SPINNEY MOUNTAIN RESERVOIR

FISHERIES MANAGEMENT PLAN

(Angler at Spinney Mountain Reservoir – Pike Tournament 1999)

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Introduction

Spinney Mountain Reservoir is a 2,450 surface acre mainstem South Platte River impoundment located between Antero and Eleven Mile Reservoirs in South Park. It is owned and operated by the City of Aurora. Colorado State Parks maintains and operates recreation facilities and access during the ice-free season. Ice angling is not allowed at Spinney Mountain Reservoir. The Colorado Division of Wildlife manages the fishery and associated wildlife in this impoundment.

Spinney Mountain Reservoir is managed to provide a trophy trout fishery. Spinney was routinely stocked with cutthroat and/or rainbow trout from 1982 through 1999. By 1988, the outstanding trout growth and catch rate was well documented. In that year, the Colorado Division of Wildlife initiated a protective bag and possession limit of 1 trout with a minimum size limit of 20 inches combined with a terminal tackle (flies and lures only) restriction to maintain and enhance the trout fishery. Northern pike numbers and sizes also continued to increase during this time, and several management strategies were implemented through 1996 to enhance the northern pike population while maintaining the trout fishery.

Northern pike were first introduced into Colorado in 1956 by the Colorado Game and Fish Department and the United States Fish and Wildlife Service. These early introductions of northern pike were made into the reservoirs on the eastern plains of the state to control abundant populations of suckers and carp. Seining and gill netting operations by the Colorado Division of Wildlife (then the Colorado Game and Fish Department) through the 1950s at Eleven Mile Reservoir revealed non-sportfish to sportfish ratios ranging from 37 to 1 to as high as 300 to 1. In 1962 northern pike were stocked into Eleven Mile Reservoir to help control the large populations of white suckers, longnose suckers and common carp. It was believed that the northern pike would not successfully reproduce in Eleven Mile Reservoir because the water level (storage) manipulations at that time de-watered prime spawning habitat for pike in the spring each year. Fishery managers felt they would be able to supplement the northern pike population with additional stocking as needed to help control the non-sportfish species.

Since 1984, water level manipulation has changed in Eleven Mile, providing optimum spawning conditions. Northern pike have responded by naturally reproducing almost every year. Finnell (1987) conducted a five-year research study at Eleven Mile Reservoir beginning in 1982 to evaluate northern pike population characteristics (age structure, growth, diet, and movement) and their impact on rainbow trout and cutthroat trout and kokanee salmon populations. Many of the management recommendations from this research study were used at Eleven Mile and Spinney Mountain Reservoirs in subsequent years.

Prior to the construction of Spinney Mountain Reservoir the mainstem South Platte River and the South Fork to Antero Reservoir were treated with a chemical application to remove all fish including northern pike that had migrated upstream from Eleven Mile Reservoir. The Division of Wildlife never intentionally introduced northern

pike into Spinney Mountain Reservoir. However, there may have been some remaining pike in the river drainage above the reservoir when it was filled.

Northern pike are able to reproduce naturally in Spinney Mountain Reservoir and their numbers and sizes continued to increase each year after the reservoir was finished and filled. In 1993, a special fishing regulation (all pike caught between 26 and 34 inches must be returned to the water immediately, bag and possession limit of 10, of which no more than 1 could be greater than 34 inches in length) was placed on the northern pike. This management option was taken from the Eleven Mile Reservoir research study (Finnell 1987) which suggested a "trophy" pike fishery could be developed and the larger northern pike would help control the numbers of smaller pike through predation. The new regulation increased the numbers of large pike in Spinney dramatically and in 1996 the protected slot limit was removed leaving a 10 fish bag and possession limit on northern pike, of which only 1 could be greater than 34 inches.

Northern pike did a tremendous job of reducing the non-sportfish numbers (their primary prey base) in Spinney Mountain Reservoir by 1995. Northern pike began to prey primarily on trout after that time. By 1999, northern pike were eating virtually all sub-catchable and catchable rainbow and cutthroat trout stocked each year in Spinney Mountain Reservoir. The Colorado Division of Wildlife planted over 100,000 3-inch rainbow trout, almost 343,000 rainbow trout between 3 and 8 inches in length and over 123,000 catchable-size (10 inch) rainbow trout in 1997, 1998 and 1999 collectively. These fish cost over $300,000 to produce in Division hatcheries and we have little to show for it, as northern pike have consumed almost everything stocked between 1997 and 1999. The majority of the remaining trout in Spinney Mountain Reservoir are greater than 18 inches in length. However, these larger trout are short lived and if we cannot reduce northern pike numbers we will not be able to maintain the quality trout fishery at Spinney Mountain Reservoir via stocking.

In the fall of 1999, the Colorado Division of Wildlife Commission removed the special fishing regulation on northern pike at Spinney Mountain and Eleven Mile Reservoirs. The Wildlife Commission removed bag and possession limits for northern pike statewide in November 2000.

This report details current information regarding the status of the fish community at Spinney Mountain Reservoir and outlines management options available to try and re-build the trophy trout fishery.

Methods

Spinney Mountain Reservoir's fish community has been sampled with cold-water experimental gill nets from 1984 through 1993, 1995, 1999 and 2000. The gill nets are set in standardized locations each year, perpendicular to shore, and are designed to sample a variety of habitat types, fish species and sizes of fish. The nets sample water ranging in depth from 3 to 42 feet. The nets are set in the late afternoon or early evening and pulled the following morning.

All fish captured in the nets were identified, measured and weighed. All northern pike captured in 1999 were examined for stomach contents. Prey items were identified and counted and/or measured in the case of fish prey. Northern pike stomach contents were also examined in 2000 and a cleithral bone (a bony component of the pectoral girdle) was collected from each fish to provide an accurate age assessment and growth history. Fish scales alone cannot provide these data because they are subject to wear and replacement, particularly on older northern pike.

In addition, we employed trap nets, short-term gill net sets and boat electrofishing gear during April, May, and June 2000 to capture and relocate northern pike from Spinney Mountain Reservoir to selected east slope dead-end waters. Twelve trap nets were initially deployed shortly after ice-off and checked each day for fish until the water temperatures reached the preferred northern pike spawning range (45 to 54 degrees Fahrenheit). Then, a total of 36 trap nets were set along the shoreline and shallow water areas and checked each day for one week. Short-term (one-hour) gill net sets were used in the afternoons in shallow water areas when the wind conditions permitted. These gill nets were 400 feet long and were made up entirely of 2-inch bar mesh. Trout captured by the nets were identified, measured, weighed and examined for northern pike bite scars then released. All northern pike captured in the trap and gill nets were measured, all greater than 2 years of age were weighed and then they were held in holding cages for later transport to new waters. Boat electrofishing was conducted during one night in May and one night in June 2000. All trout were allowed to escape the electrical field while northern pike were captured and held.

Creel surveys were conducted from June 1 through September 5, 2000. The surveys are designed to obtain shore and boat angler counts three-times/day during random week and weekend days. In addition to the angler counts, some anglers were asked a series of questions regarding their fishing trip (how long they've been fishing that day, fish caught and kept, fish caught and released, length of fish, and fish species preference). The creel survey data was entered into a statistical program by the CDOW's Research Section in Ft. Collins, CO to generate expanded angler use estimates that can be compared with creel surveys conducted in the past.

Angler education and information efforts regarding northern pike biology and management were increased in 1999 and 2000. This was done when we determined that the northern pike population in Spinney Mountain Reservoir was exhibiting signs of overpopulation. Anglers were encouraged to harvest pike through new signs posted at the reservoir.

Results

Fish Community Samping

Northern pike population size structure changed dramatically since Spinney first opened to anglers. Initially, pike responded well to the aging of the reservoir, then in response to special regulations. Trout numbers continued to decline and large trout comprised most of the gill net catch through 1995. Northern pike have effectively controlled white sucker numbers in Spinney, and have now switched to the trout as a prey base. The highest trout densities occurred in 1984-85 and 1990 when suckers were more abundant and pike numbers were low. Fish community sampling data from 1999 and 2000 revealed that northern pike dominated the fishery. Furthermore, almost no trout smaller than 15 inches total length were sampled in the gill nets despite a rigorous trout stocking program using fingerling, sub-catchable and catchable-size trout plants over the previous three years (Figure 2).

Figure 1. Northern pike size structure for several inch-size (12 to 20, 20 to 26, etc.) groups from gill net samples in Spinney Mountain Reservoir 1983 through 2000.

