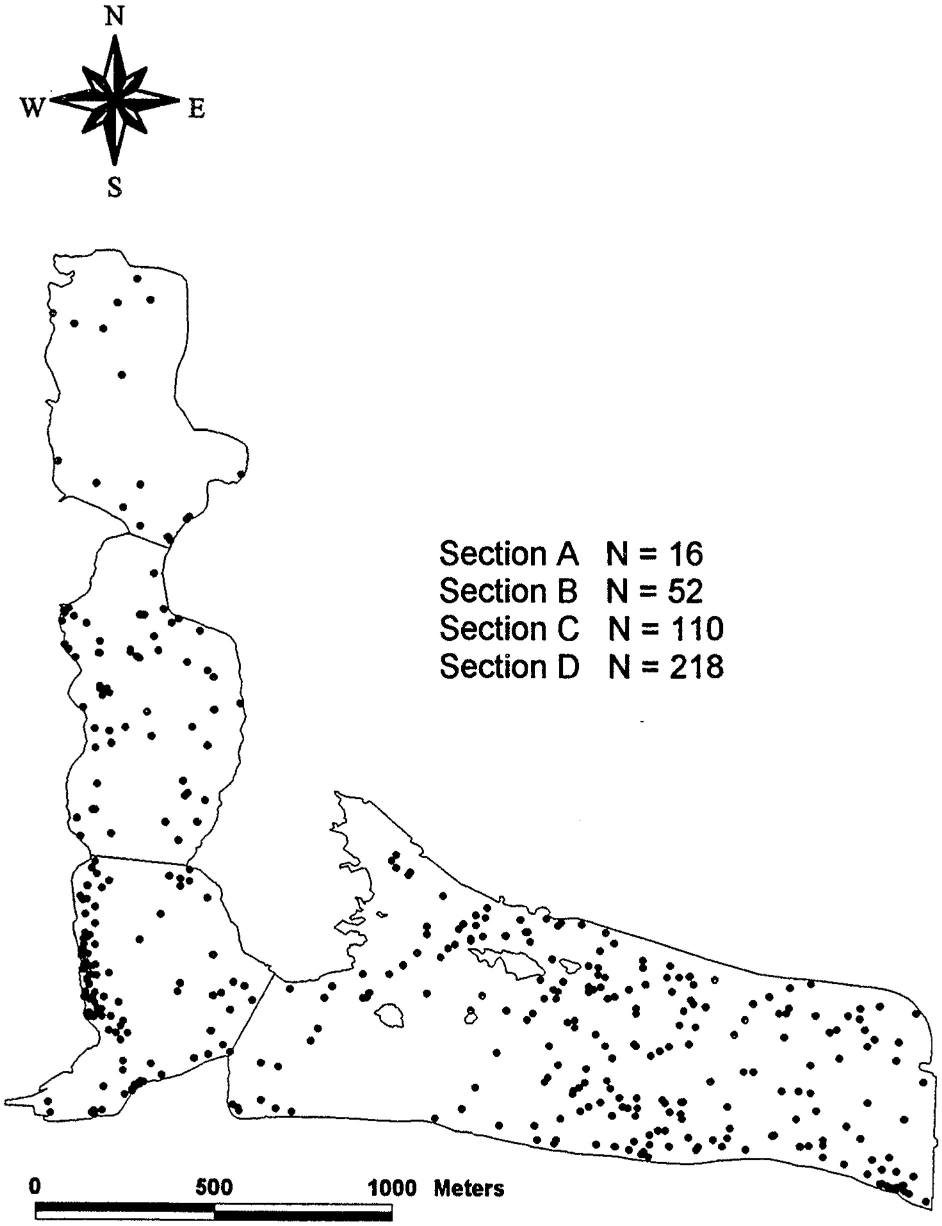

Figure 38. Locations of ultrasonically tagged resident rainbow trout in Lake Ogallala, March-September 2000.

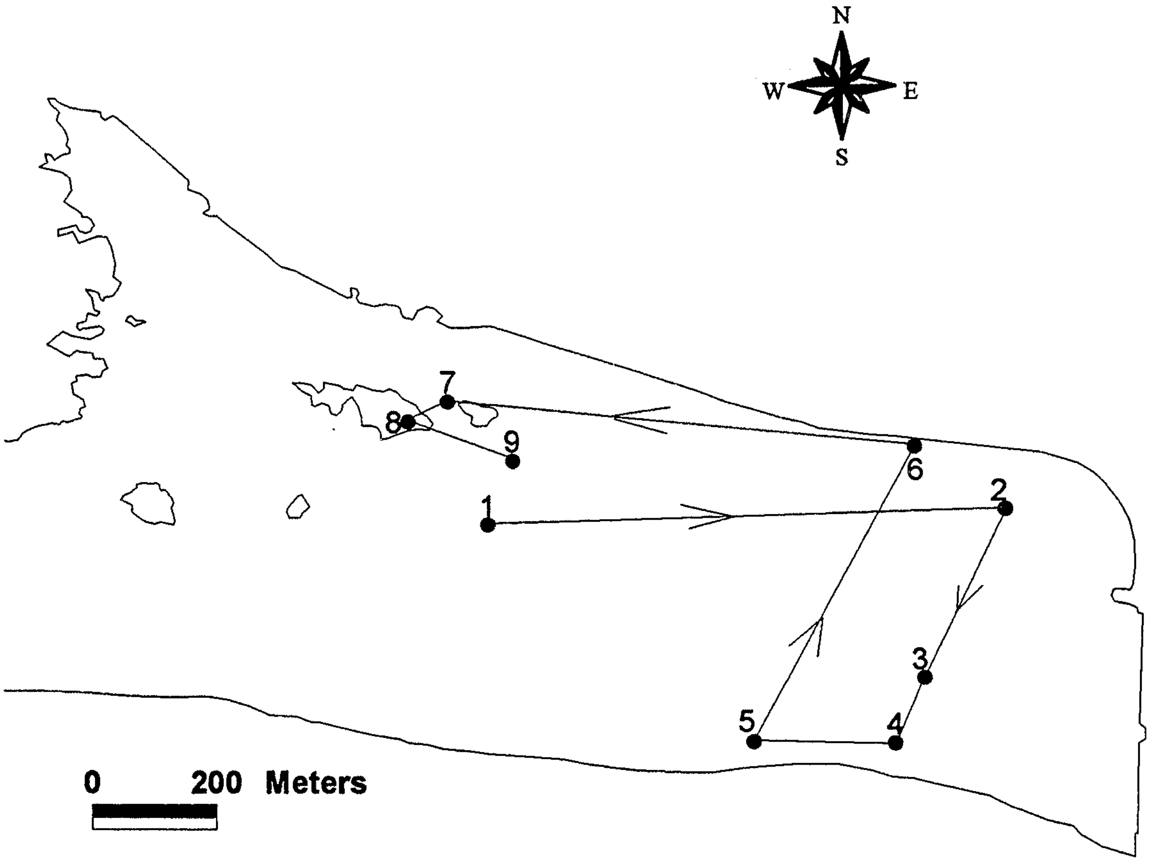

Figure 39. Movement of rainbow trout 444 within section D of Lake Ogallala at approximate 3-h intervals on 10-11 August 2000.

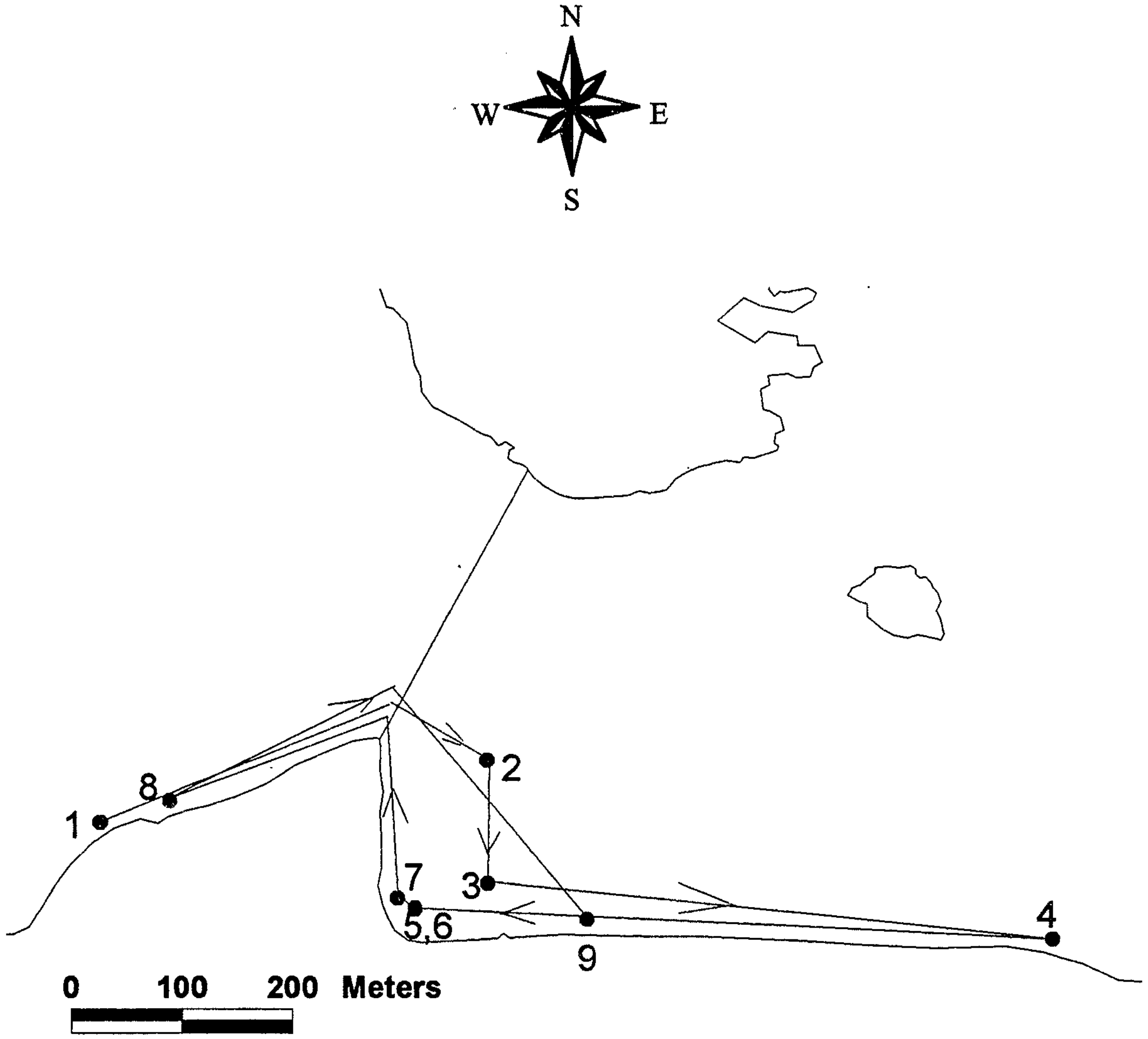

Figure 40. Movement of rainbow trout 589 between sections C and D of Lake Ogallala at approximate 3-h intervals on 24-25 May 2000.

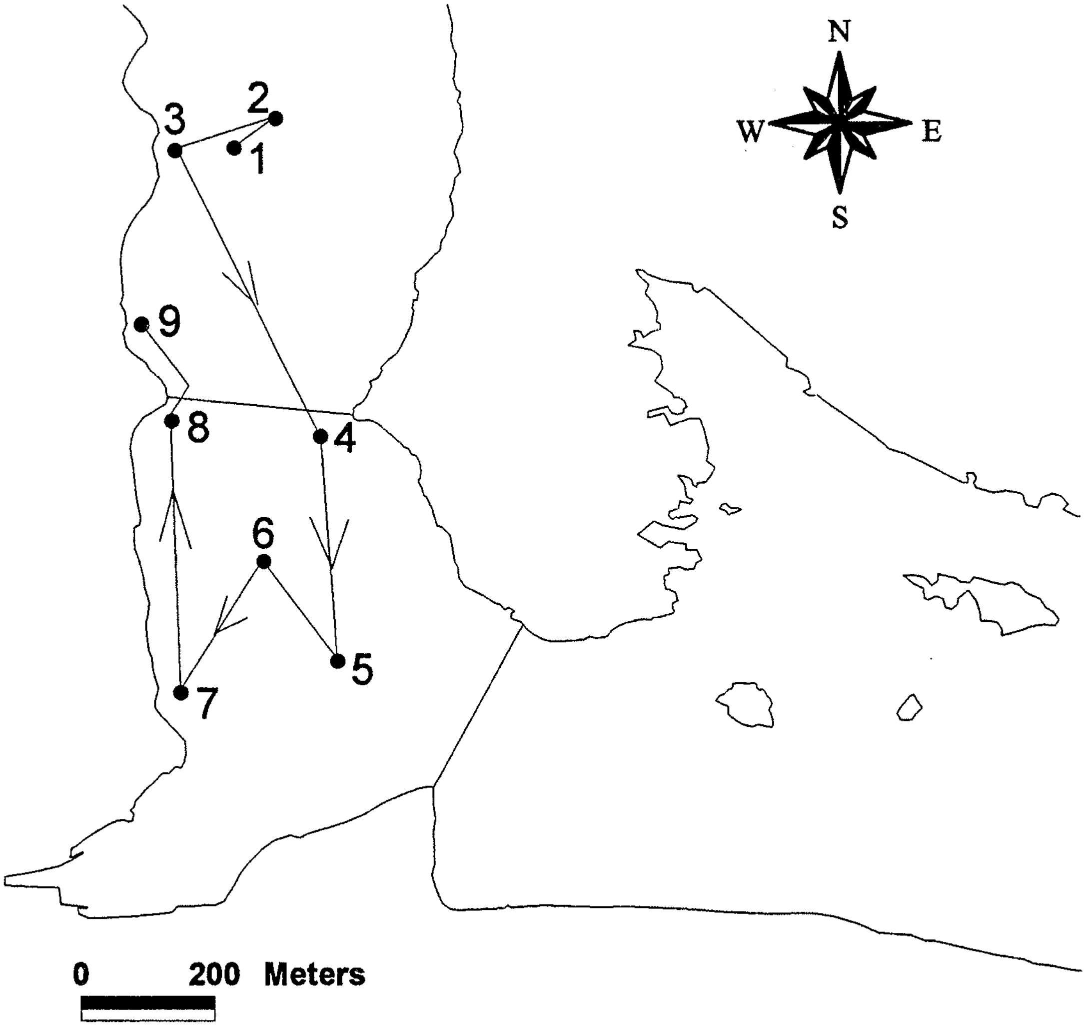

Figure 41. Movement of rainbow trout 788 between sections B and C of Lake Ogallala at approximate 3-h intervals on 20-21 June 2000.

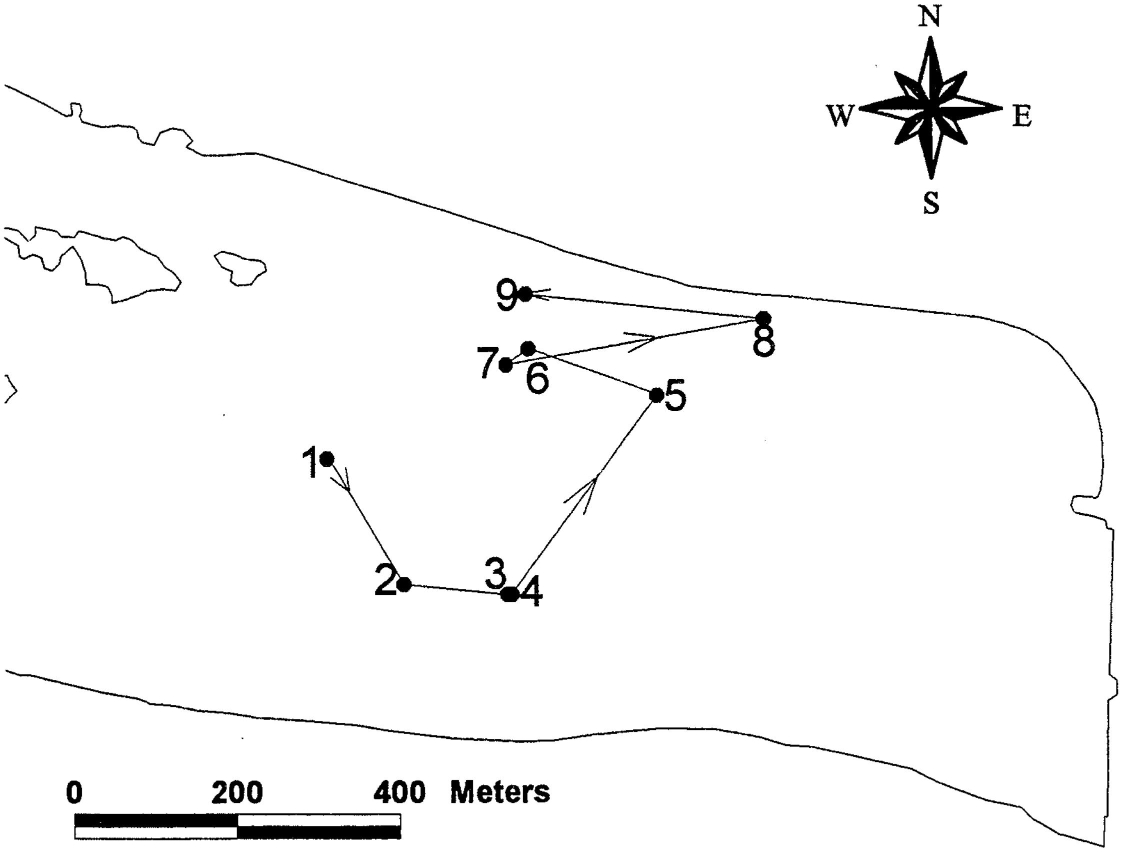

Figure 42. Movement of rainbow trout 456 within section D of Lake Ogallala at approximate 3-h intervals on 24-25 May 2000.

