Bluewater Reservoir

Historical Perspective

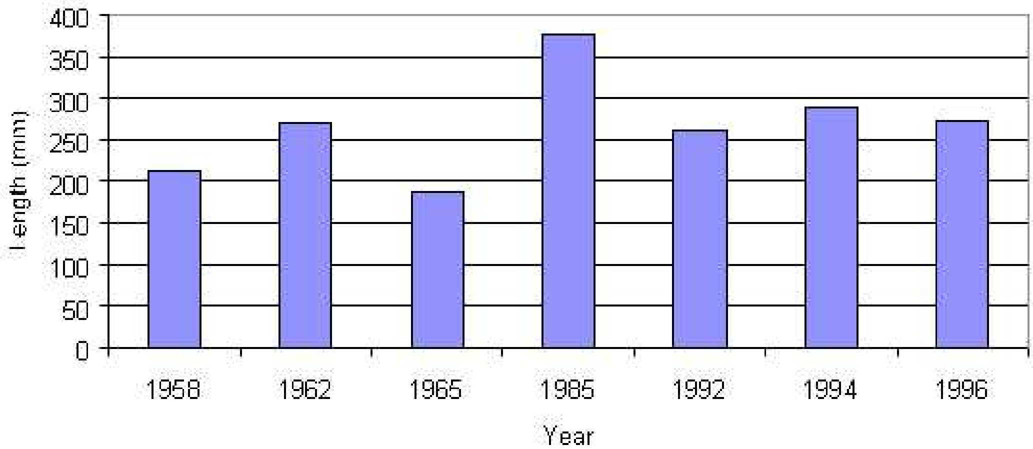
Past Management: Bluewater Reservoir is located in Cibola and Mckinley counties near Thoreau, New Mexico (Figure 1). The topographic location of the lake is T12N R12W Sec 5,8 and T13N R12W Sec 31,32 (Thoreau Quadrangle); the latitude and longitude of the lake is: Lat. 35 degrees 17' 31" N, Long. 108 degrees 6' 40"W. The reservoir was impounded in 1927. It averages approximately 1,500 surface acres in size with a maximum pool of 3,021 surface acres. An agreement between the State Game Commission and the Bluewater Toltec Irrigation District (BTID) (1948) established a permanent storage pool of approximately 320 surface acres. The BTID operates the dam and controls the water levels above the minimum pool level of 320 surface acres. The State Engineer's Office conducts occasional inspections of the dam for safety reasons (*Bluewater Reservoir Long Range Plan 2002*).

The Department of Game and Fish-NMDGF has managed Bluewater Reservoir as a put, grow, and take rainbow trout fishery since the 1950's. Current management involves stocking 415,000 fingerling rainbow trout annually. Warm water species have also been a component of the fishery in the reservoir. In 1955 Department surveys documented black crappie-(p*oxomus nigromaculatus*), yellow perch-(p*erca flavescens*), largemouth bass, and sunfish-(l*epomis* spp.) (Huntington 1956). Fingerling channel catfish-have been stocked on a routine basis since the early 1980's. By the 1990's the only game species documented in the reservoir were rainbow trout and channel catfish (Akroyd 1995). Approximately 40,000 three-inch size largemouth bass were stocked into Bluewater Reservoir in 2000. Two of these fish were recaptured during a spring 2001 survey, and 6 during a 2002 survey (*Bluewater Reservoir Long Range Plan 2002*).

Non-game Fish Population Trends (*Thru 2002*): White suckers are prolific in this reservoir. In addition, reproducing goldfish have also become established. Historically, Department biologists have implicated sucker populations for poor rainbow trout growth and creel return. Chemical eradication projects occurred in 1955, 1968, 1973, and 1977 (Hunting 1956, Thorne 1978, NMDGF unpublished data). Before each treatment (with the exception of 1973, a spot treatment) white suckers comprised more than 85% of fish sampled via gill nets. Following treatments white suckers comprised less than 5% of catch. Complete eradication of white suckers was not accomplished from any of these projects, and sucker catch for 5 to 7 years following treatments was about 25-35% using gill nets. An electrofishing survey of Bluewater Reservoir in the spring of 2001 yielded large numbers of white suckers (801.74/hour catch per unit effort or CPUE) and a number of goldfish (NMDGF unpubl. data). In 2002, an estimated 1,000 pounds comprising approximately 2000 goldfish and 2000 white suckers were removed from Bluewater Reservoir by electrofishing. Also in 2002, a fall gill-net survey was conducted which yielded a large number of white suckers and goldfish, with very few rainbow trout (*Bluewater Reservoir Long Range Plan 2002*).