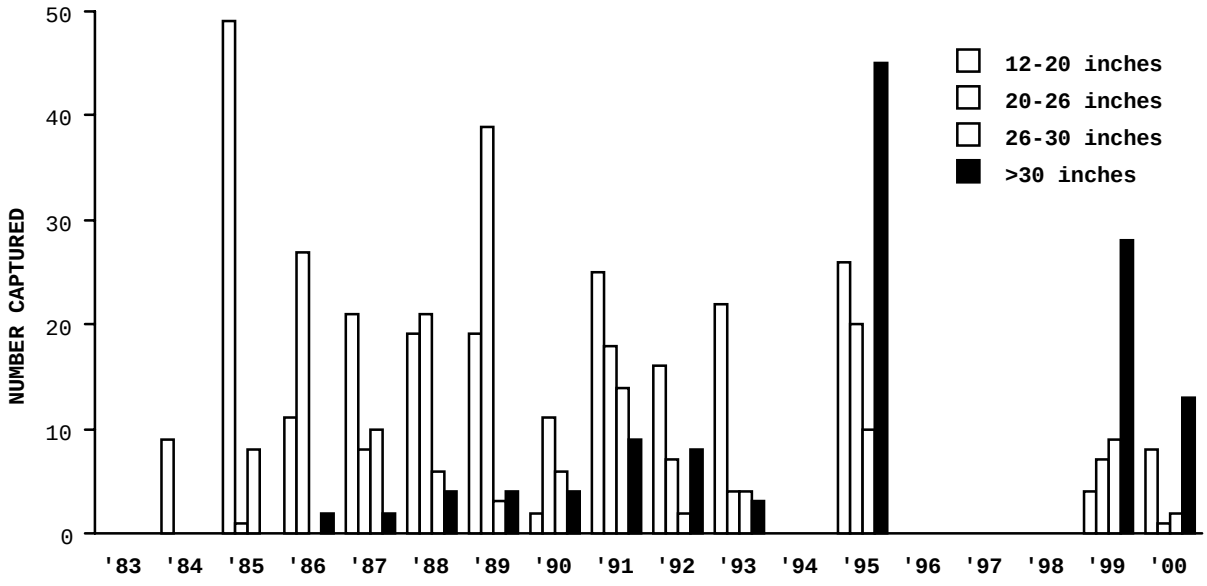
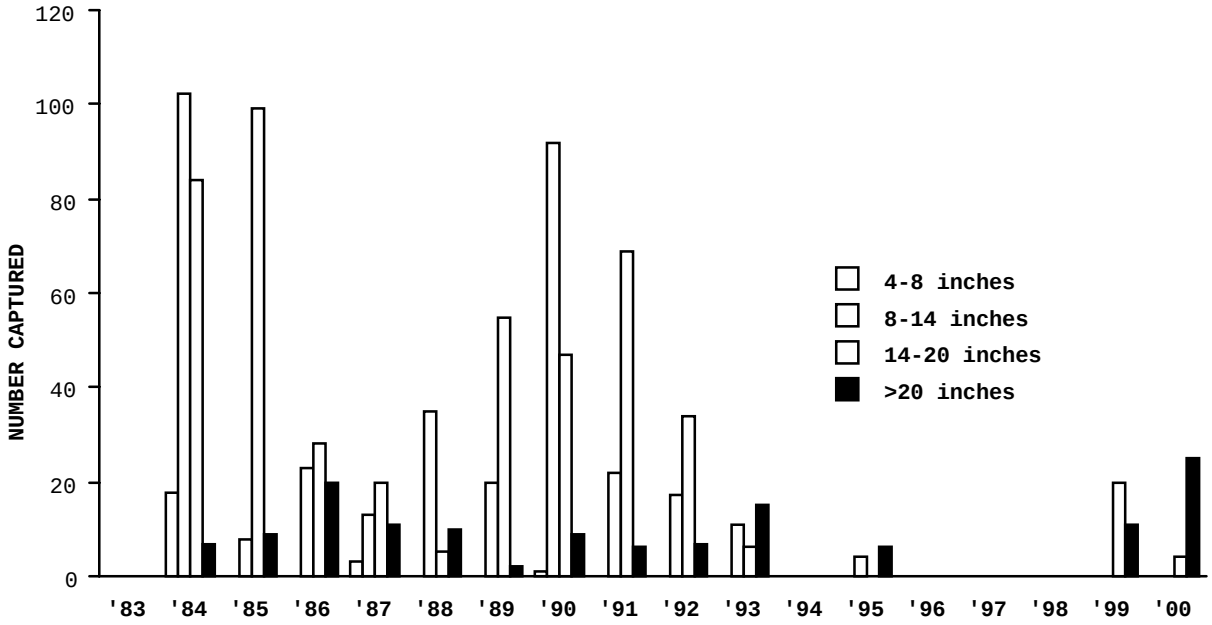
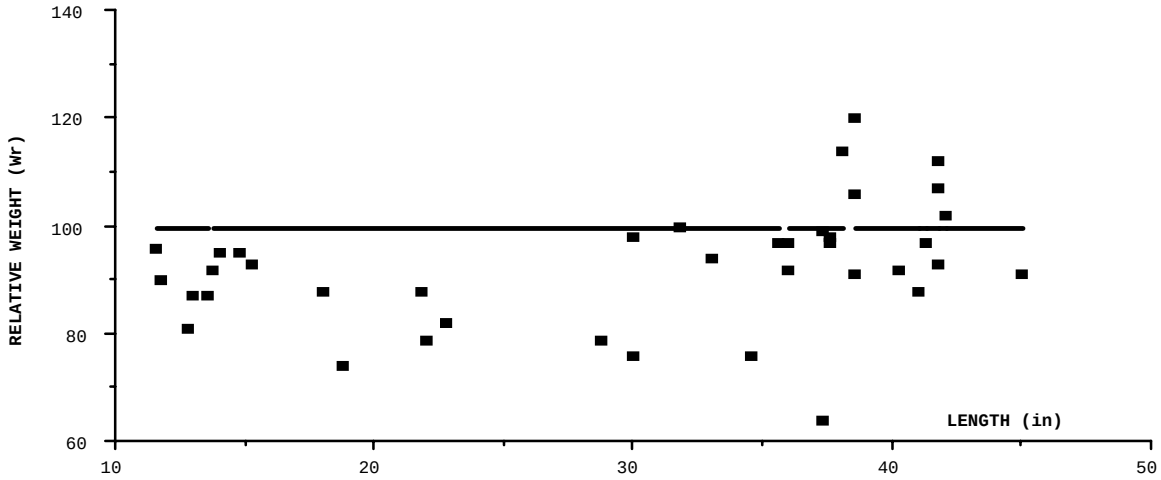


Figure 2. Rainbow and cutthroat trout size structure from gill net samples in Spinney Mountain Reservoir for 1983 through 2000.



Northern pike body condition is assessed by comparing a pike's known weight with what it should weigh based on length-weight information over the entire range of the species. This index is referred to as Relative Weight (Wr). A fish that is in good condition should have a relative weight value close to 100 percent. Figure 3 shows relative weight values for northern pike at Spinney Mountain Reservoir in 2000.

Figure 3. Relative weight (Wr) values for northern pike in Spinney Mountain Reservoir gill net and trap net samples in 2000.



Pike Food Habits

Northern pike up to 24 inches total length have diets composed primarily of invertebrate prey items (amphipods, aquatic insect larvae, crayfish, etc.). Pike larger than 24 inches show an increased selection for fish as prey with the largest pike almost exclusively feeding on fish. Figure 4 shows the results of northern pike diet analysis at Spinney for 1999 and 2000. Northern pike can eat prey fish up to one-half their body length (Figure 5). Typically, northern pike in Spinney Mountain Reservoir that contained fish prey items had ingested fish up to 1/3 their body length or smaller. Only one northern pike over 24 inches (out of 75 examined) contained another northern pike as a prey item. We also examined 229 trout that were captured in the trap nets for evidence of pike tooth scars, and 34 percent of the trout examined were scarred.

Figure 4. Northern pike stomach analysis for fish equal to or greater than 24 inches from Spinney Mountain Reservoir 1999-2000.