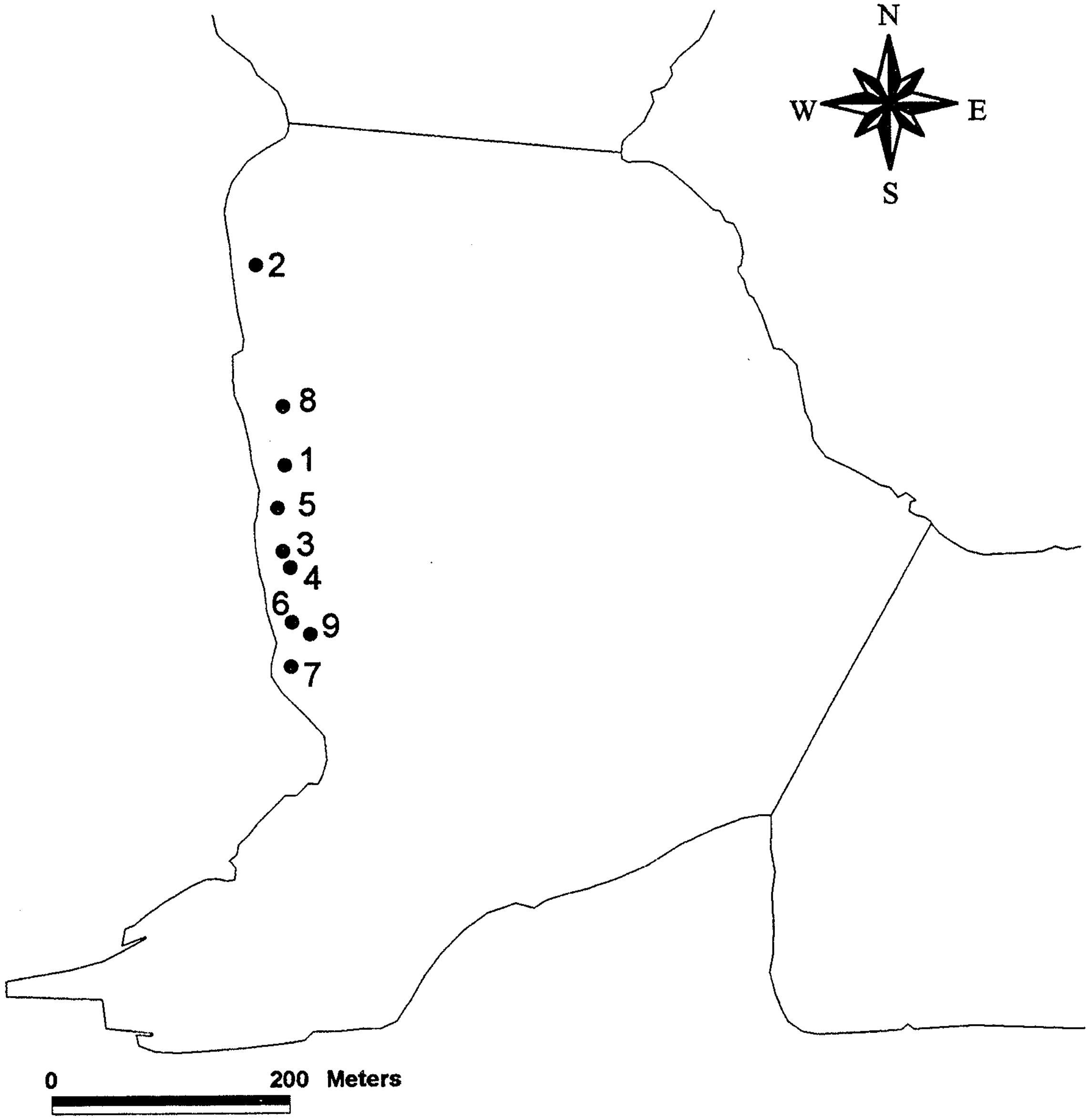

Figure 43. Movement of rainbow trout 589 within section C of Lake Ogallala at approximate 3-h intervals on 20-21 June 2000.

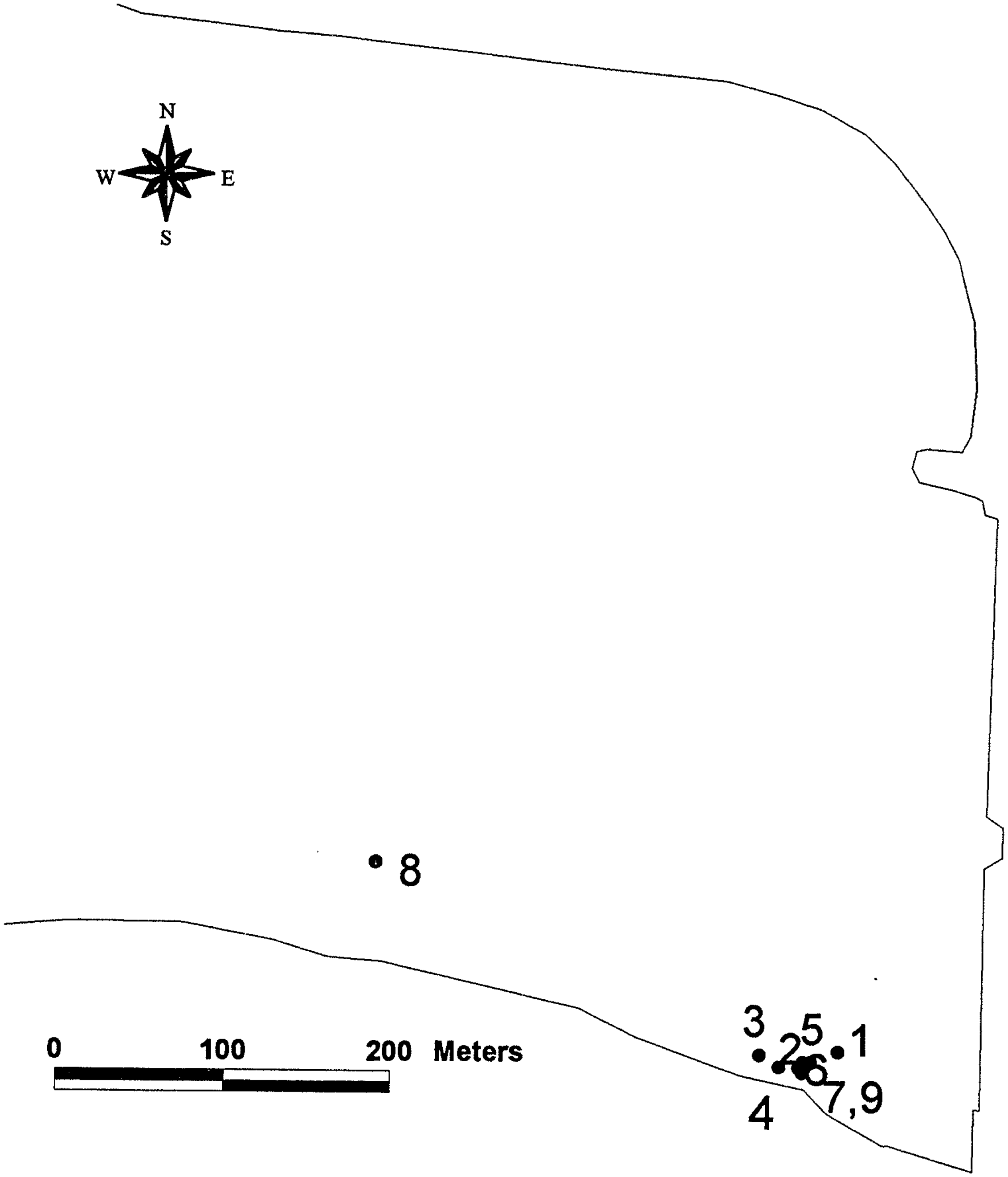

Figure 44. Movement of rainbow trout 39 within section D of Lake Ogallala at approximate 3-h intervals on 26-27 July 2000.

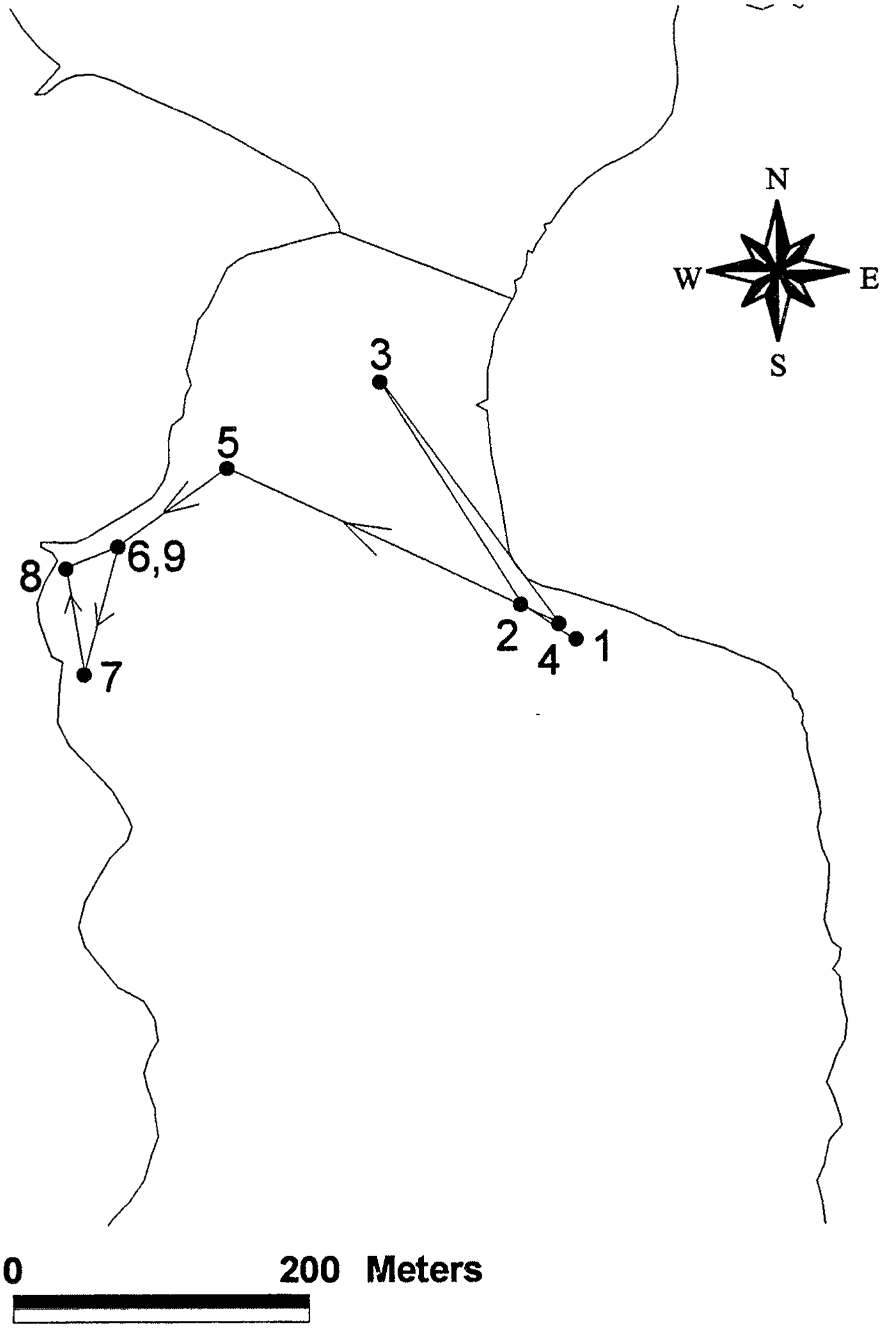

Figure 45. Movement of brown trout 555 within section B of Lake Ogallala at approximate 3-h intervals on 26-27 July 2000.

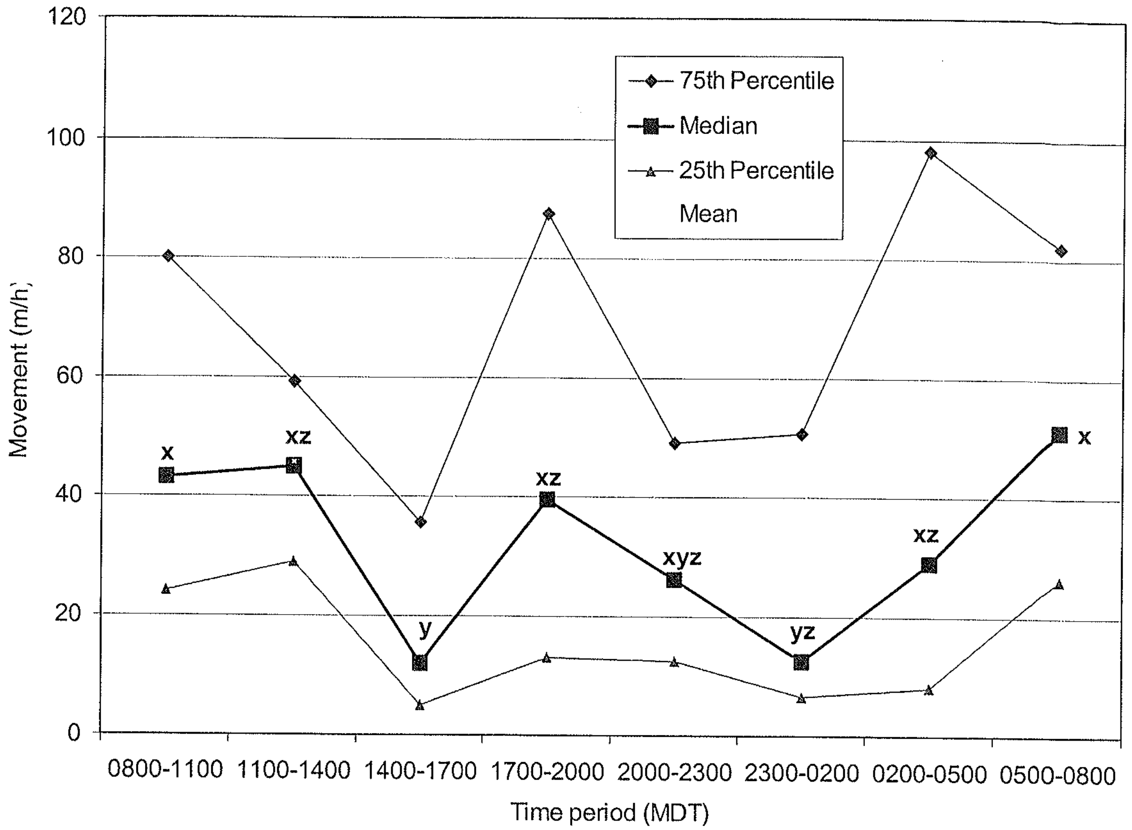

Figure 46. Minimum diel movement (m/h) of rainbow trout within Lake Ogallala over eight, 3 h time periods, May-September 2000. Values for time periods with the same letter are not significantly different (*P* > 0.05).

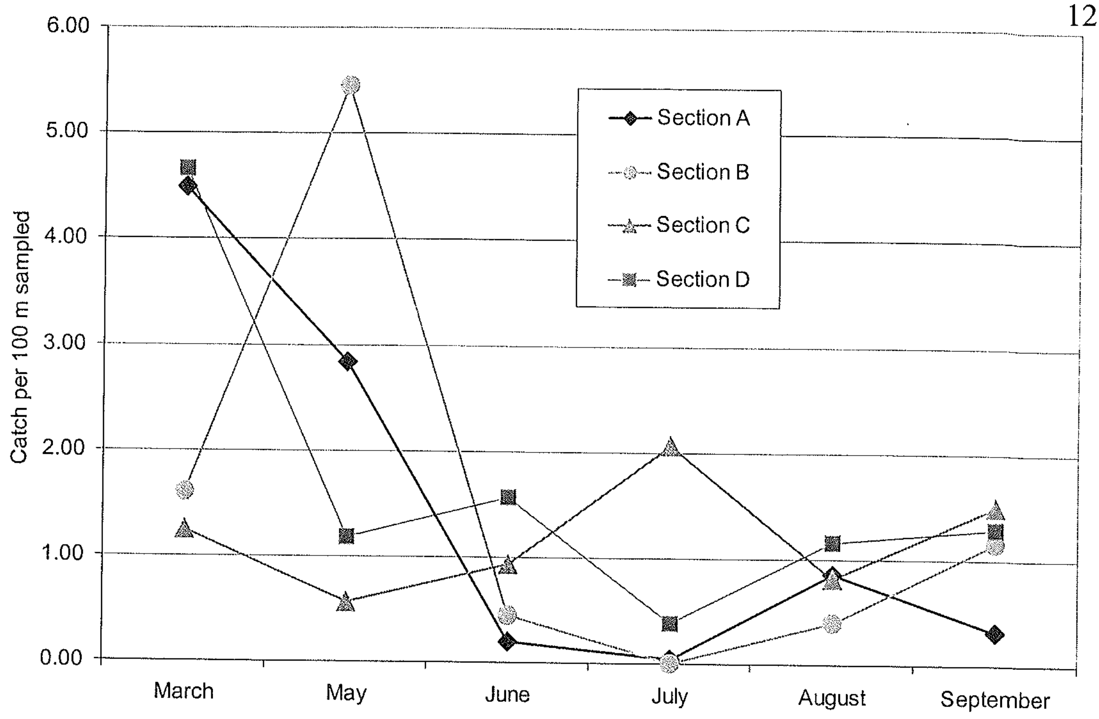

Figure 47. Electrofishing CPUE for rainbow trout in each section of Lake Ogallala, 2000.

