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# Impact of a Controlled Wetland Drawdown on Blanding's Turtles in Minnesota

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**Abstract. – Movements and mortality of Blanding's turtles *(Emydoidea blandingii)* were studied following a wetland drawdown at a wildlife management area (WMA) in east-central Minnesota. Between April and September 1990, we monitored adult radiotagged turtles at the WMA and a control site. At the WMA after the drawdown, 3 of 10 turtles emigrated from the lake traveling a mean distance of 3.1 km from the lake perimeter. Three additional turtles left the perimeter of the lake, traveled a mean distance of 0.7 km, and returned to the lake for the winter. At the control site, 1 of 6 turtles emigrated from the lake, traveling 2.2 km. Five turtles traveled a mean distance of 0.8 km from the perimeter of the lake prior to returning for the winter. Blanding's turtle mortality at the WMA was high; 5 of 10 radiotagged turtles died and 20 additional carcasses were observed at the site. Death resulted from predation, road mortality, and winterkill. No mortality was observed in Blanding's turtles from the control site. The drawdown concentrated turtles into a diminished lakebed, creating a vulnerable situation for individuals forced to traverse terrestrial habitats. Catastrophic losses of adult turtles may have drastic impacts on species that rely on long-lived adults to compensate for low recruitment of young into the population. Resource managers considering wetland drawdowns need to evaluate benefits for targeted species and potential negative impacts on other members of the wetland community.**

**Key Words. – Reptilia; Testudines; Emydidae; *Emydoidea blandingii*; turtle; wetlands; controlled wetland drawdown; global climate change; drought; conservation; dispersal; Minnesota; USA**

Blanding's turtles (*Emydoidea blandingii*; Cryptodira: Emydidae) utilize a variety of wetland types, including shallow wetlands with deep sediment and an abundance of aquatic vegetation (Ross and Anderson, 1990; Rowe and Moll, 1991; Piepgras, 1998). Shallow wetlands are also utilized by waterfowl and are often targeted for controlled drawdowns at sites with water-control structures. The purpose of this study was to determine the response of Blanding's turtles, a threatened species in Minnesota, to a controlled drawdown at the Marget Lake Wildlife Management Area (WMA) in Isanti County, Minnesota.

Controlled wetland drawdowns are commonly practiced in shallow lakes and wetlands managed for waterfowl (Yoakum et al., 1980). This technique improves waterfowl habitat by: (1) increasing growth of seed producing plants such as smartweed (*Polygonum* spp.), (2) increasing interspersion of habitat by reducing cattail growth (Kadlec, 1962; Harris and Marshall, 1963), and (3) reducing or eliminating populations of rough fishes.

Although drawdowns occur under natural conditions, artificial simulation of the natural process may have deleterious effects on many species in the wetland community, especially when a shallow lake is drained (Weller, 1987). Saumure (1997) reported significant reductions in turtle populations 1 year after a drawdown at the Big Creek National Wildlife Area in Long Point, Ontario. Crosson (1990) reported that a winter drawdown had severe impacts on invertebrates and rare plant species in Lake Bomoseen, Vermont. Cooke (1980) cited many positive and negative aspects of water level drawdowns and suggested additional research is needed to determine the response of individual species to drawdowns.

This study was designed to answer the following questions: (1) will Blanding's turtles that leave a drained wetland be less likely to return than turtles that move from a wetland with no drawdown, and (2) is Blanding's turtle mortality greater at a site with a controlled drawdown compared to a site with no drawdown?

## METHODS

Two separate populations of Blanding's turtles were studied from mid-April through late October 1990 in Isanti County, Minnesota. The drawdown occurred in October 1989 at the Marget Lake Wildlife Management Area. Turtles were also studied at Beckman Lake where water levels were not manipulated.