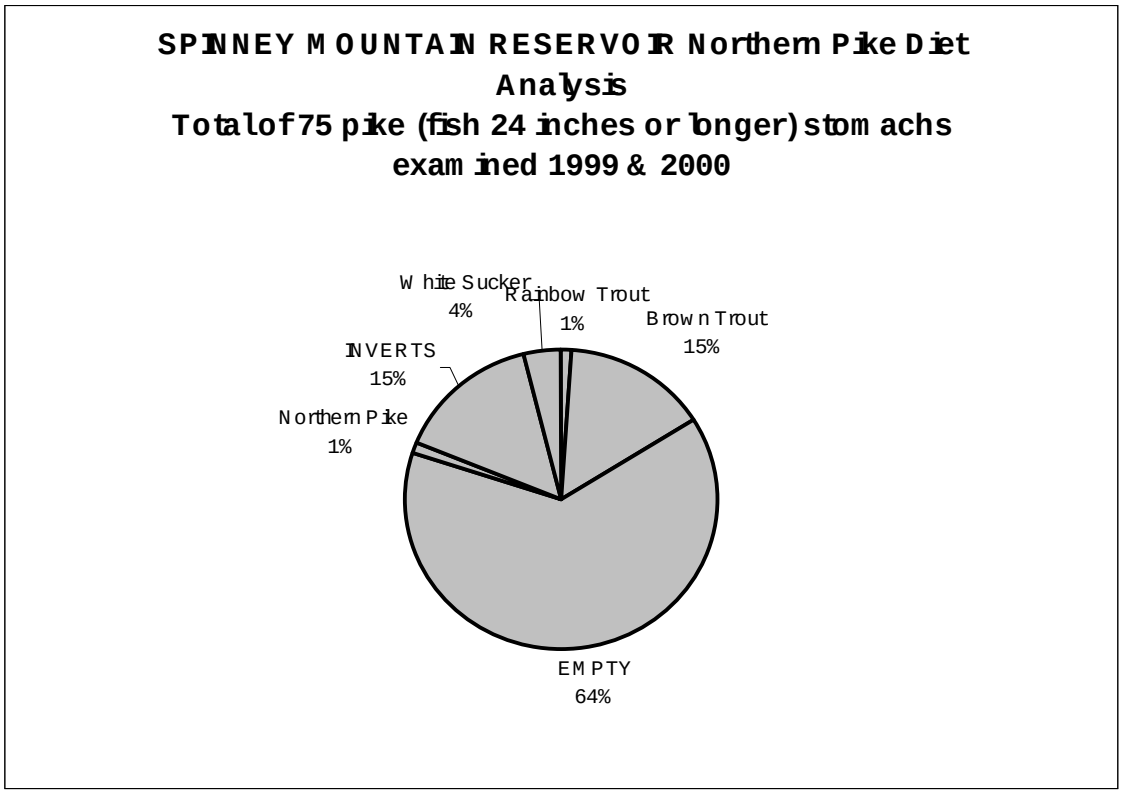
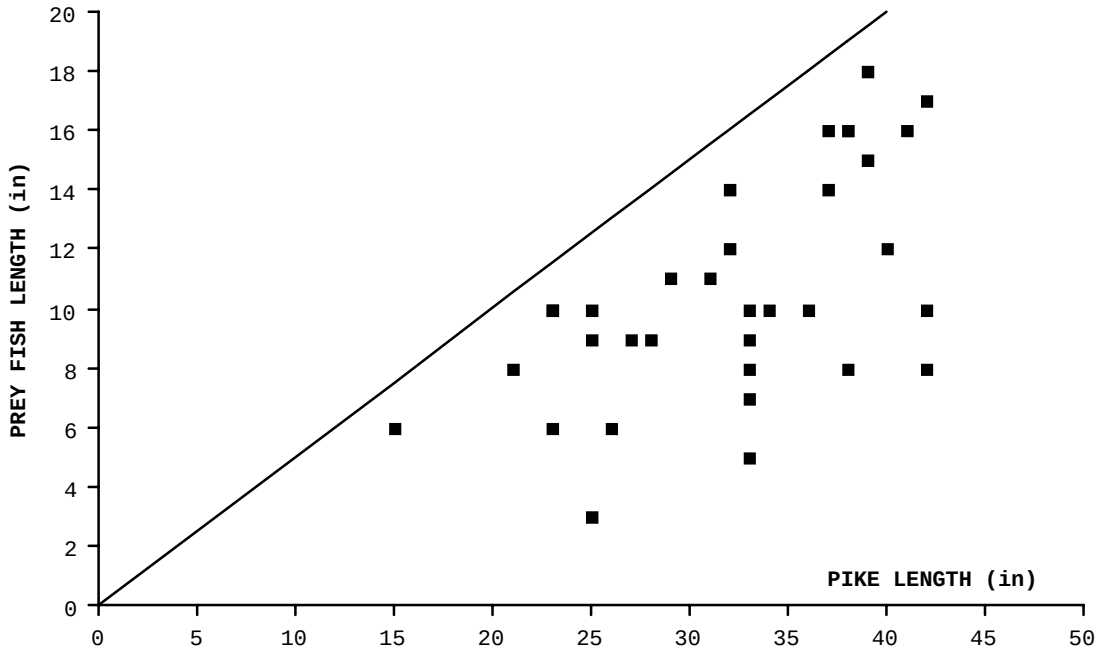


Figure 5. Relationship between northern pike and maximum size of fish prey ingested at Spinney Mountain Reservoir 1999 – 2000.



Age and Growth

Examination of cleithra revealed growth of large northern pike (age 6 to 8 years) was highest in 1995 then dropped off in subsequent years (Figure 6). A 6 to 8 year old northern pike could grow up to 5 to 6 inches in one year in 1995, but by 1999 expected growth was reduced to less than 3 inches for the same age pike due to lack of forage. Figure 7 details the growth trajectory of northern pike as it was in the early to mid-1990s. This figure also shows the predicted length at age if northern pike only grow at 50 percent and 33 percent of the rate they grew in the early to mid-1990s. Currently, northern pike growth rate at Spinney falls between the 50 and 33 percentile range. This is expected since we stopped stocking trout after June 1999. The oldest northern pike we aged with cleithra data was 12 years old (Figure 8).

Figure 6. Average annual growth (inches) for ages 6 through 8 northern pike in Spinney Mountain Reservoir given by year with associated 95% confidence interval.

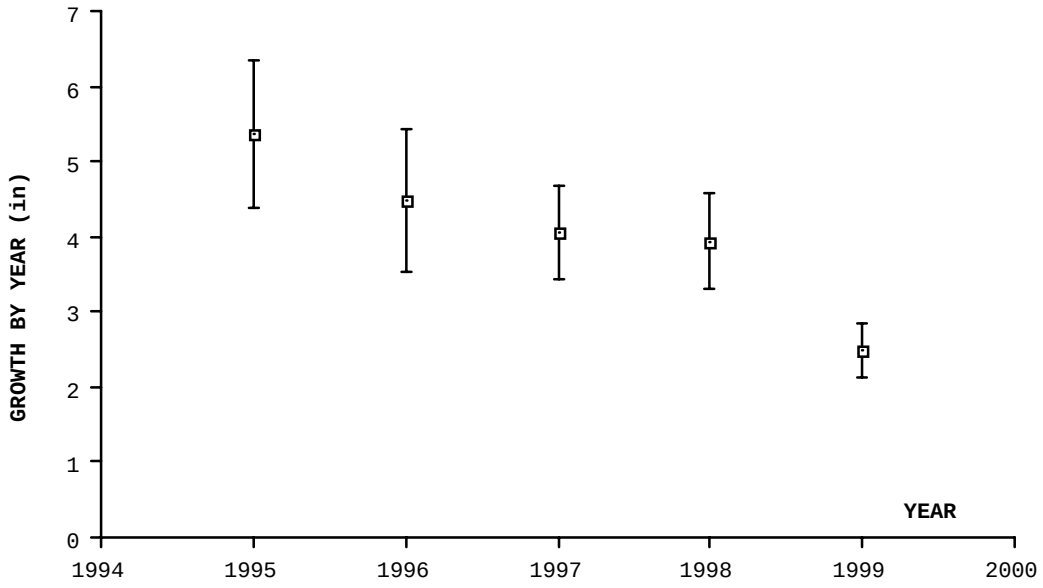


Figure 7. Northern pike growth trajectory at 100% (as it was in early to mid-1990s) and predicted length at age if northern pike only grow at 50% or 33 % of that rate at Spinney Mountain Reservoir.

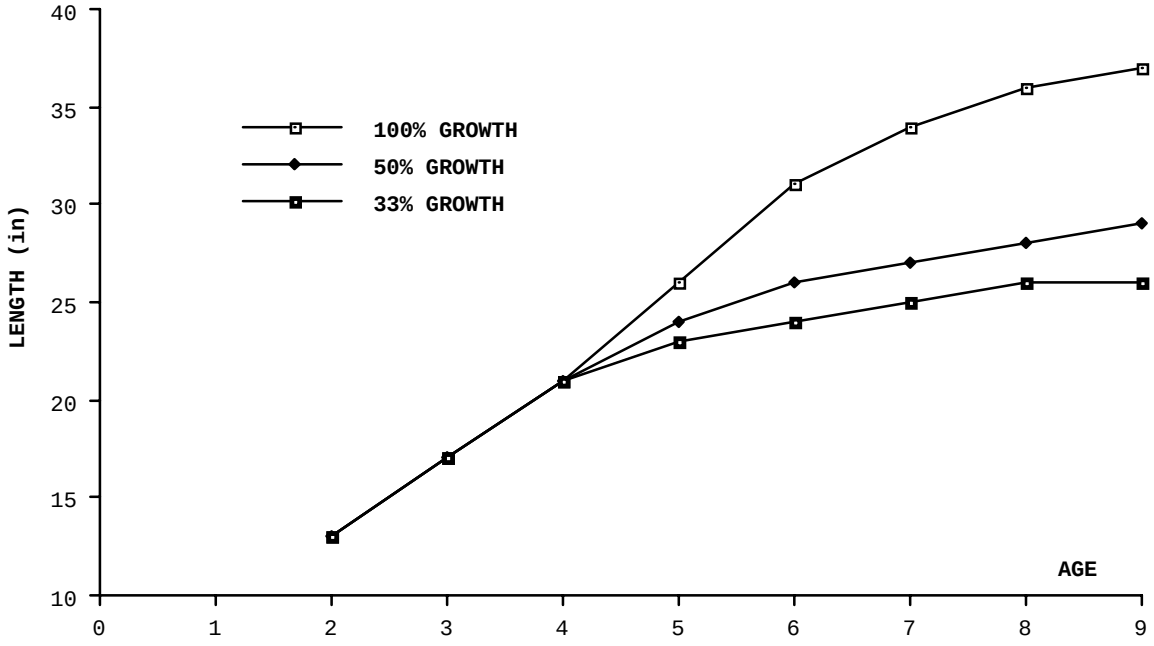
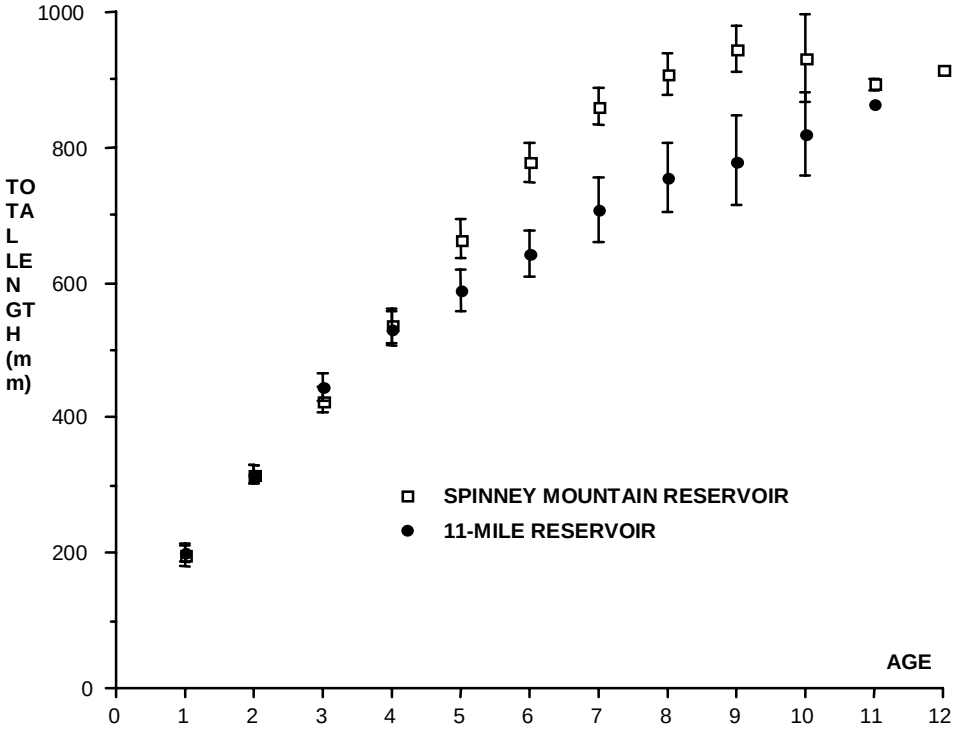