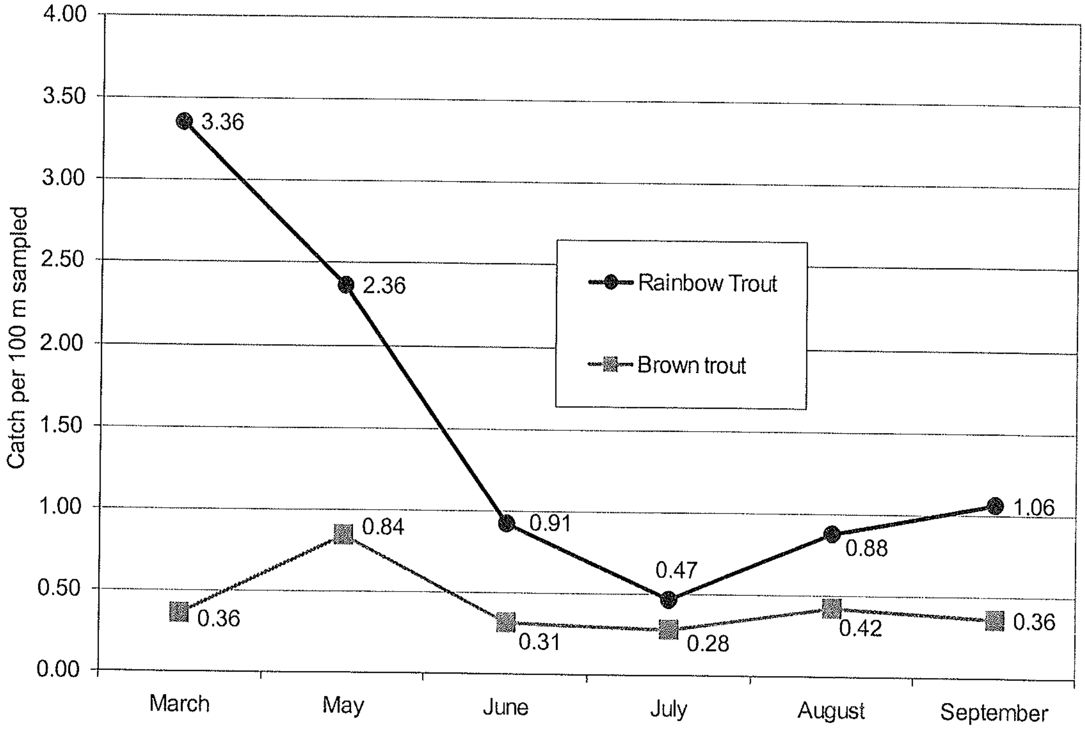

Figure 48. Electrofishing CPUE for brown and rainbow trout at Lake Ogallala, 2000.

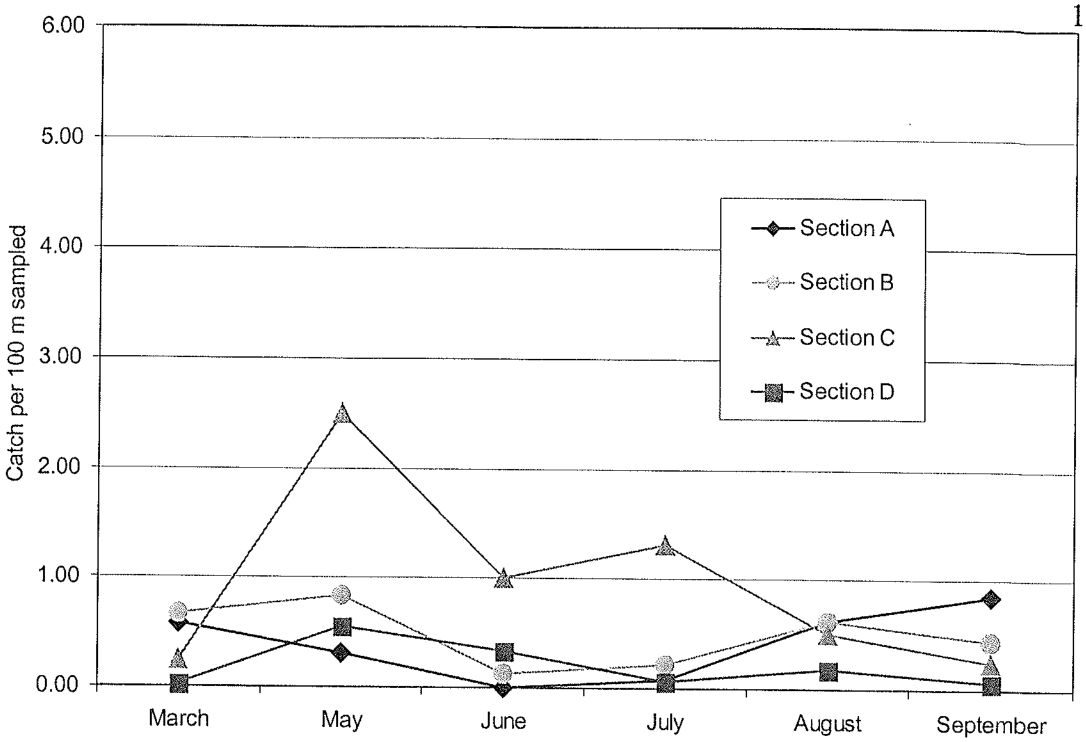

Figure 49. Electrofishing CPUE for brown trout in each section of Lake Ogallala, 2000.

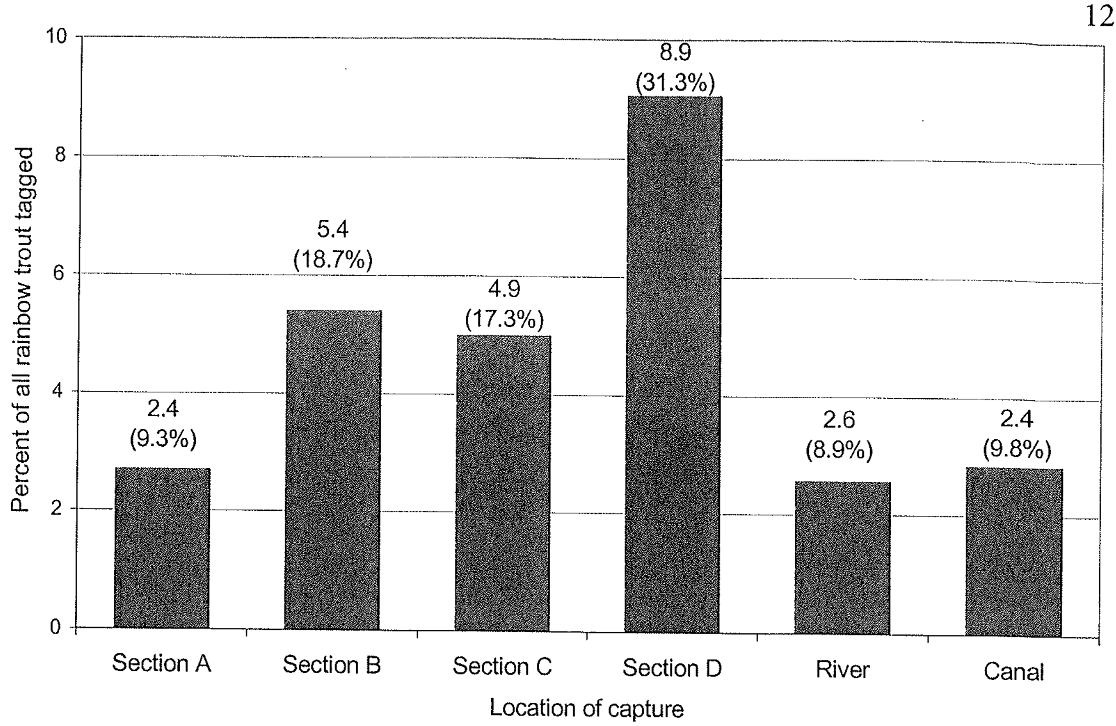

Figure 50. Rainbow trout tag returns and electrofishing recaptures from March 2000 through April 2001(Parantheses = percent of all rainbow trout recaptures).

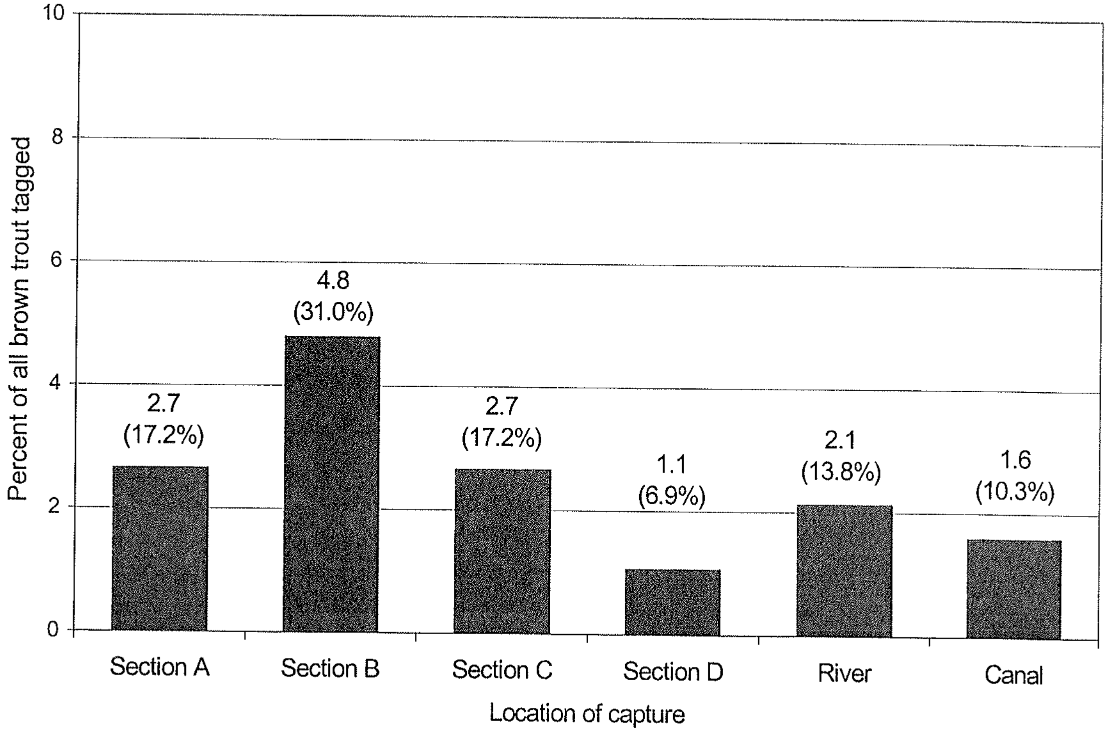

Figure 51. Brown trout tag returns and electrofishing recaptures from March 2000 through April 2001 (Parentheses = Percent of all brown trout recaptures).

Appendix 1. Locations of ultrasonically tagged rainbow trout in Lake Ogallala, March 1999-January 2000.

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 106 | 04/19/99 | | A | | Release date |
| 2 | 106 | 04/23/99 | 17:15 | B | 7.9 | ** |
| 3 | 106 | 04/24/99 | 8:25 | B | 7.9 | ** |
| 4 | 106 | 05/10/99 | 17:41 | C | 6.1 | |
| 5 | 106 | 05/11/99 | 9:35 | C | 10.7 | |
| 6 | 106 | 05/12/99 | 10:55 | C | 10.1 | |
| 7 | 106 | 05/12/99 | 18:25 | B | 9.8 | |
| 8 | 106 | 05/18/99 | 10:25 | C | 10.4 | |
| 9 | 106 | 05/19/99 | 17:34 | C | 11.6 | |
| 10 | 106 | 05/20/99 | 17:56 | B | 5.5 | |
| 11 | 106 | 05/26/99 | 11:10 | D | 1 | |
| 12 | 106 | 05/26/99 | 19:16 | D | 1.2 | |
| 13 | 106 | 05/27/99 | 10:29 | D | 1 | |
| 14 | 106 | 05/31/99 | 18:20 | D | 0.9 | |
| 15 | 106 | 06/01/99 | 17:32 | D | 1.5 | |
| 16 | 106 | 06/02/99 | 11:08 | D | 1.2 | |
| 17 | 106 | 06/03/99 | 12:02 | D | 1 | |
| 18 | 106 | 06/10/99 | 11:20 | D | 0.9 | |
| 19 | 106 | 06/15/99 | 18:45 | D | 1.9 | |
| 20 | 106 | 06/18/99 | 13:02 | D | 1.2 | |
| 21 | 106 | 06/23/99 | 19:10 | D | 0.9 | |
| 22 | 106 | 06/24/99 | 11:30 | D | 0.9 | |
| 23 | 106 | 06/29/99 | 12:50 | D | 1.2 | |
| 24 | 106 | 06/30/99 | 19:35 | D | 1.2 | |
| 25 | 106 | 07/01/99 | 9:25 | D | 1.5 | |
| 26 | 106 | 07/06/99 | 9:00 | D | 0.9 | |
| 27 | 106 | 07/08/99 | 10:00 | D | 1 | |
| 28 | 106 | 07/09/99 | 17:45 | D | 1.2 | |
| 29 | 106 | 07/12/99 | 10:50 | D | 0.9 | |
| 30 | 106 | 07/16/99 | 18:39 | D | 1.2 | |
| 31 | 106 | 07/17/99 | 16:18 | D | 0.9 | |
| 32 | 106 | 07/20/99 | 19:20 | D | 1.2 | |
| 33 | 106 | 07/21/99 | 10:30 | D | 1.5 | |
| 34 | 106 | 07/23/99 | 18:45 | D | 1.2 | |
| 35 | 106 | 07/24/99 | 14:22 | D | 0.9 | |
| 36 | 106 | 07/26/99 | 19:02 | D | 1.5 | |
| 37 | 106 | 07/27/99 | 13:35 | D | 0.9 | |

Appendix 1. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 115 | 04/19/99 | | A | | Release date |
| 2 | 115 | 04/23/99 | 18:50 | A | 8.5 | ** |
| 3 | 115 | 04/24/99 | 9:30 | A | 9.4 | ** |
| 4 | 115 | 04/24/99 | 19:10 | A | 8.8 | ** |
| 5 | 115 | 05/11/99 | 9:01 | A | 1 | |
| 6 | 115 | 05/12/99 | 8:42 | A | 9.5 | |
| 7 | 115 | 05/12/99 | 16:45 | A | 9.8 | |
| 8 | 115 | 05/17/99 | 11:32 | A | 9.1 | |
| 9 | 115 | 05/18/99 | 9:30 | A | 9.1 | |
| 10 | 115 | 05/20/99 | 16:14 | A | 10.1 | |
| 11 | 115 | 05/21/99 | 17:11 | A | 9.1 | |
| 12 | 115 | 05/26/99 | 8:25 | A | 9.4 | |
| 13 | 115 | 05/27/99 | 8:21 | A | 9.8 | Transmitter expel/fish dead |
| | | | | | | |
| 1 | 124 | 03/16/99 | | A | | Release date |
| 2 | 124 | 03/16/99 | 17:00 | A | | ** |
| 3 | 124 | 03/17/99 | 10:20 | A | | ** |
| 4 | 124 | 03/17/99 | 17:56 | A | | ** |
| | | | | | | |
| 1 | 249 | 04/19/99 | | A | | Release date |
| 2 | 249 | 05/10/99 | 18:00 | C | 5.5 | |
| 3 | 249 | 05/11/99 | 10:15 | B | 9.1 | |
| 4 | 249 | 05/12/99 | 10:15 | B | 9.5 | |
| 5 | 249 | 05/18/99 | 10:55 | C | 11.3 | |
| 6 | 249 | 05/26/99 | 9:55 | C | 9.4 | |
| 7 | 249 | 05/26/99 | 18:55 | C | 10.7 | |
| 8 | 249 | 05/27/99 | 9:35 | C | 10 | |
| 9 | 249 | 05/31/99 | 18:56 | C | 9.8 | |
| 10 | 249 | 06/01/99 | 16:05 | C | 10.1 | |
| 11 | 249 | 06/02/99 | 9:21 | C | 9.8 | |
| 12 | 249 | 06/03/99 | 10:53 | C | 8.8 | |
| 13 | 249 | 06/07/99 | 11:34 | C | 9.8 | |
| 14 | 249 | 06/10/99 | 9:58 | C | 9.1 | |
| 15 | 249 | 06/14/99 | 11:15 | C | 9.8 | |
| 16 | 249 | 06/15/99 | 17:06 | C | 10 | |
| 17 | 249 | 06/18/99 | 11:50 | C | 9.4 | |
| 18 | 249 | 06/21/99 | 9:52 | C | 9.1 | |
| 19 | 249 | 06/23/99 | 17:52 | C | 9.8 | |
| 20 | 249 | 06/24/99 | 10:04 | C | 9.4 | |
| 21 | 249 | 06/29/99 | 11:38 | C | 9.4 | |