*Study Area.* — Marget Lake (45°28'N, 93°16'W), located 55 km north of Minneapolis-St. Paul, is a permanently flooded palustrine wetland. Prior to the drawdown, this 40 ha wetland ranged in depth from 1.0–1.5 m and was surrounded by a mat of emergent vegetation consisting primarily of cattails (*Typha*) and bulrushes (*Scirpus*) (Dorff, 1995). Vegetation in the aquatic bed included coontail (*Ceratophyllum*), pondweed (*Potamogeton*), and water lilies (*Nuphar*). The gently rolling uplands surrounding the lake were comprised

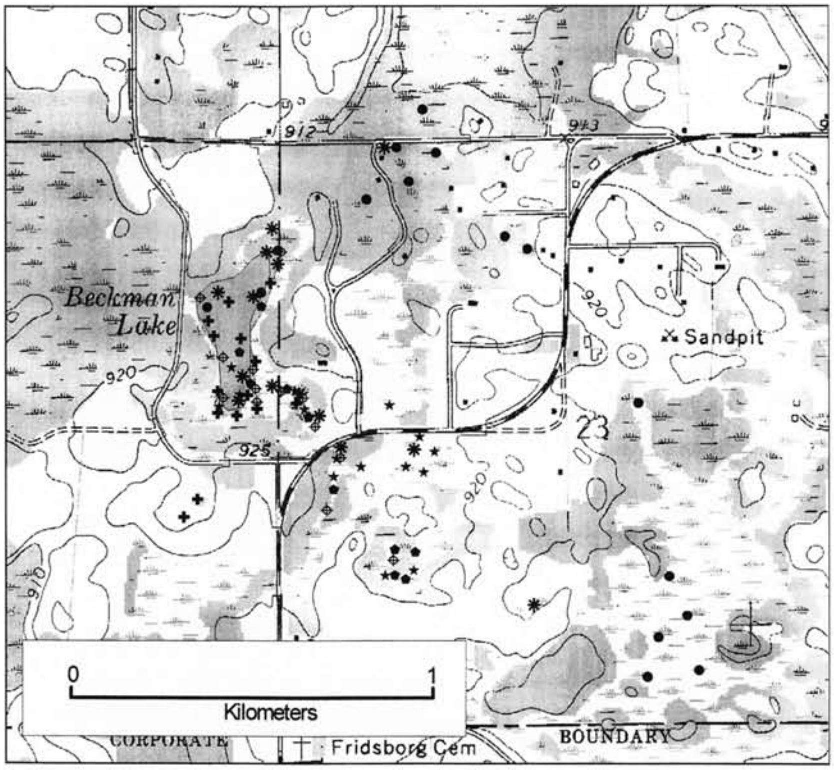


**Figure 1.** Movements of 6 radiotagged Blanding's turtles at Beckman Lake, 1990. Individual turtles distinguished by separate point types.

of old field, cultivated farmland, and woodlots on the Anoka Sand Plain landscape.

The control site, Beckman Lake, is located in the Cedar Creek Natural History Area (45°25'N, 93°10'W), 50 km north of Minneapolis-St. Paul, and 5 km southeast of Marget Lake. During the study, this 8-ha, permanently flooded, palustrine wetland ranged in depth from 1.0–2.0 m and was bordered by a floating mat of vegetation (Dorff, 1995). A 2-ha pond located on the southeast end of the wetland was created in the 1960s for rearing trout. Marotta (1966) and Lammers (1976) provided descriptions of the vegetation of Beckman Lake. The lake was selected as a control site because of its known population of Blanding's turtles and close proximity to Marget Lake.

*Controlled Drawdown.* — Marget Lake WMA is managed primarily for migrating waterfowl. A previous drawdown attempt in the 1960s resulted in only partial drainage of the lake. To ensure complete drainage, a portion of a 2-km outflow ditch was enlarged during summer 1989, facilitating the flow of water southeast into the Rum River. Upon completion, the drainage ditch contained two water-control structures and two culverts. The drawdown was initiated on 17 October 1989 and the 40 ha wetland drained within 48 hours, leaving approximately 75% of the lake bed exposed and 11 ha of shallow water in the lake basin. The water continued to recede through the spring, reaching its lowest level in mid-June 1990. Although the drawdown was scheduled to last through the summer of 1990, heavy rains on 16 June plugged a culvert with sand and debris, returning the lake to a pre-drawdown water level by late June. This water level remained constant through the remainder of the study.

*Radiotelemetry Techniques.* — At Beckman Lake, 8 turtles (4 males, 4 females) were equipped with transmitters between 12 May and 30 May 1990 (Dorff, 1995). Due to transmitter failure, only 6 were tracked for the duration of the study.

At Marget Lake, 14 turtles (4 males, 10 females) were captured and equipped with transmitters between 18 April and 1 August 1990 (Dorff, 1995). Due to transmitter failure, only 10 individuals were monitored.