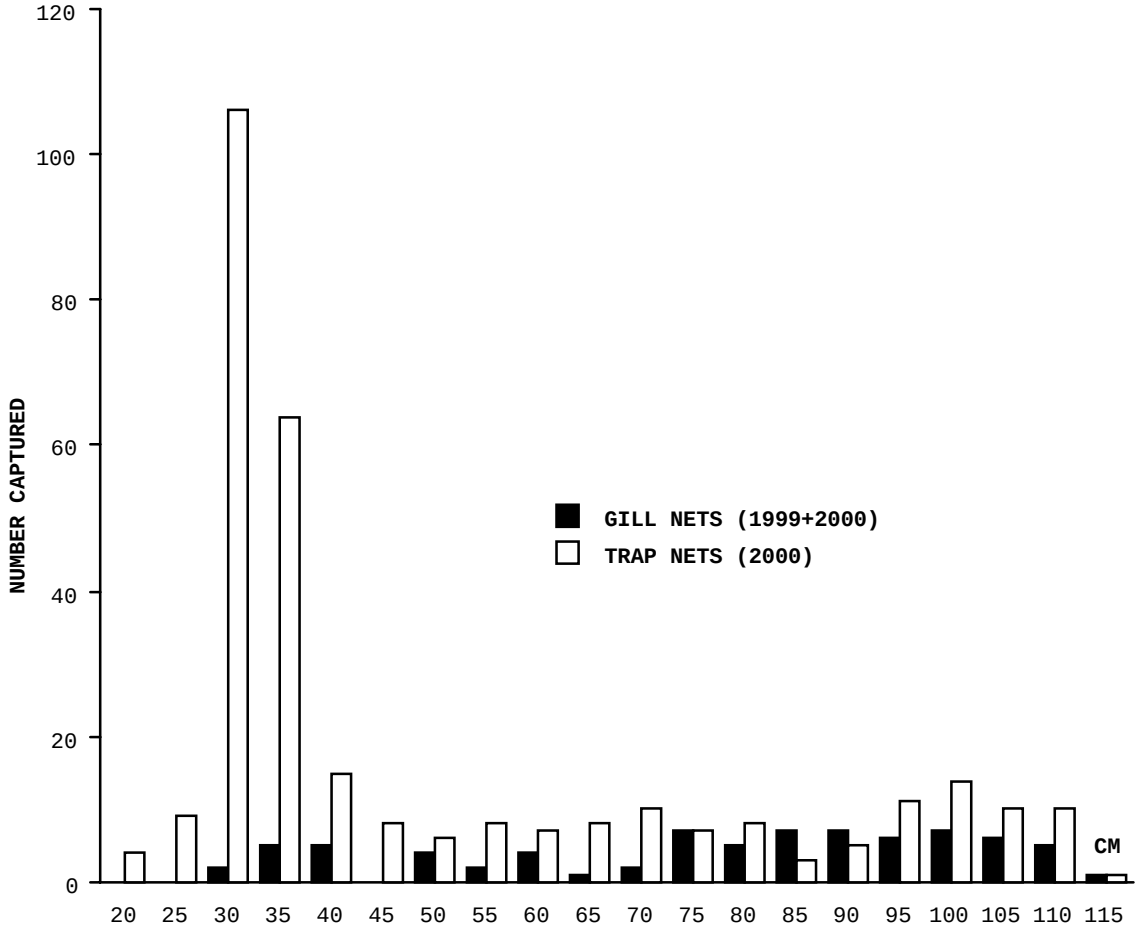
Figure 8. Northern pike lengths at age for Spinney Mountain and Eleven Mile Reservoirs, 2000.



Manual Removal of Northern Pike

Trap nets were deployed at Spinney Mountain Reservoir during the spring of 2000 during late April through mid-May in an attempt to capture and re-locate northern pike. Less than one adult (20 + inches total length) northern pike per trap net night of effort was captured during the entire operation. Numerous Age 1 and Age 2 (8 to 16 inches) northern pike were captured using trap nets (Figure 9). Approximately 600 northern pike were captured in the trap netting operation.

Figure 9. A comparison of sizes for northern pike captured in gill nets and trap nets during 1999 and 2000 at Spinney Mountain Reservoir.



Short-term (1-hour) gill net sets were used during two relatively calm weather days in May. Four 400-foot long gill nets with 2-inch bar mesh were deployed in the northwest end of Spinney in water ranging from 2 to 5 feet in depth. The gill nets were deployed and pulled four times (16-hours effort). Only 13 northern pike were captured using the short-term gill nets but all of them were adult fish (greater than 20 inches).

We used an electrofishing boat at night once in May and one night in June to capture additional northern pike. Twenty-six northern pike ranging in size from 9 inches to 41 inches were captured during 4 hours and 38 minutes of electrofishing effort.

Creel Survey

A total of 1,637 anglers were contacted from June 3 through September 4, 2000 at Spinney Mountain Reservoir. Table 1 shows the statistically expanded creel survey data.

Table 1. Expanded creel survey data for Spinney Mountain Reservoir from April through September 1994 and 2000 for angler hours. Catch data compared from June through September 1994 and 2000.

Category	Total 1994	Total 2000
Angler Hours (Expanded for April through September)	36,674 (44,000) Total = 80,674	26,843 (20,894) Total = 47,737
Total Catch (all species)	20,272	7,825
Total Catch for Northern Pike (% total catch)	12,011 (59)	6,950 (89)
Total Catch for Rainbow Trout (% total catch)	5,828 (29)	618 (8)
Total Catch for Brown Trout (% total catch)	600 (3)	254 (< 3)
Total Catch for Cutthroat Trout (% total catch)	1,833 (9)	3 (< 1)
Number of Anglers	4,748	4,374
Total Catch per Hour	0.6	0.3
Total Hours per Acre (Expanded for April through September)	15 (33)	11 (19)

Typically, many more anglers arrive to fish Spinney during April and May for trout since northern pike activity does not pick up substantially until June. Expanded creel data based on visitation use (provided by Eleven Mile State Parks Office) shows

that anglers spent over 23,000 additional hours fishing at Spinney in April and May 1994 compared to the same two month period in 2000. Total angler hours (April through September) decreased by almost 33,000 hours between 1994 and 2000 data.

Northern pike continue to make up the majority of total catch at Spinney. A comparison of northern pike catch and harvest between 1994 and 2000 is shown in Table 2.

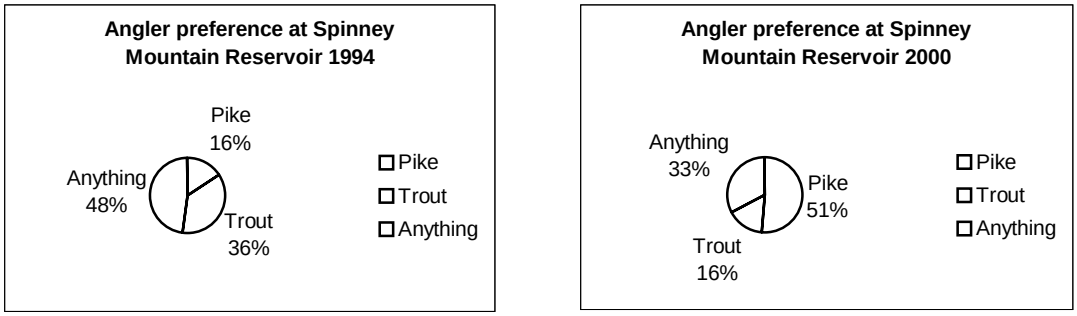
Table 2. Total catch and total harvest of northern pike at Spinney Mountain Reservoir from June through September in 1994 and 2000.

Total Catch (Pike kept and released) 1994	Total Catch (Pike kept and released) 2000	Total Harvest (Pike kept) 1994	Total Harvest (Pike kept) 2000
12,011	6,950	1,196	2,604

Note: Total harvest of pike was 10 percent of the catch in 1994. Total harvest of pike accounted for 37 percent of the catch in 2000.