Appendix 1. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 22 | 249 | 06/30/99 | 18:14 | C | 9.1 | |
| 23 | 249 | 07/01/99 | 10:15 | C | 10.1 | |
| 24 | 249 | 07/06/99 | 8:32 | C | 9.4 | |
| 25 | 249 | 07/08/99 | 9:00 | C | 9.4 | |
| 26 | 249 | 07/09/99 | 18:32 | C | 9.8 | |
| 27 | 249 | 07/12/99 | 9:48 | C | 9.8 | |
| 28 | 249 | 07/16/99 | 17:33 | C | 9.8 | |
| 29 | 249 | 07/17/99 | 14:50 | C | 9.8 | |
| 30 | 249 | 07/20/99 | 18:45 | C | 9.8 | |
| 31 | 249 | 07/21/99 | 9:10 | C | 9.8 | |
| 32 | 249 | 07/23/99 | 17:25 | C | 9.8 | |
| 33 | 249 | 07/24/99 | 12:50 | C | 9.4 | |
| 34 | 249 | 07/26/99 | 18:06 | C | | |
| 35 | 249 | 07/27/99 | 13:06 | C | 9.4 | |
| 36 | 249 | 07/29/99 | 10:55 | C | 9.4 | |
| | | | | | | |
| 1 | 258 | 04/19/99 | | A | | Release date |
| 2 | 258 | 04/24/99 | 10:15 | A | 10 | ** |
| 3 | 258 | 05/12/99 | 9:32 | A | 8.5 | |
| 4 | 258 | 05/17/99 | 11:17 | A | 8.5 | |
| 5 | 258 | 05/18/99 | 9:15 | A | 9.8 | |
| 6 | 258 | 05/20/99 | 16:31 | A | 4.9 | |
| 7 | 258 | 05/21/99 | 17:35 | A | 5.5 | |
| 8 | 258 | 05/26/99 | 9:00 | A | 0.9 | Toe drain |
| 9 | 258 | 05/26/99 | 17:40 | A | 0.6 | Toe drain |
| 10 | 258 | 05/27/99 | 8:42 | A | 0.6 | |
| 11 | 258 | 05/28/99 | 9:07 | A | 1 | |
| | | | | | | |
| 1 | 267 | 04/19/99 | | A | | Release date |
| 2 | 267 | 04/24/99 | 8:50 | A | 8.5 | ** |
| 3 | 267 | 04/24/99 | 18:25 | A | 8.8 | ** |
| 4 | 267 | 05/10/99 | 17:26 | A | 9.4 | |
| 5 | 267 | 05/11/99 | 9:29 | A | 1 | |
| 6 | 267 | 05/12/99 | 9:50 | A | 10.1 | |
| 7 | 267 | 05/12/99 | 17:23 | A | 7.3 | |
| 8 | 267 | 05/31/99 | 17:38 | D | 1 | |
| 9 | 267 | 06/01/99 | 17:30 | D | 1.5 | |
| 10 | 267 | 06/02/99 | 10:18 | D | 1.2 | |
| 11 | 267 | 06/03/99 | 11:08 | D | 0.6 | |
| 12 | 267 | 06/07/99 | 12:52 | D | 1.2 | |
| 13 | 267 | 06/10/99 | 10:55 | D | 1.2 | |

Appendix 1. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 14 | 267 | 06/15/99 | 18:18 | D | 1.8 | |
| 15 | 267 | 06/18/99 | 12:22 | D | 1.5 | |
| 16 | 267 | 06/21/99 | 10:25 | D | 1.2 | |
| 17 | 267 | 06/23/99 | | D | 1.5 | |
| 18 | 267 | 06/24/99 | 10:44 | D | 1.2 | |
| 19 | 267 | 06/29/99 | 11:53 | D | 1.5 | |
| 20 | 267 | 06/30/99 | 19:01 | D | 1.5 | |
| 21 | 267 | 07/01/99 | 9:40 | D | 1.8 | |
| 22 | 267 | 07/06/99 | 8:45 | D | 0.9 | |
| 23 | 267 | 07/07/99 | 17:45 | D | 1.8 | |
| 24 | 267 | 07/08/99 | 9:44 | D | 10.5 | |
| 25 | 267 | 07/09/99 | 16:25 | D | 1.5 | |
| 26 | 267 | 07/12/99 | 11:35 | D | 1.5 | |
| 27 | 267 | 07/13/99 | 20:00 | D | 1.8 | |
| 28 | 267 | 07/16/99 | 18:52 | D | 1.2 | |
| 29 | 267 | 07/17/99 | 15:40 | D | 1.5 | |
| 30 | 267 | 07/21/99 | 9:42 | D | 2.1 | |
| 31 | 267 | 07/23/99 | 18:02 | D | 1.5 | |
| 32 | 267 | 07/24/99 | 15:45 | D | 1.5 | |
| 33 | 267 | 07/26/99 | 18:27 | D | 1.8 | |
| 34 | 267 | 07/27/99 | 13:50 | D | 1.2 | |
| 35 | 267 | 07/29/99 | 11:24 | D | 1.5 | |
| 36 | 267 | 07/31/99 | 9:52 | D | 1.5 | |
| 37 | 267 | 08/03/99 | 19:43 | D | 1.8 | |
| 38 | 267 | 08/05/99 | 19:10 | D | 1.8 | |
| 39 | 267 | 08/07/99 | 18:59 | D | 1.5 | |
| 40 | 267 | 08/10/99 | 10:14 | D | 1 | |
| 41 | 267 | 08/11/99 | 18:19 | D | 2.1 | |
| 42 | 267 | 08/13/99 | 10:55 | C | 1.8 | |
| 43 | 267 | 08/16/99 | 19:56 | D | 1.2 | |
| 44 | 267 | 08/18/99 | 19:10 | D | 1.5 | |
| 45 | 267 | 09/06/99 | 19:25 | D | 2.1 | |
| 46 | 267 | 09/07/99 | 8:20 | D | 1.5 | |
| 47 | 267 | 10/08/99 | 19:47 | D | 2.1 | |

Appendix 1. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 294 | 03/16/99 | | A | | Release date |
| 2 | 294 | 03/16/99 | 17:00 | A | | ** |
| 3 | 294 | 03/17/99 | 10:15 | A | 4 | ** |
| 4 | 294 | 03/17/99 | 18:00 | A | | ** |
| 5 | 294 | 03/18/99 | 7:54 | A | 2.4 | ** |
| 6 | 294 | 04/02/99 | 17:20 | A | 7.6 | |
| 7 | 294 | 04/03/99 | 11:00 | A | 7 | |
| 8 | 294 | 04/03/99 | 15:45 | A | 6.4 | |
| 9 | 294 | 04/17/99 | 9:35 | A | 7.3 | |
| 10 | 294 | 04/23/99 | 19:10 | A | 4.9 | |
| 11 | 294 | 04/24/99 | 9:45 | A | 5.2 | |
| 12 | 294 | 04/24/99 | 19:20 | A | 9.4 | |
| 13 | 294 | 05/10/99 | 17:32 | A | 9.4 | |
| 14 | 294 | 05/11/99 | 9:20 | A | 10.5 | |
| 15 | 294 | 05/12/99 | 9:22 | A | 10.1 | |
| 16 | 294 | 05/12/99 | 17:00 | A | 10.4 | |
| 17 | 294 | 05/13/99 | 9:00 | A | 9.8 | Transmitter expel/fish dead |
| | | | | | | |
| 1 | 339 | 04/19/99 | | A | | Release date |
| 2 | 339 | 04/24/99 | 9:10 | A | 8.2 | ** |
| 3 | 339 | 04/24/99 | 18:15 | A | | ** |
| | | | | | | |
| 1 | 348 | 03/16/99 | | A | | Release date |
| 2 | 348 | 03/17/99 | 10:18 | A | | ** |

Appendix 1. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 357 | 06/16/99 | | C | | Implanted and released |
| 2 | 357 | 06/22/99 | 20:05 | D | 1.2 | |
| 3 | 357 | 06/23/99 | 17:54 | D | 1.8 | |
| 4 | 357 | 06/24/99 | 11:00 | D | 1.6 | |
| 5 | 357 | 06/29/99 | 13:02 | D | 1.8 | |
| 6 | 357 | 06/30/99 | 19:50 | D | 1.5 | |
| 7 | 357 | 07/01/99 | 10:00 | D | 1.5 | |
| 8 | 357 | 07/07/99 | 18:05 | D | 1.5 | Near canal gates |
| 9 | 357 | 07/09/99 | 17:02 | D | 1.8 | |
| 10 | 357 | 07/12/99 | 11:20 | D | 1.5 | |
| 11 | 357 | 07/14/99 | 20:15 | D | 1.5 | |
| 12 | 357 | 07/16/99 | 19:15 | D | 1.5 | |
| 13 | 357 | 07/17/99 | 16:04 | D | 1.5 | |
| 14 | 357 | 07/20/99 | 19:34 | D | 1.8 | |
| 15 | 357 | 07/21/99 | 10:05 | D | 1.8 | |
| 16 | 357 | 07/23/99 | 17:10 | D | 1.5 | |
| 17 | 357 | 07/24/99 | 14:45 | D | 1.8 | |
| 18 | 357 | 07/26/99 | 18:54 | D | 1.2 | |
| 19 | 357 | 07/27/99 | 11:22 | D | 3 | |
| 20 | 357 | 07/29/99 | 11:50 | D | 1.2 | |
| 21 | 357 | 07/31/99 | 10:25 | D | 1.2 | |
| 22 | 357 | 08/02/99 | 20:40 | D | 1.2 | |
| 23 | 357 | 08/07/99 | 19:35 | D | 1.2 | |
| 24 | 357 | 08/10/99 | 11:02 | D | 0.9 | |
| 25 | 357 | 08/11/99 | 18:51 | D | 1.5 | |
| 26 | 357 | 08/13/99 | 11:43 | D | 1.2 | |
| 27 | 357 | 08/18/99 | 19:20 | D | 1.2 | |
| 28 | 357 | 09/06/99 | 19:10 | D | 1.5 | |
| 29 | 357 | 09/07/99 | 8:55 | D | 3 | In front of canal gates |
| 30 | 357 | 09/10/99 | 19:22 | D | 1.8 | |
| 31 | 357 | 09/11/99 | 10:12 | D | 2 | |
| 32 | 357 | 09/17/99 | 19:25 | D | 2.1 | |
| 33 | 357 | 09/18/99 | 11:00 | D | 2.1 | |
| 34 | 357 | 09/25/99 | 9:51 | D | 2.4 | |
| 35 | 357 | 10/02/99 | 11:20 | D | 1.2 | |
| 36 | 357 | 10/08/99 | 20:02 | D | 1.8 | |

Appendix 1. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 375 | 04/19/99 | | A | | Release date |
| 2 | 375 | 04/23/99 | 18:20 | A | 10 | ** |
| 3 | 375 | 05/10/99 | 16:40 | A | 9.8 | |
| 4 | 375 | 05/11/99 | 8:45 | A | 10 | |
| 5 | 375 | 05/12/99 | 9:43 | AB | 1.2 | |
| 6 | 375 | 05/12/99 | 17:55 | AB | 5.8 | |
| 7 | 375 | 05/18/99 | 10:15 | BC | 11 | |
| 8 | 375 | 05/19/99 | 17:40 | C | 6.7 | |
| 9 | 375 | 05/20/99 | 18:15 | C | 10.7 | |
| 10 | 375 | 05/26/99 | 10:14 | C | 8.2 | |
| 11 | 375 | 05/26/99 | 18:38 | C | 5.5 | |
| 12 | 375 | 05/27/99 | 9:46 | C | 11 | |
| 13 | 375 | 05/28/99 | 12:54 | C | 11.6 | |
| 14 | 375 | 05/31/99 | 17:19 | C | 9.1 | |
| 15 | 375 | 06/01/99 | 16:12 | C | 10.4 | |
| 16 | 375 | 06/02/99 | 9:46 | C | 9.8 | |
| 17 | 375 | 06/03/99 | 9:12 | C | 10.7 | |
| 18 | 375 | 06/07/99 | 11:07 | C | 10.4 | |
| 19 | 375 | 06/10/99 | 10:12 | C | 9.1 | |
| 20 | 375 | 06/14/99 | 11:35 | C | 11 | |
| 21 | 375 | 06/15/99 | 17:24 | C | 11.3 | |
| 22 | 375 | 06/18/99 | 11:11 | C | 11.3 | |
| 23 | 375 | 06/21/99 | 9:32 | C | 8.8 | |
| 24 | 375 | 06/23/99 | 17:40 | C | 8.8 | |
| 25 | 375 | 06/24/99 | 10:36 | C | 9.4 | |
| 26 | 375 | 06/29/99 | 10:33 | C | 10.7 | |
| 27 | 375 | 06/30/99 | 18:45 | C | 11 | |
| 28 | 375 | 07/01/99 | 9:00 | D | 2.1 | |
| 29 | 375 | 07/06/99 | 8:08 | C | 1.3 | |
| 30 | 375 | 07/08/99 | 9:19 | C | 6.7 | |
| 31 | 375 | 07/09/99 | 18:04 | C | 11.6 | |
| 32 | 375 | 07/12/99 | 10:04 | C | 11.3 | |
| 33 | 375 | 07/13/99 | 19:30 | C | | |
| 34 | 375 | 07/16/99 | 18:05 | C | 11 | |
| 35 | 375 | 07/17/99 | 15:20 | C | 11.3 | |
| 36 | 375 | 07/20/99 | 18:58 | C | 10.7 | |
| 37 | 375 | 07/21/99 | 9:27 | C | 10.4 | |
| 38 | 375 | 07/23/99 | 17:40 | C | 1 | |
| 39 | 375 | 07/24/99 | 13:09 | C | 11 | |
| 40 | 375 | 07/26/99 | 17:51 | C | 10.7 | |
| 41 | 375 | 07/27/99 | 13:18 | C | 10.7 | |

Appendix 1. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 42 | 375 | 07/29/99 | 11:10 | C | 11 | |
| 43 | 375 | 07/31/99 | 9:20 | C | 10.7 | |
| 44 | 375 | 08/03/99 | 19:24 | C | 11.3 | |
| 45 | 375 | 08/05/99 | 18:07 | C | 11.3 | |
| 46 | 375 | 08/07/99 | 18:40 | C | 11.3 | |
| 47 | 375 | 08/10/99 | 10:05 | C | 10.4 | |
| 48 | 375 | 08/10/99 | 19:31 | C | 12.2 | |
| 49 | 375 | 08/11/99 | 18:06 | C | 11.6 | |
| 50 | 375 | 08/13/99 | 10:43 | C | 11 | |
| 51 | 375 | 08/16/99 | 19:47 | C | 11 | |
| 52 | 375 | 08/18/99 | 19:30 | C | 11.9 | |
| 53 | 375 | 09/06/99 | 18:40 | C | 11.6 | |
| 54 | 375 | 09/07/99 | 7:45 | C | 10.7 | |
| 55 | 375 | 09/10/99 | 18:41 | C | 11.3 | |
| | | | | | | |
| 1 | 384 | 04/19/99 | | A | | Release date |
| 2 | 384 | 04/23/99 | 18:40 | A | 9.7 | ** |
| 3 | 384 | 04/24/99 | 18:50 | A | 6.1 | ** |
| 4 | 384 | 05/10/99 | 17:07 | A | 8.5 | |
| 5 | 384 | 05/11/99 | 9:00 | A | 1 | |
| 6 | 384 | 05/12/99 | 9:11 | A | 10.1 | |
| 7 | 384 | 05/12/99 | 16:15 | A | 8.2 | |
| 8 | 384 | 05/13/99 | 9:33 | A | 8.5 | |
| 9 | 384 | 05/17/99 | 12:10 | A | 6.4 | |
| 10 | 384 | 05/18/99 | 8:30 | A | 6.1 | |
| 11 | 384 | 05/19/99 | 16:54 | A | 4.3 | |
| 12 | 384 | 05/20/99 | 17:20 | A | 4.9 | |
| 13 | 384 | 05/21/99 | 16:55 | A | 7.3 | Transmitter expel/fish dead |
| | | | | | | |
| 1 | 456 | 03/16/99 | | A | | Release date |
| 2 | 456 | 03/16/99 | 17:00 | A | | ** |
| 3 | 456 | 03/17/99 | 9:56 | A | 10.6 | ** |
| 4 | 456 | 03/17/99 | 17:49 | A | 10.1 | ** |
| 5 | 456 | 03/18/99 | 8:06 | A | 9.1 | ** |