Rainbow Trout Average Size Trends: Following past eradication projects, salmonid species have been stocked as fingerlings into Bluewater Reservoir. Rainbow trout have been the most commonly stocked species. Growth was estimated to be 1.6 cm per month during the summer of 1950 (NMDGF 1951), and in 1977 the rate was similar (Parrish 1977). Average lengths of rainbow trout sampled by Department personnel are noted in Figure 1. Past chemical treatments that reduced populations of white suckers have seemingly been beneficial for rainbow trout. The average rainbow trout length went from 14.8 inches in 1985 to 11.4 inches in 1994, and finally to 10.8 inches in 1996 (Kelly 1985; Hall 1994; Cassidy 1996). All fish were stocked at three (3) inches during the period of this decline in average length. Variability in stocking size can, therefore, be ruled out as a contributor to the size decline. Additional salmonid species were stocked following eradication projects including coho salmon (*Oncorhynchos kisutch*) and cutthroat trout (*Oncorhynchos clarkii*). Coho salmon stocking was not effective in establishing a fishery for this species (Thorne 1979). Cutthroat were only stocked occasionally in Bluewater Reservoir. A sustained cutthroat trout fishery for was never fully explored (*Bluewater Reservoir Long Range Plan 2002*).

Figure 1. Rainbow Trout Average Size Trends (1958-1996).



Bluewater Reservoir is currently about 900 surface acres in size, and located about 20 miles southwest of Grants, NM. It is designated and has historically been managed a “Put, Grow, and Take” water. However, due to recent fish health issues, many NM hatcheries have not been able to grow and stock fingerling rainbow trout (O*ncorhynchus mykiss*), because of the focus was shifted to stocking catchable size rainbow trout. The Length-Frequency analysis and CPUE for rainbow trout is something that will be discussed further in the final Grant summary. It’s unknown exactly why the CPUE has dropped so dramatically for rainbow trout from 2002-2006, but the inability to stock the required number of rainbow trout over the years can likely be a large contributing factor. Channel catfish (*Ictalurus punctatus*) also occur in Bluewater reservoir, along some largemouth bass which were stocked in 2000. In an effort to decrease non-game fish numbers, tiger muskellunge (*Esox lucius x Esox masquinongy*) have been stocked every year since 2003 .

Fall Surveys (2002-2006)

9/28-9/30, 2002

9/27-9/28, 2004

10/2-10/3, 2005

10/2-10/3. 2006

Fall surveys were conducted according to Department Protocol described as follows:

Fall Survey Protocol

Purpose: NMDGF collects fish community data from large reservoirs in order to monitor changes in the sport fishery and assess the long term effects of management strategies.

Timing: Lakes will be surveyed in the Fall when water temperatures are between 5 C and 18 C. Our intention is to target waters when capture mortality can be minimized, but fish are still actively moving within the lake.

Scheduling: Waters will be prioritized as noted in Figure 1. Prioritization is based upon expected community composition and stability, reservoir operations, and angler use. High Priority waters will be surveyed on average once per two years; Moderate Priority waters will be surveyed on average once per four years; Low Priority Waters will be surveyed on average once per eight years.