A total of 2,143 anglers in 1994 and 1,637 anglers in 2000 were asked to give their preference for fish species they were trying to catch at Spinney Mountain Reservoir (Figure 10). Angler preference for pike increased in 2000 because the number of trout anglers decreased substantially.

Figure 10. Angler preference for fish species from creel survey data in 1994 and 2000.



Anglers at Spinney exhibit size-selective harvest on northern pike. Table 3 shows the size range breakdown and corresponding harvest for pike at Spinney from the 2000 creel data (based on actual field data, not statistically expanded).

Table 3. Total number of northern pike caught and number harvested by anglers at Spinney Mountain Reservoir (raw field data) for various length ranges, summer 2000.

Northern Pike Size Range	< 24 inches	24 to 30 inches	30 to 36 inches	> 36 inches	Total
Total Number of Northern Pike Caught	1,382	93	37	40	1,552
Number of Northern Pike Harvested	480	34	27	36	577

Angler information/education efforts.

Historically, anglers at Spinney frequently practice catch and release fishing for trout but many anglers also release northern pike. Accordingly, with no ice-fishing season and low angler harvest, the pike population continued to increase dramatically. We began distributing northern pike information sheets discussing pike biology, history, impacts on stocked trout and how anglers can help in July 1999. These sheets asked anglers to increase their harvest of northern pike. Four new signs were posted at Spinney Mountain Reservoir in July 1999 encouraging anglers to harvest pike. Several Colorado Division of Wildlife/State Parks approved northern pike tournaments were held at Spinney (sponsored by the Colorado Fishing Federation) in 1999 and 2000. These pike tournaments helped increase angler awareness of the need to harvest northern pike. A Pike Festival was held in mid-July 2000 to continue information/education efforts targeting anglers and the need to harvest northern pike at Spinney.

A local television station (Channel 4) ran a story during the 5:00 p.m. news segment detailing the northern pike issue at Spinney Mountain Reservoir. Several newspaper articles (Denver Post, Rocky Mountain News, Colorado Springs Gazette, etc.) regarding this issue were also written in 1999 and 2000. We presented information about the northern pike issue at several angler round table meetings in 1999 and 2000. We also met with the Northern Chapter of Muskies, Inc. at Bennett's Bait and Tackle in Berthoud, CO to discuss this issue in 1999 and with Colorado Muskies, Inc. in November 2000 to discuss pike and trout management at Spinney Mountain Reservoir.

The overwhelming response by anglers at the round table and other public meetings is that they want to see us continue to manage Spinney Mountain Reservoir as a trophy trout fishery. We also polled the anglers at the first northern pike tournament in 1999 asking if we should continue to manage Spinney for trophy trout or pike. Forty-one teams responded (82 anglers) and 80 anglers fishing for northern pike indicated that they want us to continue to manage the reservoir for trophy trout.

Discussion

The history of trout and northern pike management at Spinney Mountain Reservoir is extremely interesting and sheds new light on previous held beliefs regarding mixed-management of the two species. The northern pike is an efficient top level predator that also has high fecundity (produces numerous offspring) under suitable environmental conditions. Spinney was never intended as another reservoir where we wanted to manage northern pike. Nevertheless, we have had to try and manage northern pike since they started showing up in substantial numbers 16 years ago. If a management biologist could design a reservoir to positively benefit a northern pike population on an annual basis, then Spinney Mountain Reservoir would fit in that category.

The large littoral area (shallow, less than 14 feet, aquatic vegetation zone) in Spinney provides ample spawning habitat for the northern pike every year despite water level fluctuations. Typically, Aurora draws the water level down during the winter months and into early June before starting to capture water from the S. Platte River and import trans-basin water through the Homestake Canal. This type of annual water level fluctuation would preclude consistent northern pike spawning/egg hatching success in impoundments where less shallow water areas exist. However, the northern pike in Spinney still have adequate spawning habitat available on a yearly basis. The need to find effective management strategies that maintain the trophy trout fishery while recognizing the persistence of the northern pike population are required.

Several studies have cited the ability of pike populations to control their own numbers through cannibalism (Mann 1982, Mauck and Coble 1971). Since this is a firmly entrenched belief in many management biologist's and angler's minds we feel the need to address this issue based on what we have seen at Spinney. We conducted a thorough literature search regarding pike population and food habit studies, yet failed to find a field population study in reservoirs where northern pike cannibalism made up over 1 percent of the diet. There was one study from an English river where other pike made up approximately 4 percent of the northern pike prey items (Mann 1982). Grimm and Klinge (1996) found that cannibalism was inhibited between December and May and during this period higher pike densities are tolerated. This inhibition period coincides with the period when the aquatic vegetation coverage is at its natural lowest level. The period lasts until after the spawning season. The inhibition protects pike that are forcibly concentrated within reduced vegetated areas in winter and on the spawning grounds. Unfortunately, this same inhibition does not apply to other prey fish resources except that pike metabolic rates are lower during the winter period as we will elaborate on later in this report.

We currently see a very similar situation in Spinney. Less than 1 percent of prey items in northern pike (24 inches or longer) were other northern pike in the 1999 and 2000 food habit analyses. This is despite the fact that no trout have been stocked since June 1999 at Spinney and the most abundant prey resource available to larger northern pike are smaller pike. The northern pike have turned in large part to other available prey resources (primarily invertebrates) and only some of the largest northern pike are

maintaining adequate body condition, because they can occasionally eat the remaining large (18 + inch) trout and suckers.

The overall pike population in Spinney is not only in poor condition, but the effects of stunting (slow growth) are already taking place. The tremendous surge in northern pike exceeding 26 inches through 1995 and beyond, coupled with the low harvest rate by anglers, set up the current fish community condition. However, northern pike research findings through the 1980s indicated that maintaining numbers of large pike in the fish community was a desirable option since big pike eat little pike. We continued to stock catchable, sub-catchable, and fingerling size rainbow and/or cutthroat trout through early June 1999. Additionally, fingerling brown trout were planted for the first time in many years in April 1999.

Unfortunately, the practice of stocking trout from ice-off in the spring through early summer fits in well with the rise in northern pike metabolism as the water temperatures warm (Figure 11). Large (25 + inch) pike require more pounds of fish flesh in their diet to maintain basic body condition than do smaller pike which can subsist on a higher proportion of invertebrates if necessary (Figure 12). In fact, the growth rates and size of pike reached by age 9 in Spinney in the early and mid-1990's, exceeded the highest growth rates and age 9 lengths recorded (Casselman 1996) for northern pike of similar ages from three continents!

However, an outstanding northern pike fishery was created at a unacceptable cost in hatchery trout resources. The statewide average price of raising a 5 inch sub-catchable trout is $0.40 each in CDOW fish hatcheries and these fish average 20 to the pound (personal communication with Tom Kingsley – Statewide Aquatic Database Manager – CDOW). Therefore, the cost of a hatchery produced pound of fingerling trout forage is $8.00. It takes 8 pounds of forage to produce a 20 inch northern pike and 120 pounds to produce a 40 inch northern pike (Figure 12). Therefore, the cost to raise a northern pike to 20 inches and 40 inches in Spinney is approximately $64.00 and $960.00 respectively per fish if trout are the primary forage base. Even though we continued to stock trout, the metabolic requirement of the burgeoning population of large pike has exceeded our hatchery trout allocation for Spinney.

The impact to the pike population has been dramatic. Relative weights for most of the northern pike in Spinney are low, and many of the largest (30+ inch) fish are in poor condition. We've seen a noticeable decline in pike growth rates since 1995 and we have not found any pike exceeding 12 years of age. This suggests that even if we eliminated all harvest at Spinney, the remaining northern pike population no longer has the available food resources to produce any northern pike larger than 30 inches before they die of old age.

Figure 11. Northern pike metabolic demand (grams prey/grams pike/day) by date in Spinney Mountain Reservoir.