Appendix 1. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 456 | 09/17/99 | 22:30 | C | | Implanted, released S ramp |
| 2 | 456 | 09/18/99 | 10:00 | AB | 2.1 | ** |
| 3 | 456 | 09/25/99 | 11:10 | A | 1.8 | ** |
| 4 | 456 | 10/29/99 | 17:40 | D | | |
| 5 | 456 | 10/30/99 | 10:00 | D | | |
| 6 | 456 | 11/13/99 | 8:00 | D | | |
| 7 | 456 | 11/14/99 | 15:00 | D | | |
| 8 | 456 | 11/27/99 | 13:00 | D | | |
| 9 | 456 | 12/21/99 | 14:00 | D | | |
| 10 | 456 | 01/07/00 | 11:00 | D | | |
| 11 | 456 | 02/22/00 | | C | | Caught by angler, hydro |
| | | | | | | |
| 1 | 555 | 04/19/99 | | A | | Release date |
| 2 | 555 | 04/23/99 | 19:30 | A | 8.8 | ** |
| 3 | 555 | 04/24/99 | 18:40 | A | 9.8 | ** |
| 4 | 555 | 05/10/99 | 18:12 | C | 11 | |
| 5 | 555 | 05/11/99 | 10:02 | C | 11.2 | |
| 6 | 555 | 05/12/99 | 11:35 | C | 10.1 | |
| 7 | 555 | 05/12/99 | 18:15 | B | 9.1 | |
| 8 | 555 | 05/18/99 | 11:25 | D | 1.2 | |
| 9 | 555 | 05/19/99 | 18:02 | D | 0.9 | |
| 10 | 555 | 05/20/99 | 9:00 | D | 0.9 | |
| 11 | 555 | 05/26/99 | 11:30 | D | 1 | |
| 12 | 555 | 05/26/99 | 19:15 | D | 1.21 | |
| 13 | 555 | 05/27/99 | 10:50 | D | 1.2 | |
| 14 | 555 | 05/31/99 | 18:27 | D | 1.2 | |
| 15 | 555 | 06/02/99 | 10:39 | D | 1.5 | |
| 16 | 555 | 06/03/99 | 11:48 | D | 1.2 | |
| 17 | 555 | 06/07/99 | 12:12 | D | 1 | |
| 18 | 555 | 06/10/99 | 11:10 | D | 1 | |
| 19 | 555 | 06/15/99 | 18:35 | D | 1.5 | |
| 20 | 555 | 06/18/99 | 12:45 | D | 1.5 | |
| 21 | 555 | 06/23/99 | 18:54 | D | 1.5 | |
| 22 | 555 | 06/24/99 | 11:00 | D | 1.5 | |
| 23 | 555 | 06/29/99 | 12:30 | D | 1.5 | |
| 24 | 555 | 06/30/99 | 19:25 | D | 1.2 | |
| 25 | 555 | 07/08/99 | 10:20 | D | 1 | |
| 26 | 555 | 07/09/99 | 17:19 | D | 1.5 | |
| 27 | 555 | 07/12/99 | 11:10 | D | 1.5 | |
| 28 | 555 | 07/14/99 | 20:30 | D | 1.5 | |

Appendix 1. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 29 | 555 | 07/16/99 | 19:03 | D | 1.2 | |
| 30 | 555 | 07/17/99 | 15:49 | D | 1.2 | |
| 31 | 555 | 07/20/99 | 19:39 | D | 1.8 | |
| 32 | 555 | 07/21/99 | 9:58 | D | 1.8 | |
| 33 | 555 | 07/23/99 | 18:15 | D | 1.5 | |
| 34 | 555 | 07/24/99 | 14:07 | D | 1.5 | |
| 35 | 555 | 07/26/99 | 18:38 | D | 1.8 | |
| 36 | 555 | 07/27/99 | 11:33 | D | 1.2 | |
| 37 | 555 | 07/29/99 | 11:35 | D | 1.2 | |
| 38 | 555 | 07/31/99 | 10:15 | D | 1.5 | |
| 39 | 555 | 08/03/99 | 19:59 | D | 1.8 | |
| 40 | 555 | 08/05/99 | 18:45 | D | 1.8 | |
| | | | | | | |
| 1 | 2228 | 10/07/99 | | A | | Release date |
| 2 | 2228 | 10/16/99 | 14:25 | D | | |
| 3 | 2228 | 10/17/99 | 13:00 | D | | |
| 4 | 2228 | 10/29/99 | 17:40 | D | | |
| 5 | 2228 | 10/30/99 | 10:00 | D | | |
| 6 | 2228 | 11/13/99 | 8:00 | D | | |
| 7 | 2228 | 11/14/99 | 15:00 | D | | |
| 8 | 2228 | 11/27/99 | 13:00 | D | | |
| 9 | 2228 | 12/21/99 | 14:00 | D | | |
| 10 | 2228 | 01/06/00 | 15:30 | D | | |
| 11 | 2228 | 01/07/00 | 11:00 | D | | |
| | | | | | | |
| 1 | 2237 | 10/07/99 | | A | | Release date |
| 2 | 2237 | 10/16/99 | 12:35 | A | | Maybe never alive? |
| 3 | 2237 | 10/17/99 | 11:05 | A | | ** |
| 4 | 2237 | 10/29/99 | 16:20 | A | | ** |
| 5 | 2237 | 10/30/99 | 10:00 | A | | ** |
| 6 | 2237 | 11/13/99 | 8:00 | A | | ** |
| 7 | 2237 | 11/14/99 | 15:00 | A | | ** |
| 8 | 2237 | 11/27/99 | 13:00 | A | | ** |
| 9 | 2237 | 12/21/99 | 14:00 | A | | ** |
| | | | | | | |
| 1 | 2247 | 10/07/99 | | A | | Release date |
| 2 | 2247 | 10/16/99 | 13:45 | B | | |
| 3 | 2247 | 10/17/99 | 10:30 | B | | |
| 4 | 2247 | 10/29/99 | 16:15 | B | | |
| 5 | 2247 | 10/30/99 | 10:00 | B | | |

Appendix 1. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 2255 | 05/25/99 | | A | | Release date |
| 2 | 2255 | 05/26/99 | 9:15 | A | 1.5 | ** |
| 3 | 2255 | 05/26/99 | 17:59 | A | 1.5 | ** |
| 4 | 2255 | 05/27/99 | 7:51 | B | 7.6 | ** |
| 5 | 2255 | 05/31/99 | 17:50 | D | 2.1 | |
| 6 | 2255 | 06/01/99 | 17:10 | D | 1.5 | |
| 7 | 2255 | 06/02/99 | 9:59 | D | 1.5 | |
| 8 | 2255 | 06/03/99 | 12:14 | D | 1.5 | |
| 9 | 2255 | 06/07/99 | 11:54 | D | 1.5 | |
| 10 | 2255 | 06/14/99 | 11:46 | D | 1.2 | |
| 11 | 2255 | 06/15/99 | 18:09 | D | 1.5 | |
| 12 | 2255 | 06/18/99 | 13:10 | D | 1.8 | |
| 13 | 2255 | 06/23/99 | 19:05 | D | 1.8 | |
| 14 | 2255 | 06/24/99 | 11:20 | D | 1.2 | |
| 15 | 2255 | 06/29/99 | 12:48 | D | 1.5 | |
| 16 | 2255 | 06/30/99 | 19:40 | D | 1.5 | |
| 17 | 2255 | 07/01/99 | 9:33 | D | 1.8 | |
| 18 | 2255 | 07/05/99 | 18:50 | D | 1.2 | |
| 19 | 2255 | 07/06/99 | 9:05 | D | 1.2 | |
| 20 | 2255 | 07/08/99 | 10:05 | D | 1.5 | |
| 21 | 2255 | 07/09/99 | 17:36 | D | 1.2 | |
| 22 | 2255 | 07/12/99 | 10:37 | D | 1.2 | |
| 23 | 2255 | 07/16/99 | 18:26 | D | 1.5 | |
| 24 | 2255 | 07/17/99 | 16:30 | D | 1.2 | |
| 25 | 2255 | 07/20/99 | 19:24 | D | 1.2 | |
| 26 | 2255 | 07/21/99 | 10:35 | D | 2.1 | |
| 27 | 2255 | 07/23/99 | 18:55 | D | 1.5 | |
| 28 | 2255 | 07/24/99 | 14:31 | D | 2.1 | |
| 29 | 2255 | 07/26/99 | 19:00 | D | 1.5 | |
| 30 | 2255 | 07/27/99 | 13:31 | D | 1.5 | |
| 31 | 2255 | 07/29/99 | 12:12 | D | 1.2 | |
| 32 | 2255 | 07/31/99 | 10:50 | D | 1.5 | |
| 33 | 2255 | 08/03/99 | 20:10 | D | 1.5 | |
| 34 | 2255 | 08/07/99 | 19:46 | D | 1.5 | |
| 35 | 2255 | 08/10/99 | 11:15 | D | 0.6 | |
| 36 | 2255 | 08/11/99 | 18:38 | D | 1.2 | |
| 37 | 2255 | 08/13/99 | 11:10 | D | 1.2 | |
| 38 | 2255 | 08/18/99 | 18:59 | D | 1.2 | |
| 39 | 2255 | 10/08/99 | 20:19 | D | 1.8 | |

Appendix 1. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 2273 | 05/25/99 | | A | | Release date |
| 2 | 2273 | 05/26/99 | 8:47 | A | 1.2 | Caught by angler today |
| | | | | | | |
| 1 | 2327 | 10/07/99 | | A | | Release date |
| 2 | 2327 | 10/16/99 | 15:10 | D | | |
| 3 | 2327 | 10/17/99 | 13:00 | D | | |
| 4 | 2327 | 10/29/99 | 17:40 | D | | |
| 5 | 2327 | 10/30/99 | 10:00 | D | | |
| 6 | 2327 | 11/13/99 | 8:00 | D | | |
| 7 | 2327 | 11/14/99 | 15:00 | D | | |
| 8 | 2327 | 11/27/99 | 13:00 | D | | |
| 9 | 2327 | 12/21/99 | 14:00 | D | | |
| | | | | | | |
| 1 | 2336 | 10/07/99 | | A | | Release date |
| 2 | 2336 | 10/16/99 | 11:30 | A | | |
| 3 | 2336 | 10/17/99 | 10:45 | A | | |
| | | | | | | |
| 1 | 2345 | 05/25/99 | | A | | Release date |
| 2 | 2345 | 05/26/99 | 17:20 | C | 11.3 | ** |
| 3 | 2345 | 05/27/99 | 11:05 | C | 2.1 | ** |
| 4 | 2345 | 06/01/99 | 16:48 | C | 10.7 | |
| 5 | 2345 | 06/02/99 | 9:41 | C | 8.8 | |
| 6 | 2345 | 06/03/99 | 8:57 | C | 10.7 | |
| 7 | 2345 | 06/15/99 | 17:50 | C | 11.3 | |
| 8 | 2345 | 06/21/99 | 10:01 | C | 7.9 | |
| 9 | 2345 | 06/24/99 | 10:23 | C | 8.2 | |
| 10 | 2345 | 06/29/99 | 10:53 | C | 10.7 | |
| 11 | 2345 | 06/30/99 | 18:40 | C | 10.4 | |
| 12 | 2345 | 07/06/99 | 8:15 | C | 11.3 | |
| 13 | 2345 | 07/08/99 | 9:29 | C | 10.1 | |
| 14 | 2345 | 07/09/99 | 18:09 | C | | |
| 15 | 2345 | 07/12/99 | 10:15 | C | 11.3 | |
| 16 | 2345 | 07/16/99 | 18:15 | C | 11 | |
| 17 | 2345 | 07/17/99 | 15:29 | C | 11.3 | |
| 18 | 2345 | 07/20/99 | 19:06 | C | 11.3 | |
| 19 | 2345 | 07/21/99 | 9:33 | C | 11.6 | |
| 20 | 2345 | 07/23/99 | 17:46 | C | 11.2 | |
| 21 | 2345 | 07/24/99 | 13:33 | C | 11.6 | |
| 22 | 2345 | 07/26/99 | 17:55 | C | 11.3 | |
| 23 | 2345 | 07/27/99 | 13:22 | C | 11 | |
| 24 | 2345 | 07/29/99 | 11:15 | C | 11.3 | |

Appendix 1. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 25 | 2345 | 07/31/99 | 9:31 | C | 11 | |
| 26 | 2345 | 08/05/99 | 18:14 | C | 11.3 | |
| 27 | 2345 | 08/10/99 | 9:55 | C | 9.8 | |
| 28 | 2345 | 08/10/99 | 19:16 | C | 10.7 | |
| 29 | 2345 | 08/11/99 | 17:49 | C | 10.1 | |
| 30 | 2345 | 08/13/99 | 10:24 | C | 10.1 | |
| 31 | 2345 | 08/16/99 | 19:36 | C | 10.4 | |
| 32 | 2345 | 08/18/99 | 19:43 | C | 11.9 | |
| 33 | 2345 | 08/30/99 | 20:10 | C | 9.1 | |
| 34 | 2345 | 09/06/99 | 18:30 | C | 11.9 | |
| 35 | 2345 | 09/07/99 | 8:10 | C | 4.3 | |
| 36 | 2345 | 09/10/99 | 18:59 | C | 11.3 | |
| 37 | 2345 | 09/11/99 | 9:38 | C | 2.4 | |
| 38 | 2345 | 09/17/99 | 18:45 | C | 10.1 | |
| 39 | 2345 | 09/18/99 | 10:30 | C | 8.8 | |
| 40 | 2345 | 09/25/99 | 9:15 | C | 11 | |
| 41 | 2345 | 10/02/99 | 10:14 | C | 9.8 | |
| 42 | 2345 | 10/16/99 | 15:30 | D | | |
| 43 | 2345 | 10/17/99 | 12:35 | C | | |
| 44 | 2345 | 10/29/99 | 17:25 | C | | |
| 45 | 2345 | 10/30/99 | 10:00 | C | | |
| 46 | 2345 | 01/14/00 | | | | Caught by angler today |

Appendix 1. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 2426 | 05/25/99 | | A | | Release date |
| 2 | 2426 | 05/26/99 | 18:25 | B | 6.4 | ** |
| 3 | 2426 | 05/27/99 | 8:00 | B | 5.8 | ** |
| 4 | 2426 | 06/02/99 | 11:32 | B | 9.4 | |
| 5 | 2426 | 06/03/99 | 9:23 | BC | 8.2 | |
| 6 | 2426 | 06/07/99 | 10:32 | B | 7.3 | |
| 7 | 2426 | 06/11/99 | 15:40 | B | 7.9 | |
| 8 | 2426 | 06/14/99 | 10:53 | B | 9.1 | |
| 9 | 2426 | 06/15/99 | 16:40 | B | 10.7 | |
| 10 | 2426 | 06/18/99 | 10:45 | B | 9.1 | |
| 11 | 2426 | 06/21/99 | 9:05 | B | 7 | |
| 12 | 2426 | 06/23/99 | 17:02 | BC | 4.9 | |
| 13 | 2426 | 06/24/99 | 9:39 | C | 8.8 | |
| 14 | 2426 | 06/29/99 | 13:14 | BC | 10.1 | |
| 15 | 2426 | 06/30/99 | 18:20 | C | 10.5 | |
| 16 | 2426 | 07/06/99 | 7:38 | C | 10.7 | |
| 17 | 2426 | 07/08/99 | 8:49 | C | 10.4 | |
| 18 | 2426 | 07/09/99 | 18:47 | C | 10.4 | |
| 19 | 2426 | 07/12/99 | 9:32 | C | 10.4 | |
| 20 | 2426 | 07/16/99 | 17:51 | C | 11 | |
| 21 | 2426 | 07/17/99 | 15:01 | C | 10.7 | |
| 22 | 2426 | 07/20/99 | 18:33 | C | 11 | |
| 23 | 2426 | 07/21/99 | 9:05 | C | 10.7 | |
| 24 | 2426 | 07/23/99 | 17:10 | C | 10.4 | |
| 25 | 2426 | 07/24/99 | 12:35 | C | 6.7 | |
| 26 | 2426 | 07/27/99 | 13:06 | C | | |
| 27 | 2426 | 07/29/99 | 10:45 | C | 9.4 | |
| 28 | 2426 | 07/31/99 | 9:05 | C | 9.4 | |
| 29 | 2426 | 08/03/99 | 19:11 | C | 8.2 | |
| 30 | 2426 | 08/05/99 | 19:30 | C | 10.7 | |
| 31 | 2426 | 08/07/99 | 18:14 | C | 10.7 | Caught by angler 8 Aug |

Appendix 2. Locations of ultrasonically tagged rainbow trout in Lake Ogallala, March-September 2000.