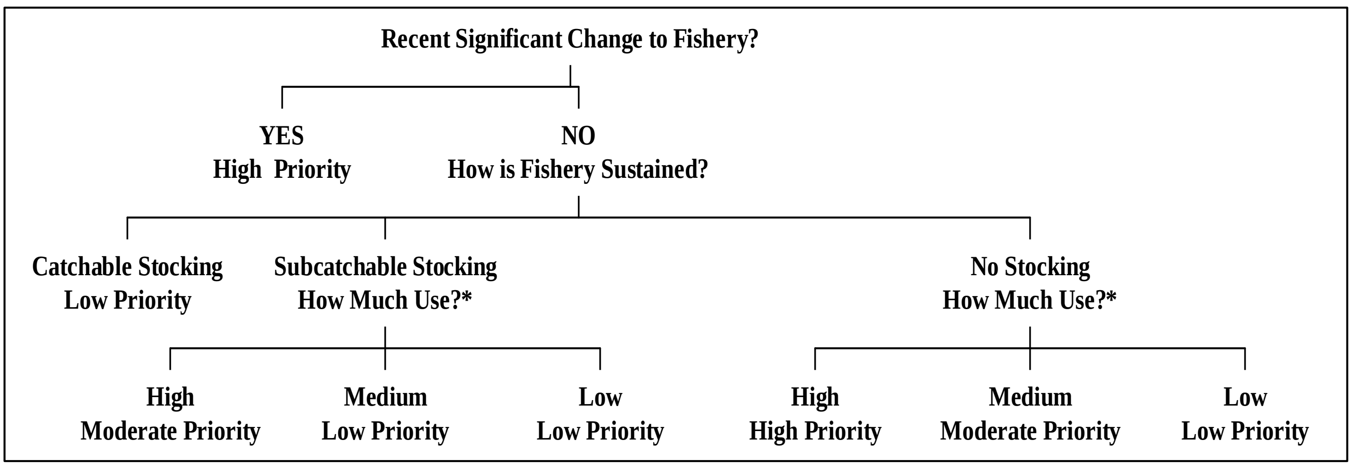


Figure 1. Prioritization flow chart for scheduling fall fish community surveys. Water body will be ranked within Area as High Use, Moderate Use, or Low Use based on off-site angler survey data.

Field Procedures-

Surveys will be conducted using a combination of nets and electrofishing. Electrofishing sites will be separate from netting sites by at least 300 m to reduce interactions between capture methods. Number of sample sites will vary by lake area (Table 1).

Table 1. Specified number of sample sites for fall fish community monitoring surveys.

Lake Size	Number of Gill Net Sets	Number of Fyke Net Sets	Number of Electrofishing Sites
<200 ha	2	2*	2
200-400 ha	3	3	3
400-800 ha	4	4	4
800-1600 ha	6	6	6
>1600 ha	9	6	9

***** Fyke nets optional at impoundments <40 ha.

<u>Sample Locations</u>

Due to the likelihood of varying water conditions in New Mexico Reservoirs, sample sites will be selected randomly each year. The suggested randomization procedure follows: Identify the northernmost, southernmost, easternmost, and westernmost portions of the lake to be sampled. Using these points, determine the Eastings that identify the eastern and western boundaries of the survey area and the Northings that identify the northern and southern boundaries of the survey area (you should end up with a "box" delimited by these UTM coordinates). Using MS Excel, or similar product, generate random UTM Eastings and Northings within the "box." Be sure to use a different random number seed for the Easthings and the Northings. Select 2-4 more random locations than you need for the survey (e.g., if you are surveying 3 sites, select 5 points). Using a GIS program (e.g., MapSource), locate the random points on a map. Select the random points closest to a shoreline, and at least 500 m from another point, and sample the portion of shoreline closest to the random point selected.

<u>Net Sets</u>

Gill nets will be set as a compliment (Fig. 2). Three, 5-panel experimental 38 m gill nets (bar mesh: 2.54 cm, 3.81cm, 5.08 cm, 6.35 cm, and 7.62 cm) will be set at each sample site. One net will be a floating set in at least 6 m of water, one net will be a sinking set in at least 6 m of water, the other gill net will be set littorally with one end attached at the shore (Fig. 2). The size mesh closest to shore will be randomly selected through a coin toss. The floating and sinking gill net sets will be between 100 and 250 m of the littoral gill net set. If survey crew is unable to locate water depths of 6 m within 250 m of the littoral gill net set, the sinking net will be omitted from the compliment. Sample time will be one net night per sample site. Nets will be set within 2 hours of sunset and will be run within 3 hours of sunrise.