Turtles at Marget Lake were hand-captured on the exposed lake-bed or trapped with baited hoop traps (Lagler, 1943) in the drainage ditch or adjacent wetlands. At the control site, all turtles were trapped within Beckman Lake. At the time of capture, turtles were sexed (Graham and Doyle, 1977), aged (Graham, 1989), weighed, and measured. Based on previous studies which indicate Blanding's turtles mature between 14 to 20 years of age (Petokas, 1986; Congdon and van Loben Sels, 1993), turtles 15 years of age or older (determined by counting scute annuli) were selected for this study.

Transmitters (Advanced Telemetry Systems [ATS], Isanti, MN) weighed approximately 15 g and had a life expectancy of 90 days. The resin-coated, waterproof transmitters were attached with stainless steel bolts onto rear marginal scutes of each turtle carapace and covered with clear silicone sealant. Instructions for contacting the researcher were inscribed on the transmitter. Whip antennas (150 mm) extended vertically from the transmitters and were flexible enough to allow turtles to move with minimal resistance. After transmitters were secured, the turtles were released at the point of capture. Radiotagged turtles were monitored with an ATS 10-channel portable receiver and a hand-held Yagi antenna, and were located from canoe or on foot at least twice weekly from the initial date of capture through October. Locations of radiotagged turtles were plotted on topographic maps. After leaving the perimeter of the lake, measurements of straight-line distances between radio locations provided estimates of total distances traveled by individual turtles. To avoid disturbing radiotagged turtles, individuals were recaptured only to replace transmitters or to determine a turtle's health or reproductive status. Upon recapture, weight and general condition were recorded for each turtle. All functioning transmitters were removed by November 1990, final measurements were obtained, and the turtles were released.

During this study, radio signals were lost from 4 turtles at Marget Lake (1 male, 3 females) and 2 at Beckman Lake (2 females). Signal loss resulted primarily from transmitter failure. Three signals were lost between late July and August shortly after transmitter batteries were refurbished. Unless specifically mentioned, calculations of movements and survival rates do not include data from turtles that experienced radio failure.

Movements of turtles were analyzed using a pooled t-test for sample means. Statistics were considered significant at $\alpha = 0.05$. Means are followed by one standard deviation. The Kaplan-Meier procedure was used to estimate survival rates ($\hat{S}$) for turtles at the two sample sites, and the log rank test was used to compare survival rates between groups of turtles (Pollock et al., 1989).

## RESULTS

### Movements

*Beckman Lake.* — Six individuals monitored for the duration of the study traveled between 0.3 and 2.2 km from the perimeter of Beckman Lake (mean = 0.9 ± 0.7 km) (Fig. 1). At the completion of the study, 5 (83%) returned to Beckman Lake and 1 (17%) emigrated to a wetland complex.

Throughout the summer, 5 turtles (4 females, 1 male) traveled between 0.3 and 1.0 km from Beckman Lake's perimeter (mean = 0.7 ± 0.29 km). They left the lake by mid-June traveling to shallow wetlands that ranged from 0.5 to 4.0 ha in size. Between late August and early October these turtles returned to the former trout pond located on the southeast edge of Beckman Lake. One male traveled approximately 2.2 km from Beckman Lake and was the only turtle that did not return to the trout pond to overwinter. He moved to a wetland complex consisting of floating emergent vegetation interspersed with pockets of open water, and was monitored within this wetland complex from 17 July to 26 October when his transmitter was removed.

In mid-July and mid-August radio signals were lost from 2 female turtles. Prior to signal loss, they traveled 0.7 km from Beckman Lake, occupying the same wetlands utilized by 3 turtles that returned to the lake.

*Marget Lake.* — Ten turtles were radiotagged at Marget Lake and monitored until death or termination of the study. Six turtles were tracked to overwintering sites (Fig. 2) and 4 died during the study (Fig. 3). Three turtles returned to overwinter in Marget Lake (33%), having traveled between 0.1 and 1.2 km from the perimeter of the lake (mean = 0.7 ± 0.57 km). Three (33%) emigrated from the area, traveling between 2.8–3.5 km (mean = 3.1 ± 0.37 km) from the perimeter of the lake. Three died, never leaving the lake perimeter (33%); and one died during a nesting attempt, 0.6 km from the perimeter of the lake. Throughout the study, the turtles traveled between 0.0–3.5 km from the perimeter of the lake (mean = 1.2 ± 1.4 km).