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 36 | 03/14/00 | | D | | Date implanted, released |
| 2 | 36 | 03/31/00 | 13:00 | D | | |
| 3 | 36 | 04/21/00 | 13:30 | A | 10.2 | |
| 4 | 36 | 05/08/00 | 14:00 | D | 1.8 | |
| 5 | 36 | 05/09/00 | 13:00 | D | 2 | |
| 6 | 36 | 05/13/00 | | D | 1.6 | |
| 7 | 36 | 05/14/00 | 10:00 | D | 1.7 | |
| 8 | 36 | 05/15/00 | | D | 1.4 | |
| 9 | 36 | 05/18/00 | 14:00 | D | 2.6 | |
| 10 | 36 | 05/21/00 | 10:00 | D | 3 | |
| 11 | 36 | 05/25/00 | 13:00 | D | 2.3 | |
| 12 | 36 | 05/29/00 | | D | 2.2 | |
| 13 | 36 | 06/01/00 | 14:20 | C | 11.3 | |
| 14 | 36 | 06/05/00 | 13:00 | D | 1.6 | |
| 15 | 36 | 06/08/00 | 11:05 | D | 1.1 | |
| 16 | 36 | 06/12/00 | 12:15 | D | | Dead or expelled |
| 17 | 36 | 06/15/00 | 11:00 | D | | Transmitter not moving |
| | | | | | | |
| 1 | 39 | 07/10/00 | | D | | Date implanted, released |
| 2 | 39 | 07/14/00 | 9:58 | D | 1 | |
| 3 | 39 | 07/17/00 | 10:45 | D | 2.5 | |
| 4 | 39 | 07/20/00 | 10:58 | D | 2.5 | |
| 5 | 39 | 07/24/00 | 10:07 | D | 2.3 | |
| 6 | 39 | 07/26/00 | 9:05 | D | 2.3 | |
| 7 | 39 | 07/26/00 | 10:55 | D | 2.4 | |
| 8 | 39 | 07/26/00 | 14:15 | D | 1.4 | |
| 9 | 39 | 07/26/00 | 17:30 | D | 1.3 | |
| 10 | 39 | 07/26/00 | 20:48 | D | 2.8 | |
| 11 | 39 | 07/26/00 | 23:20 | D | 2.6 | |
| 12 | 39 | 07/27/00 | 2:05 | D | 2.5 | |
| 13 | 39 | 07/27/00 | 5:15 | D | 1.4 | |
| 14 | 39 | 07/27/00 | 8:36 | D | 1.5 | |
| 15 | 39 | 07/28/00 | 19:02 | D | 2.4 | |
| 16 | 39 | 07/31/00 | 10:02 | D | 2.5 | |
| 17 | 39 | 08/03/00 | 11:41 | D | 2.7 | |
| 18 | 39 | 08/07/00 | 10:43 | D | 2.5 | |
| 19 | 39 | 08/14/00 | 10:53 | D | 2.2 | |
| 20 | 39 | 08/17/00 | 10:08 | D | 2.1 | |
| 21 | 39 | 09/02/00 | 10:45 | D | 1.3 | |
| 22 | 39 | 09/23/00 | 11:55 | D | 1.4 | |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 23 | 39 | 09/23/00 | 15:40 | D | 1.2 | |
| 24 | 39 | 09/23/00 | 19:39 | D | 1.5 | |
| 25 | 39 | 09/23/00 | 22:35 | D | 1.4 | |
| 26 | 39 | 09/24/00 | 1:36 | D | 1.6 | |
| 27 | 39 | 09/24/00 | 7:32 | D | 1.2 | |
| 28 | 39 | 09/30/00 | 10:00 | D | 1.8 | |
| 1 | 47 | 03/13/00 | | A | | Date implanted, released |
| 1 | 49 | 03/13/00 | | B | | Date implanted, released |
| 2 | 49 | 03/31/00 | 13:00 | A | | |
| 3 | 49 | 04/21/00 | 13:30 | A | 4.2 | |
| 4 | 49 | 04/21/00 | 16:00 | D | 1.4 | |
| 5 | 49 | 05/08/00 | 14:00 | D | 1.8 | |
| 6 | 49 | 05/09/00 | 13:00 | D | 2 | |
| 7 | 49 | 05/13/00 | | C | 11.3 | |
| 8 | 49 | 05/14/00 | 10:00 | D | 2.5 | |
| 9 | 49 | 05/15/00 | | D | 2.1 | |
| 10 | 49 | 05/18/00 | 14:00 | D | 1.6 | |
| 11 | 49 | 05/21/00 | 10:00 | C | 1.5 | |
| 12 | 49 | 05/25/00 | 13:00 | D | 1.6 | |
| 13 | 49 | 05/29/00 | | B | 9.6 | |
| 14 | 49 | 06/01/00 | 14:54 | B | 9.3 | |
| 15 | 49 | 06/05/00 | 10:32 | B | 9 | |
| 16 | 49 | 06/08/00 | 8:25 | B | 8.6 | |
| 17 | 49 | 06/12/00 | 10:30 | D | 1.2 | |
| 18 | 49 | 06/15/00 | | Canal | | Caught below gates |
| 1 | 58 | 03/13/00 | | C | | Date implanted, released |
| 1 | 79 | 08/01/00 | | C | | Date implanted, released |
| 2 | 79 | 08/03/00 | 11:17 | D | 1.1 | |
| 3 | 79 | 08/07/00 | 11:16 | D | 1.3 | |
| 4 | 79 | 08/14/00 | 9:10 | B | 7.7 | |
| 5 | 79 | 09/02/00 | 10:20 | D | 2.1 | |
| 6 | 79 | 09/09/00 | 13:55 | D | 1.7 | |
| 7 | 79 | 09/16/00 | 11:04 | D | 1.6 | |
| 8 | 79 | 09/25/00 | | Canal | | Caught below gates |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 243 | 07/10/00 | | C | | Date implanted, released |
| 2 | 243 | 07/14/00 | 9:47 | C | 11.5 | |
| 3 | 243 | 07/17/00 | 9:45 | C | 1.2 | |
| 4 | 243 | 07/20/00 | 10:12 | C | 4.7 | |
| 5 | 243 | 07/24/00 | 9:53 | D | 2 | |
| 6 | 243 | 07/28/00 | 19:49 | D | 1.6 | |
| 7 | 243 | 07/31/00 | 10:45 | D | 1.1 | |
| 8 | 243 | 08/03/00 | 12:35 | D | 1.5 | |
| | | | | | | |
| 1 | 252 | 07/10/00 | | C | | Date implanted, released |
| 2 | 252 | 07/14/00 | 9:34 | C | 10.5 | |
| 3 | 252 | 07/17/00 | 9:37 | C | 11 | |
| 4 | 252 | 07/20/00 | 9:33 | C | 6.8 | |
| 5 | 252 | 07/24/00 | 9:03 | C | 5.8 | |
| 6 | 252 | 07/26/00 | 8:20 | C | 1 | |
| 7 | 252 | 07/26/00 | 10:30 | C | 10.5 | |
| 8 | 252 | 07/26/00 | 13:50 | C | 1.7 | |
| 9 | 252 | 07/26/00 | 16:35 | C | 1 | |
| 10 | 252 | 07/26/00 | 20:20 | C | 1.8 | |
| 11 | 252 | 07/26/00 | 22:35 | C | 2.1 | |
| 12 | 252 | 07/27/00 | 1:30 | C | 1 | |
| 13 | 252 | 07/27/00 | 4:23 | C | 1.2 | |
| 14 | 252 | 07/27/00 | 7:55 | C | 7.8 | |
| 15 | 252 | 07/28/00 | 18:31 | C | 5.4 | |
| 16 | 252 | 07/31/00 | 9:42 | C | 8.4 | |
| 17 | 252 | 08/03/00 | 10:52 | C | 6.1 | |
| 18 | 252 | 08/07/00 | 9:45 | C | 7.7 | |
| 19 | 252 | 08/10/00 | 7:50 | C | 10.5 | |
| 20 | 252 | 08/10/00 | 10:50 | C | 3.8 | |
| 21 | 252 | 08/10/00 | 14:00 | C | 1 | |
| 22 | 252 | 08/10/00 | 16:20 | C | 1 | |
| 23 | 252 | 08/10/00 | 19:30 | C | 1.9 | |
| 24 | 252 | 08/10/00 | 23:00 | C | 1 | |
| 25 | 252 | 08/11/00 | 1:30 | C | 1.5 | |
| 26 | 252 | 08/11/00 | 4:21 | C | 4.8 | |
| 27 | 252 | 08/11/00 | 7:37 | C | 8.7 | |
| 28 | 252 | 08/14/00 | 10:02 | C | 4.1 | |
| 29 | 252 | 08/17/00 | 9:18 | C | 3.7 | |
| 30 | 252 | 09/02/00 | 10:25 | D | 2.1 | |
| 31 | 252 | 09/09/00 | 13:30 | D | 1.4 | |
| 32 | 252 | 09/16/00 | 11:52 | D | 2.2 | |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 33 | 252 | 09/23/00 | 11:20 | D | 3.4 | |
| 34 | 252 | 09/23/00 | 15:15 | D | 1 | |
| 35 | 252 | 09/23/00 | 20:00 | D | 1.6 | |
| 36 | 252 | 09/23/00 | 22:56 | D | 1.5 | |
| 37 | 252 | 09/24/00 | 2:10 | D | 1.5 | |
| 38 | 252 | 09/24/00 | 7:45 | D | 1.9 | |
| | | | | | | |
| 1 | 278 | 08/09/00 | | C | | Date implanted, released |
| 2 | 278 | 08/10/00 | 13:30 | C | 11 | |
| 3 | 278 | 08/14/00 | 9:43 | A | 9 | |
| 4 | 278 | 08/17/00 | 8:15 | A | 9.5 | |
| | | | | | | |
| 1 | 285 | 03/13/00 | | A | | Date implanted, released |
| | | | | | | |
| 1 | 295 | 08/01/00 | | C | | Date implanted, released |
| 2 | 295 | 08/03/00 | 11:28 | D | 1.8 | |
| 3 | 295 | 08/07/00 | 10:30 | D | 1.9 | |
| 4 | 295 | 08/10/00 | 10:45 | C | 10 | |
| 5 | 295 | 08/14/00 | 11:34 | D | 2.1 | |
| 6 | 295 | 08/17/00 | 9:35 | D | 1.6 | |
| 7 | 295 | 09/02/00 | 10:00 | D | 1.8 | |
| 8 | 295 | 09/09/00 | 12:05 | D | 2.1 | |
| 9 | 295 | 09/16/00 | 11:52 | D | 2.2 | MAYBE DEAD |
| 10 | 295 | 09/30/00 | 8:45 | D | | ** |
| | | | | | | |
| 1 | 294 | 03/15/00 | | A | | Date released |
| 2 | 294 | 03/16/00 | 15:14 | A | 1.52 | ** |
| | | | | | | |
| 1 | 267 | 03/13/00 | | B | | Date implanted, released |
| 2 | 267 | 03/31/00 | 13:00 | D | | |
| 3 | 267 | 04/21/00 | 16:00 | D | 1 | |
| | | | | | | |
| 1 | 276 | 03/15/00 | | A | | Date released |
| 2 | 276 | 03/16/00 | 14:24 | A | 1.52 | ** |
| 3 | 276 | 03/31/00 | 13:00 | A | | |
| 4 | 276 | 04/21/00 | 13:30 | A | 10.2 | |
| 5 | 276 | 05/08/00 | 14:00 | A | 3 | |
| 6 | 276 | 05/09/00 | 13:00 | B | 2 | |
| 7 | 276 | 05/13/00 | | B | 1.1 | |
| 8 | 276 | 05/14/00 | 10:00 | B | 5 | |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 339 | 03/13/00 | | B | | Date implanted, released |
| 2 | 339 | 03/16/00 | 15:17 | A | 0.9 | |
| | | | | | | |
| 1 | 348 | 03/14/00 | | D | | Date implanted, released |
| 2 | 348 | 03/31/00 | 13:00 | D | | |
| 3 | 348 | 04/21/00 | 16:00 | D | 1 | |
| 4 | 348 | 05/08/00 | 14:00 | D | 1.8 | |
| 5 | 348 | 05/09/00 | 13:00 | D | 1.5 | |
| 6 | 348 | 05/13/00 | | D | 1.7 | |
| 7 | 348 | 05/14/00 | 10:00 | D | 2.1 | |
| | | | | | | |
| 1 | 348 | 07/10/00 | | C | | Date implanted, released |
| 2 | 348 | 07/14/00 | 11:45 | B | 9.1 | |
| 3 | 348 | 07/17/00 | 9:31 | C | 10.5 | |
| 4 | 348 | 07/20/00 | 9:41 | C | 6 | |
| 5 | 348 | 07/24/00 | 9:16 | C | 5.3 | |
| 6 | 348 | 07/28/00 | 18:37 | C | 5.5 | |
| 7 | 348 | 07/31/00 | 9:35 | C | 7.8 | |
| 8 | 348 | 08/03/00 | 11:01 | C | 5.8 | |
| 9 | 348 | 08/07/00 | 9:54 | C | 6.7 | |
| 10 | 348 | 08/10/00 | 10:00 | C | 3.5 | |
| 11 | 348 | 08/10/00 | 11:00 | C | 3.8 | |
| 12 | 348 | 08/10/00 | 13:33 | C | 2 | |
| 13 | 348 | 08/10/00 | 16:20 | C | 1.6 | |
| 14 | 348 | 08/10/00 | 19:35 | C | 3.3 | |
| 15 | 348 | 08/10/00 | 22:40 | C | 1.9 | |
| 16 | 348 | 08/11/00 | 1:39 | C | 0.9 | |
| 17 | 348 | 08/11/00 | 4:32 | C | 1.8 | |
| 18 | 348 | 08/11/00 | 7:47 | C | 4.7 | |
| | | | | | | |
| 1 | 384 | 03/15/00 | | A | | Date released |
| 2 | 384 | 03/16/00 | 14:56 | A | 1.52 | |
| | | | | | | |
| 1 | 357 | 08/01/00 | | C | | Date implanted, released |
| 2 | 357 | 08/07/00 | 11:48 | A | 8.7 | |
| 3 | 357 | 08/10/00 | 7:10 | A | 1.6 | |
| 4 | 357 | 08/14/00 | 9:21 | A | 9.7 | |
| 5 | 357 | 08/17/00 | 8:26 | A | 6.7 | |
| | | | | | | |
| 1 | 364 | 07/10/00 | | D | Died after | Date implanted, released |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 366 | 03/13/00 | | C | | Date implanted, released |
| 1 | 368 | 08/09/00 | | C | | Date implanted, released |
| 2 | 368 | 08/11/00 | 7:55 | C | 7.8 | |
| 3 | 368 | 08/14/00 | 10:32 | D | 1.8 | |
| 4 | 368 | 08/17/00 | 8:53 | B | 9 | |
| 1 | 414 | 08/09/00 | | C | | Date implanted, released |
| 2 | 414 | 08/10/00 | 11:15 | C | 9 | DEAD? |
| 3 | 414 | 08/17/00 | 9:09 | C | 8.5 | ** |
| 4 | 414 | 09/02/00 | 8:45 | C | 5.3 | ** |
| 1 | 444 | 07/10/00 | | D | | Date implanted, released |
| 2 | 444 | 07/14/00 | 9:41 | C | 8.1 | |
| 3 | 444 | 07/17/00 | 10:58 | D | 2 | |
| 4 | 444 | 07/20/00 | 11:10 | D | 2.2 | |
| 5 | 444 | 07/24/00 | 10:21 | D | 2.1 | |
| 6 | 444 | 07/28/00 | 19:32 | D | 1.5 | |
| 7 | 444 | 07/31/00 | 10:16 | D | 2 | |
| 8 | 444 | 08/03/00 | 12:06 | D | 2.4 | |
| 9 | 444 | 08/07/00 | 11:03 | D | 1.5 | |
| 10 | 444 | 08/10/00 | 8:25 | D | 1.4 | |
| 11 | 444 | 08/10/00 | 11:40 | D | 1.9 | |
| 12 | 444 | 08/10/00 | 14:30 | D | 2.4 | |
| 13 | 444 | 08/10/00 | 16:50 | D | 2.4 | |
| 14 | 444 | 08/10/00 | 19:50 | D | 2.1 | |
| 15 | 444 | 08/10/00 | 23:20 | D | 1.1 | |
| 16 | 444 | 08/11/00 | 2:23 | D | 1 | |
| 17 | 444 | 08/11/00 | 5:04 | D | 0.9 | |
| 18 | 444 | 08/11/00 | 8:10 | D | 1.2 | |
| 1 | 447 | 03/15/00 | | A | | Date released |
| 1 | 357 | 03/15/00 | | A | | Date released |
| 2 | 357 | 03/16/00 | 14:10 | A | 9.75 | |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 456 | 03/13/00 | | A | | Date implanted, released |
| 2 | 456 | 03/16/00 | 14:34 | A | 1.82 | |
| 3 | 456 | 03/31/00 | 13:00 | A | | |
| 4 | 456 | 04/21/00 | 13:30 | A | 9.7 | |
| 5 | 456 | 05/08/00 | 14:00 | D | 1.8 | |
| 6 | 456 | 05/09/00 | 13:00 | D | 1.6 | |
| 7 | 456 | 05/13/00 | | D | 1.7 | |
| 8 | 456 | 05/14/00 | 10:00 | D | 1.4 | |
| 9 | 456 | 05/15/00 | | D | 1.4 | |
| 10 | 456 | 05/18/00 | 14:00 | D | 2.4 | |
| 11 | 456 | 05/21/00 | 10:00 | D | 1.8 | |
| 12 | 456 | 05/24/00 | 9:40 | D | 1.5 | |
| 13 | 456 | 05/24/00 | 12:25 | D | 1.9 | |
| 14 | 456 | 05/24/00 | 15:15 | D | 2 | |
| 15 | 456 | 05/24/00 | 18:00 | D | 2.1 | |
| 16 | 456 | 05/24/00 | 21:05 | D | 2.1 | |
| 17 | 456 | 05/25/00 | 0:21 | D | 2.1 | |
| 18 | 456 | 05/25/00 | 4:00 | D | 1.4 | |
| 19 | 456 | 05/25/00 | 6:00 | D | 1.1 | |
| 20 | 456 | 05/25/00 | 9:20 | D | 1.1 | |
| 21 | 456 | 05/25/00 | 13:00 | D | 2.1 | |
| 22 | 456 | 05/29/00 | | D | 1.7 | |
| | | | | | | |
| 1 | 458 | 08/09/00 | | C | | Date implanted, released |
| | | | | | | |
| 1 | 465 | 08/01/00 | | C | | Date implanted, released |
| 2 | 465 | 08/03/00 | 11:49 | D | 2.6 | |
| 3 | 465 | 08/07/00 | 10:21 | D | 1.8 | |
| 4 | 465 | 08/11/00 | 1:42 | C | | |
| 5 | 465 | 08/14/00 | 10:41 | D | 2 | |
| 6 | 465 | 08/17/00 | 9:42 | D | 1.9 | |
| 7 | 465 | 09/02/00 | 11:05 | D | 1.5 | |
| 8 | 465 | 09/09/00 | 14:00 | D | 1.8 | |
| 9 | 465 | 09/16/00 | 11:01 | D | 1.8 | |
| | | | | | | |
| 1 | 499 | 05/21/00 | | A | | Date released |
| 2 | 499 | 05/25/00 | 13:00 | A | 3 | ** |
| 3 | 499 | 05/29/00 | | B | 1.8 | ** |
| 4 | 499 | 06/01/00 | 15:30 | B | 7 | |
| 5 | 499 | 06/05/00 | | B | | Caught today |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 511 | 03/15/00 | | A | | Date released |
| | | | | | | |
| 1 | 555 | 03/15/00 | | A | | Date released |
| | | | | | | |
| 1 | 557 | 08/09/00 | | C | | Date implanted, released |
| 2 | 557 | 08/10/00 | 8:50 | D | DEAD? | 2** |
| 3 | 557 | 08/14/00 | 11:04 | D | | 2.1** |
| | | | | | | |
| 1 | 569 | 03/13/00 | | C | | Date implanted, released |
| | | | | | | |
| 1 | 577 | 05/21/00 | | A | | Date released |
| 2 | 577 | 05/21/00 | 10:00 | A | 5.1 | ** |
| 3 | 577 | 05/25/00 | 13:00 | A | 2 | ** |
| 4 | 577 | 05/29/00 | | D | 1.7 | |
| 5 | 577 | 06/01/00 | 13:00 | D | 2.6 | |
| 6 | 577 | 06/05/00 | 11:35 | D | 2.1 | |
| 7 | 577 | 06/08/00 | 10:00 | D | 1.8 | |
| 8 | 577 | 06/12/00 | 11:20 | D | 1.7 | |
| 9 | 577 | 06/15/00 | 9:30 | D | 1.4 | |
| 10 | 577 | 06/19/00 | 16:00 | D | 2.5 | |
| 11 | 577 | 06/22/00 | 11:25 | D | 2.2 | |
| 12 | 577 | 06/26/00 | 10:25 | D | 1.9 | |
| 13 | 577 | 06/28/00 | 12:23 | D | 2.1 | |
| 14 | 577 | 06/30/00 | 19:20 | D | 2.1 | |
| 15 | 577 | 07/05/00 | 18:10 | D | 2.3 | |