A Fyke net will be set at each survey site, except at the largest reservoirs (Table 1). In the largest reservoirs, the 6 Fyke nets will be randomly assigned within the 9 survey sites. Fyke nets will only be set if bottom conditions allow the net to be set properly (e.g., no vertical sets). Fyke nets will be set perpendicular to the shore with the lead attached securely to an object on shore. Distance from shore will be dependent on water depth. The first hoop will be between 0 and 0.75 m underwater. Fyke nets will be placed 300 m to 500 m from the littoral gill net set to reduce capture interference. Nets will be set for a minimum of 36 hours and a maximum of 48 hours.

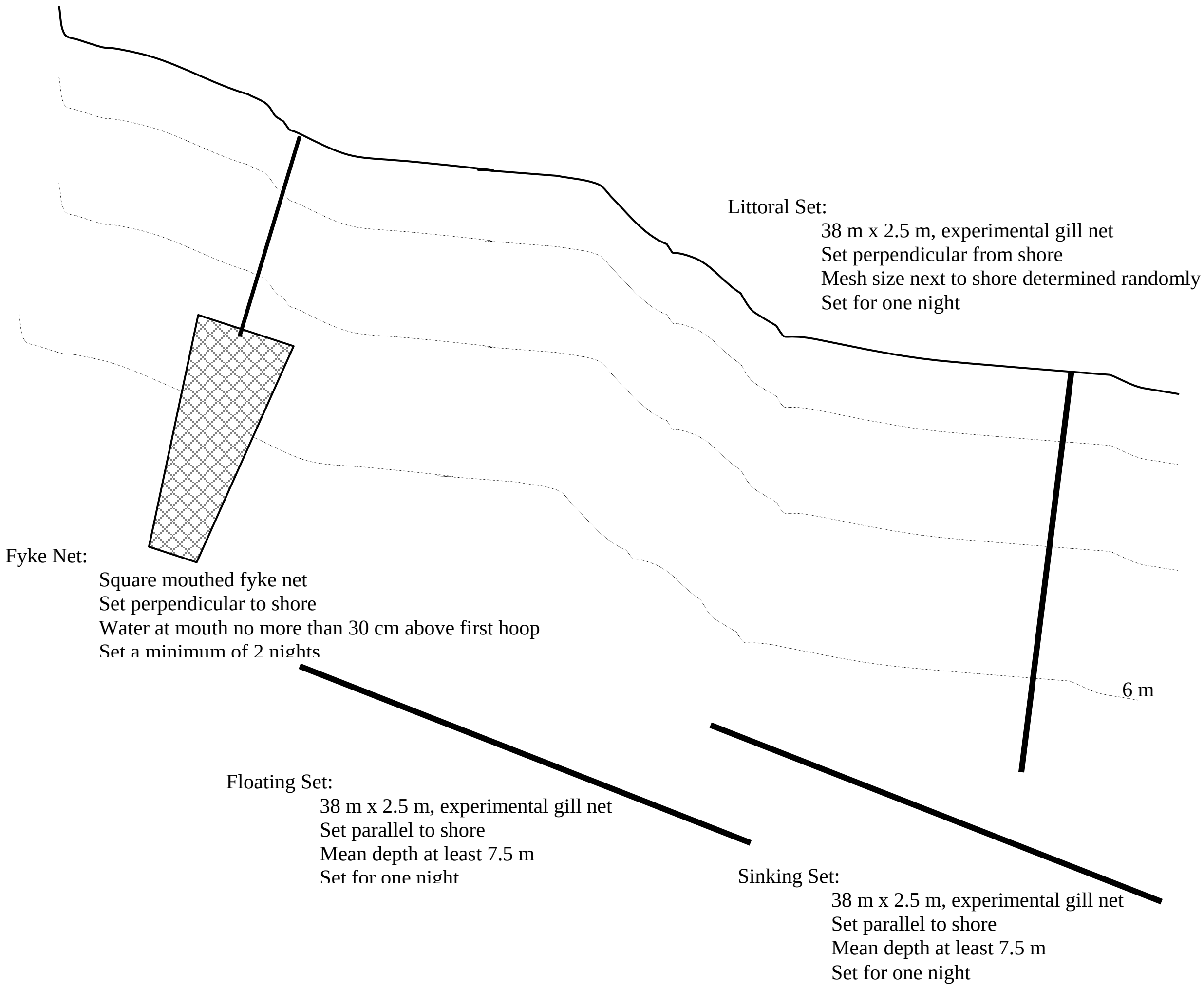


Figure 2. Schematic representation of net compliment set at a hypothetical sample site.

Electrofishing

Boat-electrofishing will be conducted in coordination with the netting surveys. Electrofishing surveys will be conducted more or less parallel to the shore in a "clockwise" direction. The starting point will be approximately 300 meters from the last net set at a survey site and will not be conducted within the net set.

Fish are collected using a percent of the low range setting, 50-500 volts, 6-10 amps, 30–60 pulse DC, depending on size of target fish and water conductivity. For fall fish community surveys we will use 60 pulse, DC. In low conductivity waters 2 amps may be sufficient, while in higher conductivity waters the amperage may have to be adjusted to 13 amps. The crew leader needs to observe how the fish are reacting to the applied electrical field and adjust accordingly. The goal is to adjust the strength of the field to just momentarily stun the fish, keeping injury of the fish to a minimum.

Fishing time will be 600 seconds per survey site. All fish stunned in the electrical field will be netted. Netters should consciously sample all sizes of fish encountered. The objective of the electrofishing portion of the sampling regime is to capture fish too small for the nets, and fish less likely to be captured in nets due to behavioral tendencies.

Data Collection and Management

Site Data

The following data will be recorded for each survey site: UTM coordinates (NAD 27), lake sampled, water temperature (C), salinity (mmhos?), dissolved oxygen (ppm), pH, and secchi depth (m). For each net set the date and time the net was set and run will be recorded. For electrofishing runs, the date and time the pass began, as well as the seconds shocked, will be recorded.