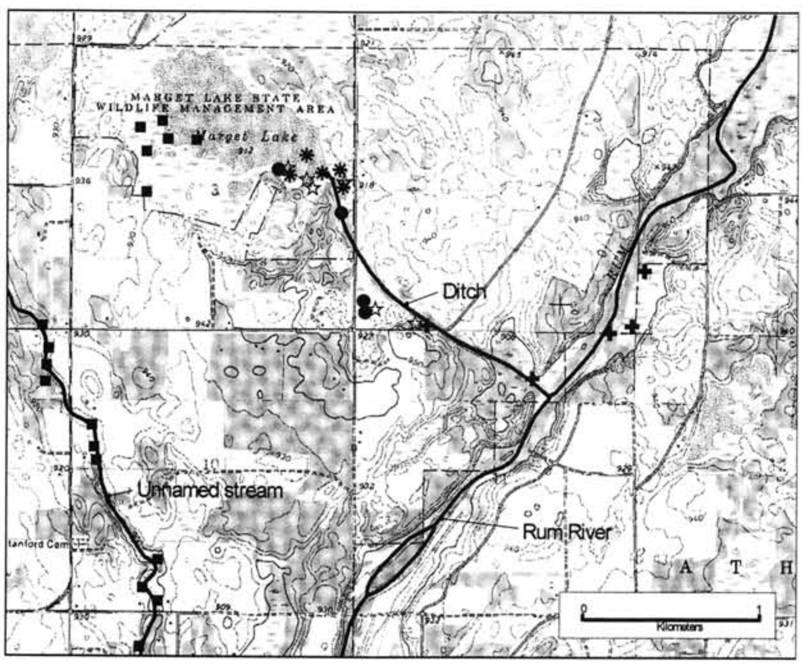


**Figure 2.** Movements of 5 radiotagged Blanding's turtles at Marget Lake, 1990. Individual turtles distinguished by separate point types.

Four turtles were initially captured in the lake basin. Three of these died in the lake basin, never leaving the perimeter of the lake, and one emigrated from the lake to a nearby creek. The turtle that emigrated was a male, initially captured on 9 May. He emigrated from the lake in early June utilizing small open bodies of water adjacent to Marget Lake. He moved in a southwesterly direction from the lake, and by mid-June was located in a small creek where he occupied shallow backwaters with an abundance of emergent vegetation. He continued to travel downstream, reaching his southern-most point in early September, at 3.5 km from his initial point of capture. He then traveled 0.5 km north to a small backwater in the creek where the transmitter was removed on 14 October.

Six turtles were captured in or near the ditch and small wetlands, and were presumed to have originated from Marget Lake prior to the drawdown. Three utilized the ditch and adjoining small wetlands prior to returning to the southeast portion of Marget Lake between mid-July and late October. One turtle, initially captured in a small wetland adjacent to the ditch, died in late June during a nesting attempt. A male turtle emigrated from the area prior to the reflooding of Marget Lake in late June. He was initially captured in the ditch on 20 April. Between 24 and 30 May, he traveled east, crossed the Rum River, and settled into a wetland complex 2.9 km from Marget Lake. He remained in this wetland and was found dead on 19 July. An additional radiotagged individual emigrated from the study area. She was initially captured on 23 July in a small wetland near the drainage ditch. Between 7 and 14 September, she traveled east across the Rum River, arriving in a wetland complex 2.8 km from Marget Lake. She remained in this wetland, which contained a large mat of floating vegetation. Her transmitter was removed on 14 October.

Between 3 May and 27 August, radio signals were lost from 4 additional turtles. These individuals had traveled between 0.2–1.2 km from Marget Lake (mean = 1.0 km).

## Mortality

*Beckman Lake.* — All radiotagged turtles survived at Beckman Lake and survival rates were estimated at $\hat{S} = 1.0$ ($n = 6$) (Fig. 4). No dead Blanding's turtles were found at Beckman Lake, but carcasses of 1 painted turtle (*Chrysemys picta*) and 1 snapping turtle (*Chelydra serpentina*) were located in early May. Both were found floating on the edge of the former trout pond; the cause of death appeared to be winterkill.