| 16 | 577 | 07/09/00 | 11:03 | D | 1.6 | |
| 17 | 577 | 07/14/00 | 11:00 | D | 2 | |
| 18 | 577 | 07/17/00 | 10:37 | D | 1.7 | |
| | | | | | | |
| 1 | 589 | 05/09/00 | | C | | Date implanted, released |
| 2 | 589 | 05/13/00 | | C | 1 | |
| 3 | 589 | 05/14/00 | 10:00 | C | 1.3 | |
| 4 | 589 | 05/15/00 | | C | 1 | |
| 5 | 589 | 05/18/00 | 14:00 | D | 1.5 | |
| 6 | 589 | 05/21/00 | 10:00 | C | 1.6 | |
| 7 | 589 | 05/24/00 | 9:10 | C | 2.3 | |
| 8 | 589 | 05/24/00 | 12:10 | D | 1.8 | |
| 9 | 589 | 05/24/00 | 15:00 | D | 1.4 | |
| 10 | 589 | 05/24/00 | 17:00 | D | 1.1 | |
| 11 | 589 | 05/24/00 | 20:15 | D | 1.4 | |
| 12 | 589 | 05/24/00 | 23:53 | D | 1.3 | |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 13 | 589 | 05/25/00 | 3:10 | D | 1.2 | |
| 14 | 589 | 05/25/00 | 5:40 | C | 1.3 | |
| 15 | 589 | 05/25/00 | 9:00 | D | 0.9 | |
| 16 | 589 | 05/25/00 | 13:00 | D | 1.6 | |
| 17 | 589 | 05/29/00 | | D | 2.6 | |
| 18 | 589 | 06/01/00 | 12:00 | D | 1.5 | |
| 19 | 589 | 06/08/00 | 8:18 | B | 1.8 | |
| 20 | 589 | 06/12/00 | 10:15 | C | 7.2 | |
| 21 | 589 | 06/15/00 | 10:00 | C | 10 | |
| 22 | 589 | 06/19/00 | 15:00 | C | 10.5 | |
| 23 | 589 | 06/20/00 | 8:05 | C | 2.7 | |
| 24 | 589 | 06/20/00 | 10:15 | C | 2.3 | |
| 25 | 589 | 06/20/00 | 13:30 | C | 1.6 | |
| 26 | 589 | 06/20/00 | 16:50 | C | 1.5 | |
| 27 | 589 | 06/20/00 | 19:31 | C | 1.8 | |
| 28 | 589 | 06/21/00 | 4:10 | C | | |
| 29 | 589 | 06/21/00 | 1:35 | C | 1.6 | |
| 30 | 589 | 06/21/00 | 22:15 | C | 2.4 | |
| 31 | 589 | 06/21/00 | 7:40 | C | 8.6 | |
| 32 | 589 | 06/22/00 | 10:32 | C | 6.4 | |
| 33 | 589 | 06/26/00 | 9:49 | C | 8.1 | |
| 34 | 589 | 06/28/00 | 12:01 | C | 1 | |
| 35 | 589 | 06/30/00 | 17:00 | D | 2.8 | |
| 36 | 589 | 07/05/00 | 17:45 | D | 3.1 | |
| 37 | 589 | 07/09/00 | 11:32 | D | 1.4 | |
| 38 | 589 | 07/14/00 | 10:22 | D | 1.5 | |
| 39 | 589 | 07/17/00 | 10:17 | D | 1.4 | |
| 40 | 589 | 07/20/00 | 10:31 | D | 1.3 | |
| 41 | 589 | 07/24/00 | 9:47 | D | 1.8 | |
| 42 | 589 | 07/26/00 | 8:45 | D | 1.2 | |
| 43 | 589 | 07/26/00 | 10:45 | D | 1.3 | |
| 44 | 589 | 07/26/00 | 14:00 | D | 1.4 | |
| 45 | 589 | 07/26/00 | 17:15 | D | 1.3 | |
| 46 | 589 | 07/26/00 | 20:34 | D | 2 | |
| 47 | 589 | 07/26/00 | 23:00 | D | 2.1 | |
| 48 | 589 | 07/27/00 | 1:50 | D | 2 | |
| 49 | 589 | 07/27/00 | 4:51 | D | 1.8 | |
| 50 | 589 | 07/27/00 | 8:20 | D | 1.1 | |
| 51 | 589 | 07/28/00 | 18:49 | D | 1.7 | |
| 1 | 610 | 03/15/00 | | A | | Date released |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 678 | 03/14/00 | | D | | Date implanted, released |
| | | | | | | |
| 1 | 679 | 05/21/00 | | A | | Date released |
| 2 | 679 | 05/21/00 | 10:00 | A | 2.1 | ** |
| 3 | 679 | 05/25/00 | 13:00 | B | 8 | ** |
| 4 | 679 | 05/29/00 | | B | 9.5 | |
| 5 | 679 | 06/01/00 | 15:08 | B | 9.6 | |
| 6 | 679 | 06/05/00 | 10:57 | C | 8.4 | |
| 7 | 679 | 06/08/00 | 9:50 | B | 8.3 | |
| 8 | 679 | 06/12/00 | 9:30 | B | 8.5 | |
| 9 | 679 | 06/15/00 | 10:20 | C | 10.5 | |
| 10 | 679 | 06/19/00 | 14:30 | C | 8.3 | |
| 11 | 679 | 06/25/00 | | C | | Caught in front of hydro |
| | | | | | | |
| 1 | 788 | 05/08/00 | | A | | Date implanted, released |
| 2 | 788 | 05/09/00 | 13:00 | A | 2 | |
| 3 | 788 | 05/13/00 | | B | 1.8 | |
| 4 | 788 | 05/14/00 | 10:00 | B | 1 | |
| 5 | 788 | 05/15/00 | | C | 2.6 | |
| 6 | 788 | 05/18/00 | 14:00 | B | 9.2 | |
| 7 | 788 | 05/21/00 | 10:00 | B | 9.1 | |
| 8 | 788 | 05/24/00 | 8:40 | B | 7.1 | |
| 9 | 788 | 05/24/00 | 11:25 | B | 7.7 | |
| 10 | 788 | 05/24/00 | 14:30 | B | 7.6 | |
| 11 | 788 | 05/24/00 | 17:15 | B | 7.5 | |
| 12 | 788 | 05/24/00 | 20:15 | B | 8.1 | |
| 13 | 788 | 05/24/00 | 23:27 | B | 1.7 | |
| 14 | 788 | 05/25/00 | 2:40 | B | 1.2 | |
| 15 | 788 | 05/25/00 | 5:15 | B | 3.5 | |
| 16 | 788 | 05/25/00 | 8:40 | B | 7.5 | |
| 17 | 788 | 05/25/00 | 13:00 | B | 9 | |
| 18 | 788 | 05/29/00 | | B | 1.6 | |
| 19 | 788 | 06/01/00 | 14:45 | B | | |
| 20 | 788 | 06/05/00 | 10:00 | B | 7.8 | |
| 21 | 788 | 06/08/00 | 9:30 | C | 7 | |
| 22 | 788 | 06/12/00 | 9:20 | B | 9 | |
| 23 | 788 | 06/15/00 | 9:40 | B | 10.5 | |
| 24 | 788 | 06/19/00 | 14:10 | B | 10 | |
| 25 | 788 | 06/20/00 | 7:45 | B | 8.5 | |
| 26 | 788 | 06/20/00 | 10:00 | B | 9.2 | |
| 27 | 788 | 06/20/00 | 12:45 | B | 7.8 | |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 28 | 788 | 06/20/00 | 16:40 | C | 9.7 | |
| 29 | 788 | 06/20/00 | 19:10 | C | 12 | |
| 30 | 788 | 06/21/00 | 4:30 | C | 9.7 | |
| 31 | 788 | 06/21/00 | 1:20 | C | 8.5 | |
| 32 | 788 | 06/21/00 | 22:00 | C | 10.5 | |
| 33 | 788 | 06/21/00 | 7:30 | B | 4.3 | |
| 34 | 788 | 06/22/00 | 10:20 | B | 6.2 | |
| 35 | 788 | 06/26/00 | 9:22 | B | 8 | |
| 36 | 788 | 06/28/00 | 11:33 | B | 8.1 | |
| 37 | 788 | 06/30/00 | 17:00 | C | 2.1 | |
| 38 | 788 | 07/05/00 | 17:22 | B | 10.5 | |
| 39 | 788 | 07/09/00 | 10:32 | B | 9.7 | |
| 40 | 788 | 07/14/00 | 9:28 | B | 9.2 | |
| | | | | | | |
| 1 | 3444 | 05/08/00 | | B | | Date implanted, released |
| 2 | 3444 | 05/09/00 | 13:00 | B | 1.8 | |
| 3 | 3444 | 05/13/00 | | D | 2 | |
| 4 | 3444 | 05/14/00 | 10:00 | D | 1 | |
| 5 | 3444 | 05/15/00 | | D | 1.3 | |
| 6 | 3444 | 05/18/00 | 14:00 | D | 3.1 | |
| 7 | 3444 | 05/21/00 | 10:00 | D | 2.6 | |
| 8 | 3444 | 05/25/00 | 13:00 | D | 2.1 | |
| 9 | 3444 | 05/29/00 | | D | 2.2 | |
| 10 | 3444 | 06/01/00 | 12:40 | D | 1.4 | |
| 11 | 3444 | 06/05/00 | 12:10 | D | 2.2 | |
| 12 | 3444 | 06/08/00 | 11:35 | D | 2.2 | |
| 13 | 3444 | 06/12/00 | 11:50 | D | 2.5 | |
| 14 | 3444 | 06/15/00 | 9:30 | D | 1.4 | |
| | | | | | | |
| 1 | 3455 | 05/09/00 | | C | | Date implanted, released |
| 2 | 3455 | 05/18/00 | 14:00 | C | | Directly in front of hydro |
| 3 | 3455 | 05/21/00 | 10:00 | C | | Hydro |
| | | | | | | |
| 1 | 3845 | 05/21/00 | | A | | Date released |
| 2 | 3845 | 05/25/00 | 13:00 | A | 4 | ** |
| 3 | 3845 | 05/29/00 | | D | 2 | |
| 4 | 3845 | 06/01/00 | 13:15 | D | 2.1 | |
| 5 | 3845 | 06/05/00 | 12:40 | D | 1.7 | |
| 6 | 3845 | 06/08/00 | 11:20 | D | 1.3 | |
| 7 | 3845 | 06/12/00 | 12:20 | D | 1.6 | |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 3946 | 05/08/00 | | A | | Date implanted, released |
| 2 | 3946 | 05/09/00 | 13:00 | A | 2 | |
| 3 | 3946 | 05/13/00 | | B | 8.7 | |
| 4 | 3946 | 05/14/00 | 10:00 | B | 2 | |
| 5 | 3946 | 05/15/00 | | B | 2 | |
| 6 | 3946 | 05/18/00 | 14:00 | B | 9.2 | |
| 7 | 3946 | 05/21/00 | 10:00 | B | 7 | |
| 8 | 3946 | 05/25/00 | 13:00 | D | 2.4 | |
| 9 | 3946 | 05/29/00 | | D | 2.5 | |
| 10 | 3946 | 06/01/00 | 12:45 | D | 2.4 | |
| 11 | 3946 | 06/05/00 | 11:45 | D | 2 | |
| 12 | 3946 | 06/08/00 | 10:00 | D | 1.2 | |
| | | | | | | |
| 1 | 4117 | 05/09/00 | | D | | Date implanted, released |
| 2 | 4117 | 05/13/00 | | D | 1.5 | |
| 3 | 4117 | 05/14/00 | 10:00 | D | 1.4 | |
| 4 | 4117 | 05/15/00 | | D | 1 | |
| 5 | 4117 | 05/18/00 | 14:00 | D | 2.1 | |
| 6 | 4117 | 05/21/00 | 10:00 | D | 1.6 | |
| 7 | 4117 | 05/25/00 | 13:00 | D | 1.1 | |
| 8 | 4117 | 05/29/00 | | D | 1.6 | |
| 9 | 4117 | 06/01/00 | 12:15 | D | 1.5 | |
| 10 | 4117 | 06/05/00 | 11:35 | D | 1.2 | |
| 11 | 4117 | 06/08/00 | 9:35 | D | 1.1 | |
| 12 | 4117 | 06/12/00 | 10:40 | D | 1 | |
| 13 | 4117 | 06/15/00 | 10:15 | D | 0.9 | |
| 14 | 4117 | 06/19/00 | 15:15 | D | 1.1 | |
| 15 | 4117 | 06/22/00 | 11:05 | D | 1.1 | |
| 16 | 4117 | 06/26/00 | 10:10 | D | 1.4 | |
| 17 | 4117 | 06/28/00 | 13:08 | D | 1.3 | |
| 18 | 4117 | 06/30/00 | 17:00 | D | 1.7 | |
| 19 | 4117 | 07/05/00 | 18:28 | D | 1.5 | |
| 20 | 4117 | 07/09/00 | 10:40 | D | 1.4 | |
| 21 | 4117 | 07/14/00 | 10:11 | D | 1.3 | |
| 22 | 4117 | 07/17/00 | 10:05 | D | 1.2 | |
| 23 | 4117 | 07/20/00 | 10:42 | D | 1.4 | |
| 24 | 4117 | 07/24/00 | 11:06 | D | 1.2 | |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 4610 | 05/21/00 | | A | | Date released |
| 2 | 4610 | 05/21/00 | 10:00 | A | 5.1 | ** |
| 3 | 4610 | 05/25/00 | 13:00 | C | 3.8 | ** |
| 4 | 4610 | 06/01/00 | 12:20 | D | 0.6 | |
| 5 | 4610 | 06/05/00 | 11:20 | D | 1.2 | |
| 6 | 4610 | 06/08/00 | 9:20 | D | 1.3 | |
| 7 | 4610 | 06/12/00 | 11:40 | D | 2 | |
| 8 | 4610 | 06/15/00 | 11:00 | D | 1.7 | |
| 9 | 4610 | 06/19/00 | 15:32 | D | 1.5 | |
| 10 | 4610 | 06/20/00 | 19:49 | D | 2.6 | |
| 11 | 4610 | 06/21/00 | 5:45 | D | 2 | |
| 12 | 4610 | 06/21/00 | 2:45 | D | 0.8 | |
| 13 | 4610 | 06/21/00 | 23:00 | D | 0.8 | |
| 14 | 4610 | 06/21/00 | 8:30 | D | 2.3 | |
| 15 | 4610 | 06/22/00 | 11:12 | D | 1.3 | |
| 16 | 4610 | 06/26/00 | 10:14 | D | 1.4 | |
| 17 | 4610 | 06/28/00 | 12:55 | D | 1.2 | |
| | | | | | | |
| 1 | 5157 | 05/21/00 | | A | | Date released |
| 2 | 5157 | 05/21/00 | 10:00 | A | 1.8 | ** |
| 3 | 5157 | 05/25/00 | 13:00 | D | 2.2 | ** |
| 4 | 5157 | 05/29/00 | | D | 2.5 | |
| 5 | 5157 | 06/01/00 | 13:40 | D | 2.6 | |
| 6 | 5157 | 06/05/00 | 14:10 | D | 2.1 | |
| 7 | 5157 | 06/08/00 | 11:30 | D | 2.1 | |
| 8 | 5157 | 06/12/00 | 12:40 | D | 2.4 | |
| 9 | 5157 | 06/15/00 | 10:00 | D | 2.4 | |
| 10 | 5157 | 06/19/00 | 16:10 | D | 2.3 | |
| 11 | 5157 | 06/22/00 | 11:36 | D | 2.4 | |
| 12 | 5157 | 06/26/00 | 10:31 | D | 2.1 | |
| 13 | 5157 | 06/28/00 | 12:31 | D | 2.3 | |
| 14 | 5157 | 06/30/00 | 17:00 | D | 2 | |
| 15 | 5157 | 07/05/00 | 18:19 | D | 2.5 | |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 6147 | 05/21/00 | | A | | Date released |
| 2 | 6147 | 05/21/00 | 10:00 | A | 1.9 | ** |
| 3 | 6147 | 05/24/00 | 8:15 | A | 3.9 | ** |
| 4 | 6147 | 05/24/00 | 11:00 | A | 10 | ** |
| 5 | 6147 | 05/24/00 | 14:05 | A | 8.7 | ** |
| 6 | 6147 | 05/24/00 | 17:00 | A | 8.7 | ** |
| 7 | 6147 | 05/24/00 | 20:15 | A | 7.4 | ** |
| 8 | 6147 | 05/24/00 | 23:00 | A | 3.8 | ** |
| 9 | 6147 | 05/25/00 | 2:10 | A | 2.8 | ** |
| 10 | 6147 | 05/25/00 | 5:00 | A | 4 | ** |
| 11 | 6147 | 05/25/00 | 8:00 | A | 9 | ** |
| 12 | 6147 | 05/25/00 | 13:00 | A | 9 | ** |
| 13 | 6147 | 05/29/00 | | B | 10 | |
| 14 | 6147 | 06/01/00 | 15:17 | B | 7.5 | |
| 15 | 6147 | 06/05/00 | 10:15 | B | 6.8 | |
| 16 | 6147 | 06/08/00 | 8:00 | B | 5.8 | |
| 17 | 6147 | 06/12/00 | 9:00 | B | 6.6 | |
| 18 | 6147 | 06/15/00 | 9:20 | B | 8.6 | |
| 19 | 6147 | 06/19/00 | 13:40 | B | 9 | |
| 20 | 6147 | 06/22/00 | 10:05 | B | 6.3 | |
| | | | | | | |
| 1 | 7713 | 05/09/00 | | D | | Date implanted, released |
| 2 | 7713 | 05/13/00 | | D | 1.8 | |
| 3 | 7713 | 05/14/00 | 10:00 | D | 1.4 | |
| 4 | 7713 | 05/15/00 | | D | 1.4 | |
| 5 | 7713 | 05/21/00 | 10:00 | D | 1 | |
| 6 | 7713 | 05/25/00 | 13:00 | D | 0.9 | |
| 7 | 7713 | 05/29/00 | | D | 0.5 | |
| 8 | 7713 | 06/01/00 | 14:00 | D | 0.7 | |
| 9 | 7713 | 06/05/00 | 13:40 | D | 1 | |
| 10 | 7713 | 06/08/00 | 11:00 | D | 1.3 | |
| 11 | 7713 | 06/12/00 | 11:00 | D | 1.3 | |
| 12 | 7713 | 06/15/00 | 10:30 | D | 1.3 | |
| 13 | 7713 | 06/19/00 | 15:40 | D | 1.2 | |
| 14 | 7713 | 06/20/00 | 8:50 | D | 1.6 | |
| 15 | 7713 | 06/20/00 | 10:40 | D | 1 | |
| 16 | 7713 | 06/20/00 | 14:20 | D | 1 | |
| 17 | 7713 | 06/20/00 | 20:05 | D | 1.8 | |
| 18 | 7713 | 06/21/00 | 4:55 | D | 1.1 | |
| 19 | 7713 | 06/21/00 | 2:10 | D | 0.7 | |
| 20 | 7713 | 06/21/00 | 23:25 | D | 0.7 | |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 21 | 7713 | 06/21/00 | 7:50 | D | 0.8 | |
| 22 | 7713 | 06/22/00 | 11:48 | D | 1.3 | |
| 23 | 7713 | 06/26/00 | 10:45 | D | 1.1 | |
| 24 | 7713 | 06/28/00 | 13:15 | D | 1.3 | |
| 25 | 7713 | 07/09/00 | 11:48 | D | 1.1 | |
| 26 | 7713 | 07/14/00 | 11:41 | D | 1 | |
| | | | | | | |
| 1 | 7812 | 05/08/00 | | B | | Date implanted, released |
| 2 | 7812 | 05/09/00 | 13:00 | D | 1.8 | |
| 3 | 7812 | 05/25/00 | | Canal | | Caught near Paxton |
| | | | | | | |
| 1 | 71014 | 05/08/00 | | A | | Date implanted, released |
| 2 | 71014 | 05/09/00 | 13:00 | A | 4.1 | |
| | | | | | | |
| 1 | 71113 | 05/21/00 | | A | | Date released |
| | | | | | | |
| 1 | 71212 | 05/08/00 | | B | | Date implanted, released |
| 2 | 71212 | 05/09/00 | 13:00 | B | 3.1 | |
| 3 | 71212 | 05/13/00 | | B | 10.1 | |
| 4 | 71212 | 05/14/00 | 10:00 | B | 9.1 | |
| 5 | 71212 | 05/15/00 | | B | 9 | |
| 6 | 71212 | 05/18/00 | 14:00 | C | 11.5 | |
| 7 | 71212 | 05/21/00 | 10:00 | B | 9.7 | |
| 8 | 71212 | 05/25/00 | 13:00 | C | 8 | |
| 9 | 71212 | 05/29/00 | | B | 10 | |
| 10 | 71212 | 06/01/00 | 14:31 | C | 6 | |
| 11 | 71212 | 06/05/00 | 10:45 | C | 10.5 | |
| 12 | 71212 | 06/08/00 | 8:40 | B | 9.1 | |
| 13 | 71212 | 06/12/00 | 9:50 | B | 9.2 | |
| 14 | 71212 | 06/15/00 | 10:30 | C | 11.4 | |
| 15 | 71212 | 06/19/00 | 14:45 | C | 11.5 | |
| 16 | 71212 | 06/22/00 | 10:40 | C | 10 | |
| 17 | 71212 | 06/26/00 | 9:38 | C | 11 | |
| 18 | 71212 | 06/28/00 | 11:44 | C | 11.5 | |
| 19 | 71212 | 06/30/00 | 17:00 | C | 8 | |
| 20 | 71212 | 07/05/00 | 17:35 | C | 11.5 | |
| 21 | 71212 | 07/09/00 | 11:13 | D | 1.6 | |
| 22 | 71212 | 07/14/00 | 10:30 | D | 1.1 | |
| 23 | 71212 | 07/17/00 | 10:25 | D | 1.2 | |