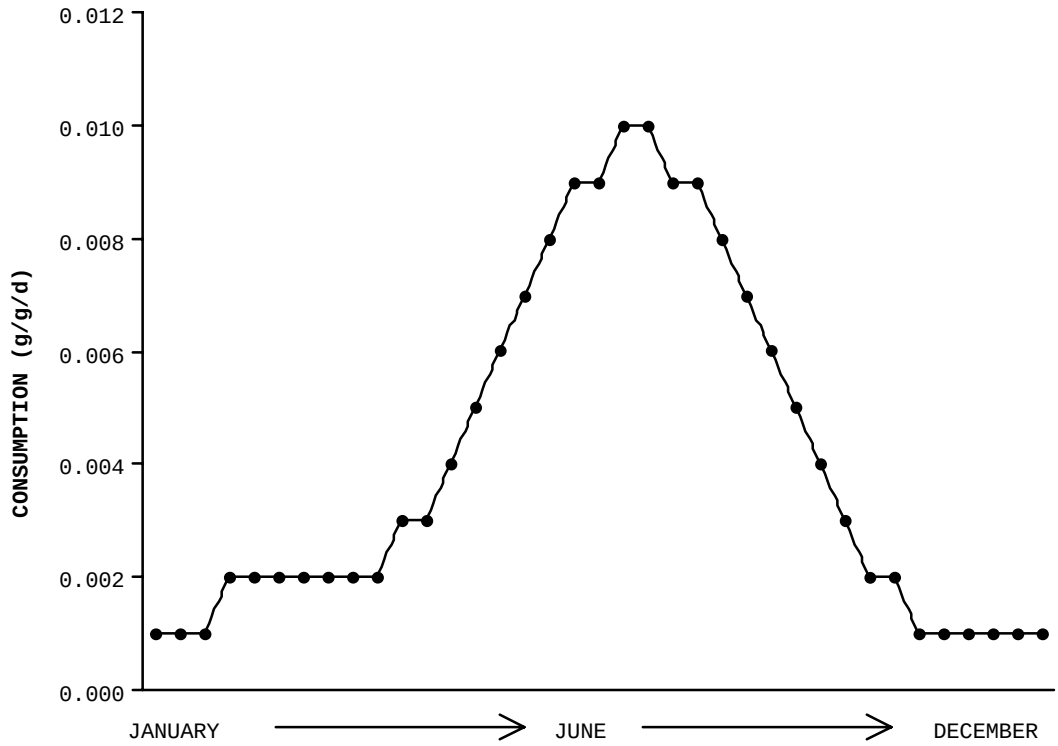
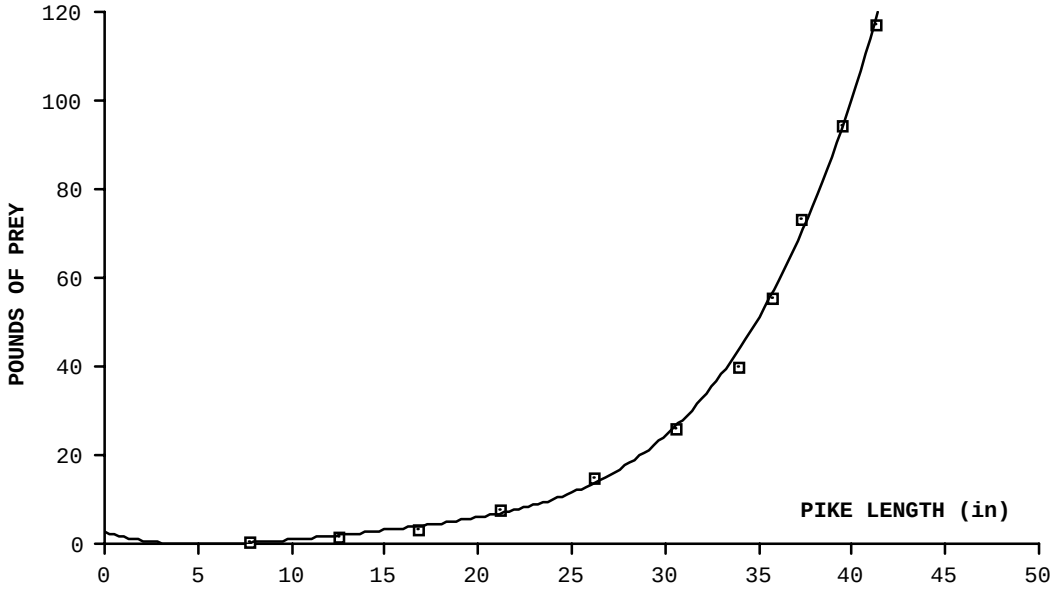


Figure 12. Requirement in pounds of prey to grow various sizes of pike in Spinney Mountain Reservoir.



Recently, new Whirling Disease (WD) Research information forced us to take a hard look where WD positive (whirling disease infected) and WD negative fish should be stocked. We decided that Spinney Mountain Reservoir should only be stocked for the foreseeable future with WD negative trout. Our supply of WD negative trout is substantially lower than what we had available prior to 1996 or even a year ago, especially catchable-size trout. Therefore, the necessity of reducing the number of pike in Spinney to a more manageable level is required to maintain the trophy trout fishery.

Other states, such as Minnesota and Wisconsin, have struggled with managing northern pike for years. Biologists have seen a general decline in northern pike sizes in Minnesota which may be attributed to historical increases in recreational fishing effort and few special fishing regulations (Pierce, R.B. and C.M. Tomcko 1995). Currently, Minnesota biologists are evaluating 33 experimental regulations including minimum, maximum and slot length limits and some catch and release fisheries for northern pike. Some of their preliminary information seems to indicate that "very good angler compliance, and very strong protective actions for large pike will be necessary to effectively change size structure {for pike} in Minnesota lakes" (Pierce and Tomcko 1998).

The evolution of northern pike population characteristics, dynamics, and management at Spinney Mountain Reservoir in the last decade provides an evaluation of very good angler compliance combined with strong protective actions for northern pike. The nature of the trophy trout fishery (flies and lures only, 1 trout bag and possession limit, minimum size 20 inches) meant that anglers already expected to release most of the fish they caught. Further, the majority of anglers (until recently) were fishing Spinney to catch trout and when they caught northern pike they typically released them. Therefore, when we set a protective slot-length limit (26 to 34 inches) for northern pike in 1993, angler compliance potential was already high. It took only two years for the northern pike population size structure to respond favorably by showing a dramatic increase in the number of pike exceeding 26 inches in length. When we lifted the protective slot limit and replaced it with a trophy pike regulation in 1996 (only 1 pike allowed over 34 inches in length) the northern pike population also contained numerous pike exceeding 30 inches. As seen in Figure 12, these larger pike require numerous large prey items (primarily fish) to maintain basic metabolic functions and even more to grow to trophy sizes.

Popular belief regarding management of northern pike is that 1) they are a top level predator that have the potential to control their own recruitment and 2) they exert top-down effects on the rest of the fish community. Our fish community and creel survey information from 1999 and 2000 at Spinney definitely supports the latter premise, but not the former. Spinney angler's size-selective nature for northern pike harvest mirrors that found in many states. Angler exploitation rates are much higher for pike exceeding 24 inches total length than for pike less than 24 inches (Table 3). This trend is heightened at Spinney because few anglers will keep a pike of any size despite our recent increased angler information/education efforts. Thus, we are faced with the realization that high

numbers of small pike will continue to perpetuate in Spinney for the foreseeable future.

Numerous studies show that northern pike populations are vulnerable to angler exploitation of large pike (Pierce, et.al. 1995, Pierce and Tomcko 1988, Beyerle 1978, Weithman and Anderson 1978). Studies have also shown the tendency for northern pike populations to over-populate and stunt (Diana 1987, Jacobson 1993). The number of large pike at Spinney appears to have declined since 1995 based on the 1999 and 2000 gill net data. Northern pike average annual growth rate has also declined during this period. The northern pike population is already exhibiting signs of stunting as their fish prey resources have disappeared (i.e. the reservoir is currently not being stocked with trout). Soon, northern pike growth potential in Spinney may result in few if any pike recruiting past 30 inches in length.

Herein may lie a solution to continue managing Spinney as a trophy trout fishery. The change in the pike population provides us with an opportunity to stock larger (12+ inch) trout to support the trophy trout fishery. Larger trout are less vulnerable to predation by smaller (less than 25 inches) northern pike. Mann (1985) found that in a put-and-take fishery for brown trout in the Avon River in England, removal of larger pike increased the numbers of age 1 and 2 year old pike. However, the stocked trout were too large to be eaten by the smaller pike and it was possible to stock fewer trout each year to maintain the fishery without a reduction in angler harvest.

Additionally, we can take advantage of low northern pike metabolic rates in the winter and stock the larger trout in the fall before ice cover occurs. It may require fewer large trout stocked each fall to continue supporting the trophy trout fishery than if we stock trout in the spring and summer when pike metabolism is high. We will still lose some trout to pike predation. However, trout stocked in the fall can grow up to 1 inch per month through the winter [unpublished Colorado Division of Wildlife (Anderson) trout growth rate data from Spinney Mountain and Eleven Mile Reservoirs 1988 and 1989]. There is good potential for a 12-inch trout stocked in the fall to reach 16 to 18 inches by ice-off in the spring. Even if an extremely conservative winter growth rate only yielded 15 inch trout by ice-off, these fish would only be vulnerable to pike exceeding 30 inches in length. Therefore, only the largest pike will be able to take advantage of the fall stocked trout, leaving the smaller (less than 25 inch) pike to continue to compete for available food resources. This may result in an abundance of smaller, stunted pike, but the few pike that grow large enough to consume large fish prey will be in better condition and grow to a size that is of interest to anglers.

We also considered introducing additional forage fish species to Spinney in an effort to decrease pike predation on trout. Fish species such as gizzard shad, spottail shiner, emerald shiner, fathead minnow and white sucker have been investigated. Also, we looked at introducing or increasing the allocation of sportfish species such as yellow perch, kokanee salmon and brown trout. The following section discusses the potential positive and negative benefits for various fish species introduced to Spinney Mountain Reservoir.

Gizzard Shad

Gizzard shad have been used successfully in many Colorado reservoirs to provide an additional fish forage base. Colorado is at the northern range where gizzard shad adults survive through the ice-covered season. We often see some proportion of adult gizzard shad die-off in each spring at reservoirs such as Cherry Creek. However, the remaining shad usually respond to this annual void by reproducing with great success. The result is an abundance of YOY shad available for a forage base each year.

Positive Attributes

- Suitable spawning habitat present.
- YOY shad are a potential source of prey for trout and pike.