*Marget Lake.* — Of the 10 turtles monitored for the duration of the study, 50% died (2 males, 3 females). At Marget Lake, survival rates declined from an estimated $\hat{S} = 0.83 \pm 0.02$ during the ninth week of the study, to $\hat{S} = 0.33 \pm 0.01$ at the completion of the study (Fig. 4). Mortality increased as the water continued to recede from the lake basin.

Of the 4 radiotagged turtles initially captured in the lake basin, 3 (1 male, 2 females) were found dead in thick vegetation along the perimeter of the lake. One fresh carcass

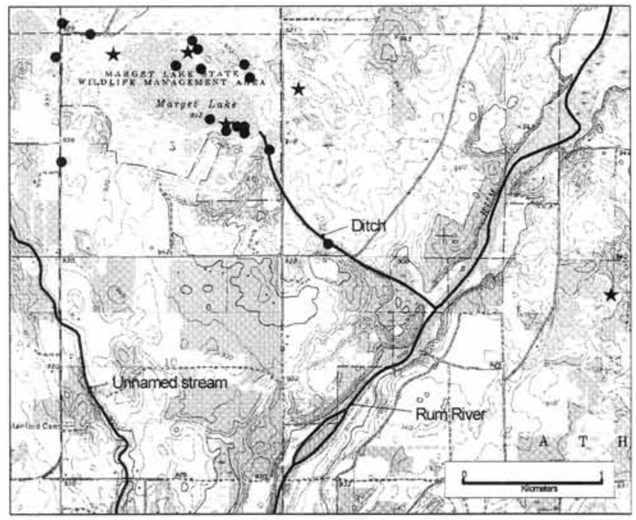


**Figure 3.** Locations of Blanding's turtle carcasses at Marget Lake, 1990 (stars = radiotagged animals; dots = non-radiotagged animals).

was recovered on 15 June. This turtle had been bitten on the neck, but all limbs were intact. The other two partially decomposed carcasses were located on 18 June and 6 July. Two of the 6 turtles captured in the ditch and adjacent wetlands died during the study. One was a gravid female whose empty shell was located near egg shell fragments, indicating she had been killed at or near her nesting site. The second, a male, left the ditch on 23 May, traveled across the Rum River, and was relocated in a wetland complex on 30 May. His carcass was retrieved from the wetland on 19 July. Cause of death could not be determined but the distance traveled by this individual suggests that he was in good condition prior to leaving Marget Lake.

In addition to the dead radiotagged turtles, 20 non-radiotagged Blanding's turtle carcasses were located within or near Marget Lake (Fig. 3). Of these, 13 were found along the perimeter of the exposed lake basin and were presumably killed by predators; 4 were crushed by automobiles on county roads; 2 were intact bodies found bloated and floating in the shallow water of the lake, apparent victims of winterkill; and the gnawed shell of 1 turtle was found on top

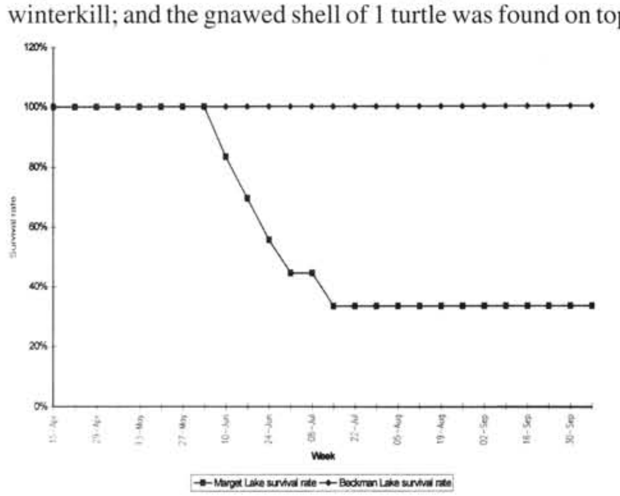


**Figure 4.** Survival rates of radiotagged Blanding's turtles at Beckman Lake (diamonds, upper line, $n = 6$) and Marget Lake (squares, lower line, $n = 10$), 1990.