Fish Processing

All fish captured will be speciated and enumerated. Type of capture will be noted (i.e. Fyke net, sinking net, floating net, littoral net, and electrofishing). Lengths (mm) and weights (gm) will be taken from a minimum of 100 fish per species. Otoliths will be removed from moralities for aging. Scales will be taken from a minimum of 50 fish per game species, other species may also be aged depending on management needs. Fish will be processed and released in an area that will not conflict with survey sites.

Data Handling

Data will be recorded on data sheets. Data will be transferred to an MS Access database resident on the Department's Intranet. Data will be archived in this database for the use of all our fisheries managers. Primary analysis can be accomplished using this database.

Fall Survey Metrics

Community Composition

All survey data will be used to calculate community composition metrics. A species list will be composed. Percent of capture by species will be presented. Percent of captured biomass by species will be presented. Managers may further amalgamate results by presenting percent of community composed of top predators and/or desirable game fish.

Abundance

Abundance data will be presented in a number of formats. Catch Per Unit Effort (CPUE) will be calculated for gill nets, fyke nets, and electrofishing separately. CPUE will be reported as number caught per hour and per net night (where relevant). Gill net capture will be reported on an individual net basis and on a "compliment" basis (i.e. all three gill nets of a compliment considered as one capture instrument). Confidence intervals at both the 80% and 95% level will be calculated for all CPUE's reported.

Species Specific Metrics

Mean lengths (mm) and weights (gm) will be reported with 80% and 95% confidence intervals. Relative weights (Wr) will be calculated for all species with a published standard weight equation and mean Wr will be reported with 80% and 95% confidence interval (Wege and Anderson 1978, Anderson 1980). For those species with greater than 30 captures length frequency histograms will be created. Proportional Stock Densities (PSD) and Relative Stock Densities (RSD) will be calculated for all species with published length categories and more than 10 captures (Anderson 1976, Anderson 1978, Gablehouse 1984).