Negative Attributes

- Direct competition with kokanee (both species eat zooplankton) and trout in Eleven Mile Reservoir when shad escape downstream.
- Adult shad do not transport well and we have had mixed success trying to establish new populations in some reservoirs.
- Prolonged ice cover period and colder water temperature regime annually at Spinney may result in ineffective introduction.
- May allow more pike to recruit past 25 inches in length.
- May displace available reservoir trout biomass potential (i.e. the fish bowl can only hold a finite number of fish).
- Adult shad can quickly reach sizes that preclude them from being eaten by all but the largest pike (i.e. a 3 year old shad can be 12 inches in length).
- Increases fish community complexity.
- No angling value as a sportfish.
- Must be trapped and transported from another source since they are not hatchery reared.
- Not likely to reproduce each year.

Spottail Shiner

Spottail shiners have been used as an additional forage fish species in Colorado reservoirs with some success. This species is one of the most widely ranging North American freshwater fishes. The adults rarely exceed 5 inches total length and they feed on a variety of insects, crustaceans and filamentous algae.

Positive Attributes

- Suitable spawning habitat present.
- May reproduce successfully each year.
- Provide a potential source of prey for trout and pike even at adult sizes.

Negative Attributes

- May allow more pike to recruit past 25 inches in length.
- May displace available reservoir trout biomass potential.
- May compete with trout for available food resources.

- Increases fish community complexity.
- May establish new populations downstream from Spinney.
- No angling value as a sportfish.
- Must be trapped and transported from another source since they are not hatchery reared.

Emerald Shiner

Emerald shiners have not been used in many Colorado reservoirs to date. Recently we introduced emerald shiner to Horsetooth Reservoir near Ft. Collins, CO and have only just begun the process of evaluating that introduction. This species is widely distributed in North America and the adults rarely exceed 4 inches total length. They eat a wide range of terrestrial and aquatic insects and crustaceans (including zooplankton).

Positive Attributes

- The same as spottail shiner.

Negative Attributes

- The same as spottail shiner, except they may also have a higher potential to compete with kokanee salmon at Eleven Mile Reservoir if they migrate downstream and establish a viable population.

Fathead Minnow

Fathead minnows are native to eastern Colorado but are found in many impoundments statewide because of their popularity as a bait minnow. Adults rarely exceed 4 inches total length and they are mostly herbivorous.

Positive Attributes

- Suitable spawning habitat present.
- Likely to reproduce successfully each year.
- Provide a potential source of prey for trout and pike even at adult sizes.
- Existing populations already upstream and downstream from Spinney Mountain Reservoir.
- Native to S. Platte River drainage in Colorado.

Negative Attributes

- May allow more pike to recruit past 25 inches in length.
- May displace available reservoir trout biomass potential.
- Increases fish community complexity.
- No angling value as a sportfish.
- Must be trapped and transported from another source since they are not hatchery reared.
- Difficult to establish viable population in a reservoir where predator species is already abundant.

White Sucker

White suckers are native to Colorado and the S. Platte River drainage. They were the principal prey species for northern pike in Spinney for many years. They spawn upstream in the spring and typically recruitment is high where predation impacts are low. The northern pike have effectively controlled white sucker recruitment at Spinney for many years and any suckers captured in the annual gill net samples are typically large adult fish. Sucker numbers increased in Spinney in past years when Antero Reservoir was drained and many white suckers migrated downstream. However, their numbers quickly dropped in subsequent years. The only way to significantly increase white sucker numbers in Spinney now would entail trapping them as adults during the spring from another reservoir (such as Antero) and transporting them to Spinney. This type of operation would be labor intensive and it is questionable whether or not the result would be favorable or result in long term benefits. That is, would we realize a significant increase in sucker recruitment to Spinney and/or reduction in pike predation on trout past the year of the sucker stocking operation.

Positive Attributes

- Suitable spawning habitat present.
- Likely to reproduce successfully each year.
- YOY provide a potential source of prey for trout and pike (also, large pike can also eat the adult suckers).
- Existing populations already upstream and downstream from Spinney Mountain Reservoir.
- Native to S. Platte River drainage in Colorado.

Negative Attributes

- May allow more pike to recruit past 25 inches in length.
- May displace available reservoir trout biomass potential.
- May compete with trout for available food resources.
- Increases fish community complexity.
- No angling value as a sportfish.
- Must be trapped and transported from another source since they are not hatchery reared.

Yellow Perch

Yellow perch are often found in fish communities with northern pike, particularly in the mid-western U.S. and Canada. Yellow perch have also been documented as a prey item in numerous studies (Mauck and Coble. 1971, Engstrom-Heg et al. 1986.) They are also in Eleven Mile, Cheesman and Chatfield Reservoirs so introducing them in Spinney would not inadvertently allow them to establish new reservoir populations downstream. Yellow perch are known to directly compete with trout for available food resources and can quickly out-compete trout populations in reservoir communities (Galbraith 1967, unpublished CDOW data from Lake John in early 1990s, N. Park, Colorado; personal communication with Gary Wheelan, Michigan Department of Natural Resources 1993). Yellow perch have been present in Eleven Mile Reservoir since 1983 and they have yet

to show any significant population increase. However, they are providing an additional forage option for pike there even though we have not found any in the pike stomach samples.

Positive Attributes
- Suitable spawning habitat is present.
- YOY and adults may provide additional forage item for trout and pike.
- May provide additional sportfish species for anglers to catch.

Negative Attributes
- Directly competes for same prey resources as trout.
- May allow more pike to recruit past 25 inches in length.
- Increases fish community complexity.
- May displace available reservoir trout biomass potential.
- Must be trapped and transported from another source since they are not hatchery reared.
- Will utilize small trout as prey base.

Kokanee Salmon

Kokanee salmon are a popular sportfish species and are found in select mountain impoundments in Colorado. They grow rapidly and mature at 3 to 4 years of age, then they attempt to return and spawn in rivers or littoral reservoir areas where they were born. Young kokanee are stocked annually to support their populations since natural recruitment is low to non-existent in most waters. Young and sub-adult kokanee are a potential prey resource for top level predators such as pike and lake trout. Kokanee feed primarily on zooplankton and other aquatic insects/crustaceans throughout all life stages.

Positive Attributes
- YOY and sub-adults may provide a potential source of prey for trout and pike.
- Existing populations already downstream from Spinney Mountain Reservoir.
- Popular sportfish species.
- Pelagic species, competition minimized, as is exposure to pike predation.

Negative Attributes
- Must be annually stocked to support population.
- Currently low numbers of available kokanee for stocking Colorado reservoirs, so allocating kokanee for Spinney would be low priority.
- Increases fish community complexity.
- May compete with trout for available food resources.
- May allow more pike to recruit past 25 inches in length.
- May displace available reservoir trout biomass potential.

Brown Trout

Brown trout are a valuable sportfish species across much of Colorado's mountain region. They maintain self-sustaining populations in most streams and rivers where they are found and anglers enjoy catching brown trout. However, unless regularly stocked, they typically do not develop high numbers in lakes and reservoirs (this is also true for other trout species such as rainbow, cutthroat, etc.) Brown trout exist in Spinney in low numbers and 45,000 3-inch brown trout were stocked in Spinney in April 1999. Some of these fish survived to become 15 to 18 inch brown trout by spring 2000 when they were sampled by our gill nets and anglers reported them in the catch during the creel survey. We had also stocked 45,000 3-inch rainbow trout in April 1999. None of these fish were sampled in our gill nets and very few rainbow trout less than 18 inches were reported during the creel survey.

Brown trout may have a better chance at recruiting past pike predation in Spinney than smaller rainbow trout. The specific mechanisms for why brown trout may survive pike predation impacts in Spinney better than rainbow trout are not well understood. However, we speculate that the brown trout may be selectively using different habitat as sub-adults and adult brown trout tend to be more active from dawn to dusk when sight-oriented predators, like northern pike, are at a disadvantage. These attributes may enhance brown trout survival in Spinney. Since we do not raise brown trout past 5 inches in length in the hatcheries, it would be more prudent to stock brown trout late in the fall at the largest possible size when pike metabolic requirements are dropping off. There are additional benefits to enhancing the brown trout fishery in Spinney. Large (14+ inch) brown trout are increasingly piscivorous and may play an active role in feeding on small northern pike. Also, adult brown trout ascend the S. Platte River in the fall to spawn upstream in the mainstem, S. Fork and Middle Fork river segments. Since increasing the number of brown trout in Antero Reservoir, we have seen a dramatic increase in the number of adult brown trout in our fall electrofishing samples in the S. Fork, S. Platte River above Antero.

Positive Attributes

- YOY and sub-adults may provide a potential source of prey for other trout and pike.
- Existing populations already established.
- Popular sportfish species.
- Adults may prey on northern pike.
- May have better recruitment past northern pike predation than other trout species.

Negative Attributes

- Must be annually stocked to support population.
- Increases fish community complexity.
- May compete with other trout species for available food resources.
- May allow more pike to recruit past 25 inches in length.
- May displace available reservoir biomass potential for other trout species.

Conclusions

We have documented the evolution of northern pike and trout interactions at Spinney Mountain Reservoir since 1983. We have learned that the tendency for trout or pike anglers to harvest northern pike (especially pike less than 24 inches in length) is low. We have documented what happens to a trout population in the presence of elevated numbers of larger pike, and we have proved that northern pike do not control their own numbers very efficiently. We are faced with some tough management choices and some of the alternatives are theoretical and the results remain to be tested.

Our ability to enhance and maintain a trophy trout fishery at Spinney is limited by the presence of the self-sustaining northern pike population. However, the majority of anglers wish for us to continue managing for the trophy trout option. We feel that our best chance lies in stocking larger rainbow and/or cutthroat trout in the fall. This option allows us to stock "over-the-top" of the smaller northern pike and at a time when lower northern pike metabolism reduces their predation impact on trout. A higher proportion of the fall (as opposed to spring) stocked trout should survive and become available to anglers in the spring and angler catch rate for trout should increase.