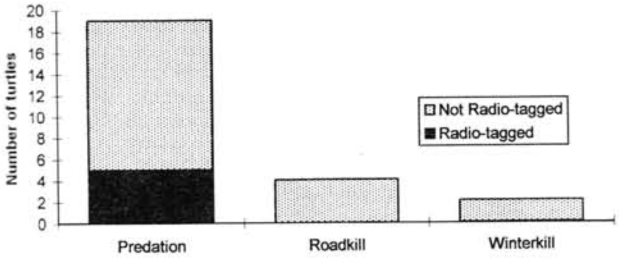


**Figure 5.** Presumed causes of Blanding's turtle mortality at Marget Lake, 1990 ($n = 25$).

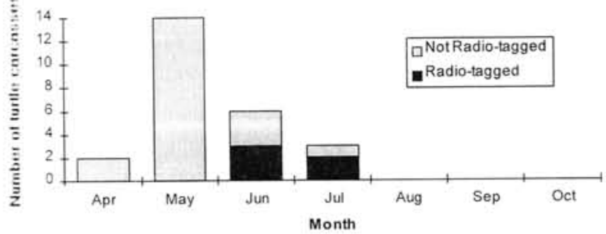


**Figure 6.** Blanding's turtle carcasses located by month at Marget Lake, 1990 ($n = 25$).

of the ditch early in the spring, presumably preyed on during the previous fall or winter (Figs. 5 and 6).

Several hundred dead painted turtles and 3 dead snapping turtles also were found at Marget Lake during the spring of 1990. The cause of death was uncertain, but it appeared to be winterkill, presumably caused by low levels of dissolved oxygen or lack of insulating layers of water, sediment, and vegetation. Numerous painted turtle carcasses were concentrated near the ditch entrance. The force of water channeling down the ditch as the drawdown was initiated may have caused these individuals to drown.

## DISCUSSION

*Movements*. — At both Marget and Beckman lakes, Blanding's turtles moved to adjacent small, shallow wetlands during May and June. All surviving turtles left the lakes by late June. Seasonal movements of Blanding's turtles have been observed by several researchers who found that travel among wetlands may include use of streams, and may involve relatively long distances (Gibbons, 1968; Ross and Anderson, 1990; Rowe and Moll, 1991). Such movements are probably attempts to locate mates or suitable habitat for nesting and overwintering.

At Marget Lake turtles responded to the receding water by traveling overland or following the drainage of water into the ditch. Most activity appeared to take place during late May and early June, when the lake basin was the driest and radiotagged turtles were leaving or attempting to leave the lake basin. During this time, several carcasses were found along the lake perimeter. Although carcasses were widely distributed, concentrations of carcasses near the ditch in the southeast portion of the lake indicated that Blanding's turtles were moving towards available water, or were following the stream until making an attempt to travel overland.

Of turtles monitored to known fates, 3 (30%) dispersed from and did not return to overwinter in Marget Lake, compared to 1 (17%) at the control site. Saumure (1997) studied Blanding's turtles inhabiting an impoundment in the Big Creek National Wildlife Refuge, Long Point, Ontario. That population was reduced by approximately 43% following a controlled drawdown. Although water levels at Marget Lake returned to a pre-drawdown level by late June, the three radiotagged turtles that emigrated from the area during June did not return by the end of the study in October. Turtles that emigrated from Marget and Beckman lakes traveled greater than 2.0 km, while those that returned to overwinter traveled 1.2 km or less from the lake perimeter. There was no significant difference in the distances traveled by the turtles that overwintered within Marget Lake and those that overwintered in Beckman Lake ($t = 0.1773$ at 6 df, $p < 0.05$). Distances traveled by turtles which returned to overwinter (mean = 0.7 km) were comparable to mean distances calculated in other studies of Blanding's turtles: 0.906 km (Piepgras, 1998), 0.489 km (Ross and Anderson, 1990), and 0.703 km (Rowe and Moll, 1991).

At both study sites, turtles arrived at overwintering areas between mid-July and early October, with the majority arriving by mid-September. Prior to entering an overwintering site, aquatic turtles may use areas in the immediate vicinity (Gregory, 1982), and may utilize summer activity centers as overwintering sites, including creek and excavated pond habitats (Ross and Anderson, 1990).