Appendix 2. (continued)

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 71310 | 05/09/00 | | C | | Date implanted, released |
| 2 | 71310 | 05/13/00 | | C | 2.8 | |
| 3 | 71310 | 05/14/00 | 10:00 | C | 1.1 | |
| 4 | 71310 | 05/15/00 | | C | 1 | |
| 5 | 71310 | 05/18/00 | 14:00 | C | 1.1 | |
| 6 | 71310 | 05/21/00 | 10:00 | C | 0.6 | |
| 7 | 71310 | 05/25/00 | 13:00 | C | 1.8 | |
| 8 | 71310 | 05/29/00 | | C | 1 | |
| 9 | 71310 | 06/01/00 | 14:20 | C | 2 | |
| 10 | 71310 | 06/05/00 | 13:41 | C | 1.8 | |
| 11 | 71310 | 06/08/00 | 9:00 | C | 1.7 | |
| 12 | 71310 | 06/12/00 | 10:25 | C | | |
| 13 | 71310 | 06/15/00 | 10:50 | C | 12 | |
| 14 | 71310 | 06/17/00 | | C | | Caught today by angler |

Appendix 3. Locations of ultrasonically tagged brown trout in Lake Ogallala, March-December 1999.

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 366 | 03/16/99 | | A | | Release date |
| 2 | 366 | 03/16/99 | 17:00 | A | | ** |
| | | | | | | |
| 1 | 465 | 03/16/99 | | A | | Release date |
| 2 | 465 | 03/16/99 | 17:00 | A | | ** |
| 3 | 465 | 03/17/99 | 10:20 | A | | ** |
| 4 | 465 | 03/18/99 | 7:45 | A | 9.6 | ** |
| 5 | 465 | 04/02/99 | 17:13 | A | 4.6 | |
| 6 | 465 | 04/03/99 | 8:30 | B | 1.2 | |
| 7 | 465 | 04/03/99 | 15:10 | B | 7.6 | |
| 8 | 465 | 04/17/99 | 10:00 | B | 10.7 | |
| | | | | | | |
| 1 | 488 | 10/12/99 | | A | | Release date |
| 2 | 488 | 10/16/99 | 12:30 | A | | ** |
| 3 | 488 | 10/17/99 | 12:30 | C | | Near hydro** |
| 4 | 488 | 11/13/99 | 8:00 | A | | |
| 5 | 488 | 11/14/99 | 15:00 | A | | |
| 6 | 488 | 11/27/99 | 13:00 | A | | |
| 7 | 488 | 12/21/99 | 14:00 | A | | |
| | | | | | | |
| 1 | 569 | 10/12/99 | | A | | Release date |
| 2 | 569 | 10/16/99 | 12:22 | A | | ** |
| 3 | 569 | 10/17/99 | 10:45 | A | | ** |
| 4 | 569 | 10/29/99 | 16:20 | A | | |
| 5 | 569 | 10/30/99 | 10:00 | A | | |
| | | | | | | |
| 1 | 668 | 10/12/99 | | A | | Release date |
| 2 | 668 | 10/16/99 | 11:45 | A | | ** |
| 3 | 668 | 10/17/99 | 11:25 | A | | ** |
| 4 | 668 | 10/29/99 | 16:20 | A | | |
| 5 | 668 | 10/30/99 | 10:00 | A | | |
| 6 | 668 | 11/12/99 | 15:00 | C | | |
| 7 | 668 | 11/13/99 | 8:00 | A | | |
| | | | | | | |
| 1 | 2273 | 06/16/99 | | C | | Release date, resident fish |
| 2 | 2273 | 06/18/99 | 11:35 | D | | ** |
| 3 | 2273 | 06/21/99 | 11:13 | A | 1 | Toe drain |
| 4 | 2273 | 06/23/99 | 17:42 | C | 5.2 | |
| 5 | 2273 | 06/29/99 | 11:28 | C | 2.1 | Hydro |
| 6 | 2273 | 07/08/99 | 10:47 | B | 1.2 | |
| 7 | 2273 | 07/12/99 | 10:25 | D | 1.2 | |

Appendix 4. Locations of ultrasonically tagged brown trout in Lake Ogallala, June-September 2000.

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 555 | 06/14/00 | | D | | Date implanted, released |
| 2 | 555 | 06/15/00 | 10:30 | D | 1.2 | |
| 3 | 555 | 06/19/00 | 13:55 | B | 6.8 | |
| 4 | 555 | 06/22/00 | 9:55 | B | 1.8 | |
| 5 | 555 | 06/26/00 | 9:00 | B | 2.6 | |
| 6 | 555 | 06/28/00 | 11:22 | B | 3.8 | |
| 7 | 555 | 06/30/00 | 17:00 | B | 5.8 | |
| 8 | 555 | 07/05/00 | 17:10 | B | 4.3 | |
| 9 | 555 | 07/09/00 | 10:21 | B | 7.6 | |
| 10 | 555 | 07/14/00 | | B | 3 | |
| 11 | 555 | 07/17/00 | 9:16 | A | 2.5 | |
| 12 | 555 | 07/20/00 | 9:21 | A | 1.7 | |
| 13 | 555 | 07/24/00 | 8:53 | B | 7.5 | |
| 14 | 555 | 07/26/00 | 8:00 | B | 7.7 | |
| 15 | 555 | 07/26/00 | 10:10 | B | 1 | |
| 16 | 555 | 07/26/00 | 13:30 | B | 6.6 | |
| 17 | 555 | 07/26/00 | 16:25 | B | 7.2 | |
| 18 | 555 | 07/26/00 | 20:00 | B | 5.8 | |
| 19 | 555 | 07/26/00 | 22:20 | B | 2.8 | |
| 20 | 555 | 07/27/00 | 1:12 | B | 2.5 | |
| 21 | 555 | 07/27/00 | 4:10 | B | 1.2 | |
| 22 | 555 | 07/27/00 | 7:35 | B | 1.8 | |
| 23 | 555 | 07/28/00 | 18:15 | B | | |
| 24 | 555 | 07/31/00 | 9:15 | B | 7.8 | |
| 25 | 555 | 08/03/00 | 10:41 | B | 1.3 | |
| 26 | 555 | 08/07/00 | 11:42 | A | 1.8 | |
| 27 | 555 | 08/10/00 | 7:25 | A | 1.3 | |
| 28 | 555 | 08/10/00 | 10:20 | A | 1.8 | |
| 29 | 555 | 08/10/00 | 13:15 | A | 1.6 | |
| 30 | 555 | 08/10/00 | 16:05 | A | 2 | |
| 31 | 555 | 08/10/00 | 19:10 | A | 1.7 | |
| 32 | 555 | 08/10/00 | 22:05 | A | 1.8 | |
| 33 | 555 | 08/11/00 | 1:04 | A | 2 | |
| 34 | 555 | 08/11/00 | 4:05 | A | 4.5 | |
| 35 | 555 | 08/11/00 | 7:05 | A | 1.6 | |
| 36 | 555 | 08/14/00 | 9:27 | A | 1.8 | |
| 37 | 555 | 08/17/00 | 8:32 | A | 1.4 | Fish dead/expel transmitter |
| 1 | 48 | 07/10/00 | | B | | Date implanted, released |
| 2 | 48 | 07/14/00 | 9:15 | B | 2.1 | |
| 3 | 48 | 09/08/00 | 20:30 | A | 1.7 | Caught electrofishing |

Appendix 4. (continued).

| Location Number | Trans. Number | Date | Time | Section | Water column depth (m) | Comments |
|---|---|---|---|---|---|---|
| 1 | 339 | 07/10/00 | | C | | Date implanted, released |
| 2 | 339 | 07/17/00 | 9:55 | C | 2.1 | |
| 3 | 339 | 07/20/00 | 10:03 | C | 1.5 | |
| 4 | 339 | 07/24/00 | 9:30 | C | 2 | |
| 5 | 339 | 07/28/00 | 18:24 | B | 10.5 | |
| 6 | 339 | 07/31/00 | 11:12 | B | 3.1 | |
| 7 | 339 | 08/03/00 | 13:00 | A | | |
| 8 | 339 | 08/07/00 | 11:31 | A | 6.1 | |
| 9 | 339 | 08/10/00 | 15:30 | A | 1.8 | |
| 10 | 339 | 08/14/00 | 9:30 | A | 4.6 | |
| 11 | 339 | 08/17/00 | 8:40 | A | 9.8 | |