Bioenergetics models show that increasing the availability of smaller prey fish may well allow more small pike to recruit to large size where they greatly impact the trout population. Brown trout sub-catchables have exhibited a higher propensity to survive and recruit to larger sizes at Spinney than rainbow sub-catchable size trout. A strategy that would involve increasing the number of brown trout stocked at Spinney may lead to increased growth of smaller pike. This is the case with introducing additional forage fish too. To adequately study the efficacy of using larger rainbow and/or cutthroat trout stocked in the fall, we must try it as a stand-alone option. The same case applies if we want to stock additional brown trout, then we should investigate that alternative by itself. In either instance trout will be marked before they are planted to allow tracking these fish to larger sizes and for growth rate comparisons.

Fish community assessments and characteristics will continue to be documented at Spinney Mountain Reservoir. Public input will be welcomed and angler education/information efforts will continue regarding management of this valuable sport-fishery. As information is collected regarding the success of selected management alternative(s), the anglers who enjoy fishing Spinney Mountain Reservoir will continue to be informed of those results.

Management Alternatives

Alternative 1 - No Change

- Do not stock Spinney with trout.
- Allow existing northern pike population to subsist on available food resources.

Alternative 1 means that we stop managing Spinney Mountain Reservoir with stocked trout. We did not stock any trout at Spinney in 2000 and under Alternative 1 we would continue with this management strategy. The remaining large trout would eventually

succumb to old age or other mortality factors (i.e. angler harvest, catch and release stress induced mortality, spawning stress related mortality, etc.). Eventually, the trout populations (brown, rainbow, cutthroat, etc.) would decline to levels that would not support angler interest.

The northern pike population would continue to stunt as available prey resources diminished. Few pike would live long enough to recruit to sizes of interest to anglers (30 + inches). Eventually, the Spinney Mountain Reservoir fish community would consist primarily of numerous small pike and very few trout.

Alternative 2 - Manage for Trophy Trout Fishery

- Stock larger (12 inch) rainbow and/or cutthroat trout, and/or rainbow X cutthroat trout hybrids in late fall.
- Continue angler education efforts to emphasize harvest on northern pike.
- Continue with selective pike removal sampling efforts.

Alternative 2 means that we would continue managing Spinney Mountain Reservoir as a Trophy Trout Fishery. We would stock large trout in late fall when northern pike metabolic rates a low and the impact from pike predation would be reduced. The large trout would not be as vulnerable to pike less than 25 inches in length, and larger pike would not consume as many trout if we were to stock trout in the spring. Many of the small pike would be deprived of extra prey resources that would allow them to grow to large size. The trout stocked in late fall would continue to grow throughout the winter and many would reach sizes by spring that would make them vulnerable to only the largest remaining pike.

We would continue to emphasize angler harvest on northern pike through signs, information handouts, and pike angling tournaments/seminars similar to the Pike Festival held in July 2000.

We would continue to use short-term gill net sampling in the spring to remove additional adult northern pike as time and personnel resources permitted. These adult pike would be transported to selected east slope waters. We would not employ trap nets or electrofishing gear since the return on pike per effort expended was very low in 2000.

We would construct a live-cage holding facility at Spinney Mountain Reservoir where anglers could drop off northern pike that they caught but did not want to harvest or release back to the reservoir. We feel that this may improve the percentage of pike removed by anglers willing to harvest pike but not inclined to keep pike less than 20 inches in length. Periodically we would transport these northern pike to selected east slope waters throughout the angling season. The live cage holding facility would be removed at the end of October each year. It is unlikely that the number of small pike removed by anglers would alter the size structure of the northern pike population over time. However, the pike deposited in the holding facility would provide us a reliable source of small pike to transport to selected east

slope waters. There are several eastern plains reservoirs in Colorado where we could use northern pike to help control non-sportfish species such as white sucker, river carpsucker and common carp.

Alternative 3 - Manage for Brown Trout Fishery

- Increase stocking of sub-catchable size (5 inch) brown trout in late fall.
- Continue angler education efforts to emphasize harvest on northern pike.
- Continue with selective pike removal sampling efforts.

Alternative 3 means that we would emphasize enhancement and maintenance of a brown trout fishery at Spinney Mountain Reservoir. We would stock sub-catchable size (since we do not culture catchable-size brown trout) brown trout in the late fall each year. A certain proportion of the brown trout would fall prey to northern pike, but the level of predation impact would be reduced due to lower northern pike metabolic rates through the winter. We feel that sub-catchable size brown trout stocked in 1999 exhibited a higher potential for recruiting to large size than did similar numbers and sizes of rainbow trout. More mid-size (14 to 20-inch) brown trout showed up in our fish community and creel surveys than similar size rainbow and cutthroat trout.

This management option may provide enough additional forage to allow more pike to recruit to sizes greater than 25 inches. Large pike consume an increasing amount of fish as they grow. Thus, this management option may preclude using large (valuable) rainbow and /or cutthroat trout stocked in the fall because more of these large trout would succumb to pike predation if numbers of large pike increased.

We would continue with northern pike angler harvest information/education and manual removal efforts as discussed under Alternative 2.

Alternative 4 – Introduce Additional Forage Fish Species

- Introduce one or more of the forage fish species discussed in earlier in this management plan.

Alternative 4 means that we try to establish one or more additional fish species in Spinney Mountain Reservoir in an effort to provide additional prey resources for pike and/or trout and/or increase sportfish angling opportunity. Pros and cons were discussed for each species. In general, any successful introduction for any of the species discussed may increase the number of northern pike able to grow past 25 inches in length. We have seen in the past at Spinney that during years when sucker numbers were high, trout numbers were higher too. This suggests that additional forage may allow more trout to escape predation by northern pike. However, trout are high on the preferred prey-item list for northern pike. If we continue to support recruitment of small northern pike to larger sizes we can expect the trout fishery to suffer.

The ramifications of introducing a new fish species to Spinney may be positive, negative or not understood. It is unlikely that we would be able to get any of these forage fish species established in the face of current pike predation potential. A good example is

the presence of yellow perch in Eleven Mile Reservoir. After showing up in our sampling gear in the early 1980s from an unknown source, yellow perch have never contributed significantly to the sport fishery and we do not know how much they are utilized as an alternate prey resource by northern pike or other fish species in Eleven Mile. One of the positive aspects of the fish community at Spinney is that it is relatively simple, that is, there are essentially trout, pike and some suckers. The more species that we add to the mix the more complex the management strategies to successfully maintain a sport fishery desirable to the anglers. Also, the majority of anglers still want us to try and manage Spinney as a trophy trout fishery. Introducing more fish species may complicate this objective by enhancing the ability of northern pike to recruit to sizes beyond 25 inches in length.

Preferred Management Alternative

Our preferred management option is Alternative 2 – Manage for a Trophy Trout Fishery. Currently, we have an advantage over the northern pike population because they are already beginning to stunt and their growth is slowing down. We also know that larger northern pike in the population are vulnerable to exploitation by anglers. We feel that continued removal of large northern pike combined with stunting of small pike will allow us to stock "over-the-top" of the remaining pike with large trout in the late fall.

We feel that Alternative 2 offers some very positive benefits for the Spinney Mountain Reservoir trout fishery:

- The majority of the small pike will stay small,
- Anglers will still catch the occasional large pike (in good condition),
- Angler catch rate of mid-range size (14 to 20-inch) rainbow and/or cutthroat trout should increase,
- The catch rate of trophy size (20+ inch) rainbow and cutthroat trout should increase,
- This option coincides with the majority of angler's wishes.

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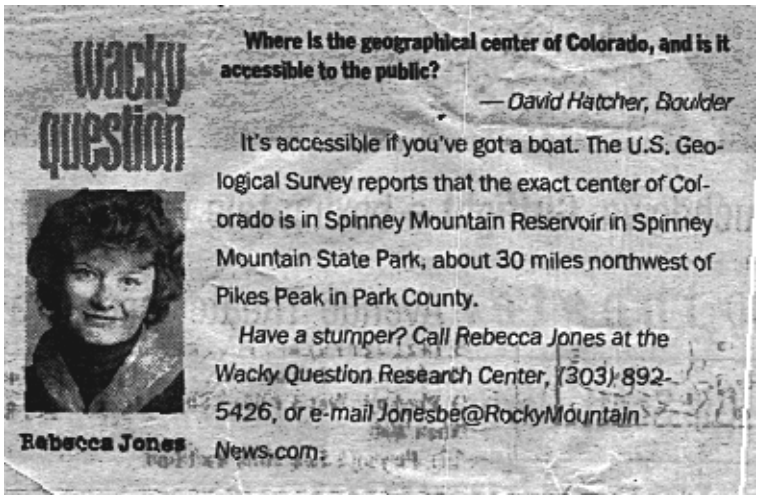

wacky question

Rebecca Jones

Where is the geographical center of Colorado, and is it accessible to the public?

— David Hatcher, Boulder

It's accessible if you've got a boat. The U.S. Geological Survey reports that the exact center of Colorado is in Spinney Mountain Reservoir in Spinney Mountain State Park, about 30 miles northwest of Pikes Peak in Park County.

Have a stumper? Call Rebecca Jones at the Wacky Question Research Center, (303) 892-5426, or e-mail Jonesbe@RockyMountainNews.com.