*Mortality*. — Although little information is available on survival rates of adult Blanding's turtles, adult mortality is typically low in Blanding's turtle populations. Congdon et al. (1993) reported adult annual survival as exceeding 93% in a stable population. Radiotagged Blanding's turtles at Marget and Beckman lakes had survival rates of 50 and 100%, respectively. Mortality rates at Marget Lake were higher among turtles captured in the lake (75%, $n = 4$), compared to turtles captured in adjacent wetlands (33%, $n = 6$). Individuals captured in the lake were vulnerable to predation as they attempted to emigrate overland during low water levels. Turtles captured in the ditch and adjacent wetlands presumably had been in Marget Lake prior to the drawdown and successfully moved to these aquatic refuges where they were less vulnerable to predation.

High levels of mortality appeared to occur during the lowest level of water in the lake basin in mid-June (Fig. 4). Apparently, turtles dispersing overland were captured by predators (Dorff, 1995). Raccoons (*Procyon lotor*) and raccoon sign were frequently observed along the perimeter of the lake. Red fox (*Vulpes vulpes*), mink (*Mustela vison*), and river otter (*Lontra canadensis*) were also observed.

During fall drawdowns, turtles may become more vulnerable to disease and mortality caused by stress and injury. Although winter mortality of Blanding's turtles appeared to be minimal at Marget Lake, large numbers of painted turtle carcasses found in the spring indicated that the drawdown had severe impacts on this smaller species. Low water levels resulted in heavy winter mortality of painted turtles in Iowa (Christiansen and Bickham, 1989) and Nebraska (McAuliffe, 1978). Turtles hibernating in anoxic mud conditions may die from metabolic acidosis which causes ionic changes in the blood (Jackson and Ultsch, 1982). Meeks (1990) stated that severe physiological stress can develop in turtles hibernating in anoxic conditions, due to the production of anaerobic lactic acid. At Marget Lake, a lethargic snapping turtle was captured in April and diagnosed by Minnesota Department of Natural Resources pathologists as having ulcerative stomatitis, known as shell-rot or mouth-rot. This disease is caused by bacteria (*Aeromonas hydrophila*) which enter through an injury to the oral mucosa. This snapping turtle later died from the disease. On 12 May, a juvenile Blanding's turtle was found in a very lethargic state. Although it appeared uninjured, it did not retreat into its shell, would have been vulnerable to predation, and may have been diseased.

## Conservation Implications

*Controlled Drawdowns and Biodiversity Impacts.* — This study demonstrated that fall controlled drawdowns can negatively impact Blanding's turtle populations and other turtle species. At Marget Lake the impact on Blanding's turtles appeared to be indirect, caused primarily by predators at the drawdown site. Initially predators may have been attracted to the numerous painted turtle carcasses and invertebrates that probably died from direct drawdown effects and later preyed on dispersing individuals. Long-term impacts of controlled drawdowns on turtles were not addressed in this study but are probably significant. This study found a significant negative impact on at least two turtle species within the wetland complex (*C. picta* and *E. blandingii*) suggesting many other species are also vulnerable during use of this common management method.

Turtle life history characteristics limit the ability of populations to recover from a significant loss of adults and therefore present special conservation challenges (Brooks et al., 1991; Congdon et al., 1993). Blanding's turtle reproductive strategy relies on adult longevity to compensate for a high rate of predation on nests and young (Congdon et al., 1983; Brecke and Moriarty, 1989). Low recruitment of juveniles and immigrants results in a very slow rate of recovery from exploitation or increased mortality of adults.

The following are recommendations for decreasing the impact of drawdowns on survival of Blanding's and other turtles.

1. Drawdowns should not be initiated in the fall. Turtles overwintering at drawdown sites become stranded or relatively exposed when the water level is lowered in the fall, resulting in increased winter mortality.

2. Drawdowns should be done gradually. This may prevent large numbers of turtles from leaving the wetland at one time, thus discouraging the concentration of predators. Gradual drawdowns may also limit the direct effects of rapid waterflow on smaller species such as *C. picta*.

3. Channels (e.g., ditches, streams) to adjacent wetlands should be incorporated to facilitate safe dispersal of threatened turtles. Results of our study indicate that travel corridors, such as streams and ditches, are a critical component of Blanding's turtle habitat and result in higher survival rates among dispersing turtles. Sites with known Blanding's turtle populations need water-filled travel corridors to connect wetlands and refugia for dispersing turtles.

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