Survival and Growth Metrics

Aging structures will be used to determine survival and growth in species of interest. von Bertalanffy (1938) growth equations will be estimated with the assistance of FAST software (Slipke and Maceina 2001). Survival will be calculated using catch curve (Ricker 1975) analysis with the assistance of FAST software, or general statistical softeware (e.g., SPSS [1999]).

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Wege, G.J., and R.O. Anderson. 1978. Relative weight (Wr): a new index of condition for largemouth bass. Pp. 79-91 <u>in</u> G.D. Novinger and J.G. Dillard, Eds. New approaches to the management of small impoundments. North Central Division, American Fisheries Society, Special Publication No. 5, Bethesda, MD.

Bluewater Reservoir is currently about 900 surface acres in size, and located about 20 miles southwest of Grants, NM. It is designated and has historically been managed a “Put, Grow, and Take” water. However, due to recent fish health issues, many NM hatcheries have not been able to grow and stock fingerling rainbow trout (O*ncorhynchus mykiss*), because of the focus was shifted to stocking catchable size rainbow trout. The Length-Frequency analysis and CPUE for rainbow trout is something that will be discussed further in this Grant summary. It’s unknown exactly why the CPUE has dropped so dramatically for rainbow trout from 2002-2006, but the inability to stock fingerling rainbow trout over the last five years can be a large contributing factor. Channel catfish (*Ictalurus punctatus*) also occur in Bluewater reservoir, along some largemouth bass which were stocked in 2000. In an effort to decrease non-game fish numbers, tiger muskellunge (*Esox lucius x Esox masquinongy*) have been stocked every year since 2003.

Table 1. Community structure broken down by year (2002-2006)

		2002		2004		2005	
Species Name	Common Name	% Captured	% Biomass	% Captured	% Biomass	% Captured	% Biomass
Oncorhynchus mykiss	Rainbow Trout	9.63	9.33	8.09	4.29	48.64	24.16
Esox lucius x Esox masquinongy	Tiger Muskellunge			8.74	20.19	4.86	23.17
Carassius auratus	Goldfish	19.26	17.82	2.59	1.72	3.01	3.52
Catostomas commersoni	White sucker	62.96	57.92	76.05	65.87	42.82	45.57
Ictalurus punctatus	Channel catfish	5.93	12.69	3.24	4.95	.69	3.57
Micropterus salmoides	Largemouth bass	.74	1.84	1.29	2.98		
Notemigonus crysoleucus	Golden shiner	1.48	.39				
		2006					
Species Name	Common Name	% Captured	% Biomass	% Captured	% Biomass	% Captured	% Biomass
Oncorhynchus mykiss	Rainbow Trout	.94	.18				
Esox lucius x Esox masquinongy	Tiger Muskellunge	44.13	80.16				
Carassius auratus	Goldfish	4.69	1.36				
Catostomas commersoni	White sucker	47.42	15.83				
Ictalurus punctatus	Channel catfish	2.35	2.44				
Micropterus salmoides	Largemouth bass						
Notemigonus crysoleucus	Golden shiner	.47	.03				

Table 1 illustrates the total species composition representing total fall gill net surveys conducted at Bluewater reservoir from 2002-2006. The species are broken down by year into percent of catch and percent biomass. As discussed in the background information, white suckers and goldfish have historically been demonstrated as quite prolific, comprising much of the surveys composition. In fact, white suckers comprise the vast majority of total species caught (47.31% yearly average), and until 2006 comprised the bulk of total biomass. The trend over the years shows a modest decrease in the number of white suckers caught, and a large decrease in biomass composition. This sharp decrease can surely be attributed to the biomass “dominance” of Tiger muskellunge.

Goldfish once represented as much as 19.26% of the total in 2002. The trend has shown a rather sharp decrease as early as 2004, dropping to 2.59% of the total catch. The 2006 results show a slight increase in goldfish survey composition, rising to 4.69% of the total catch.

Tiger muskellunge were first stocked into Bluewater in 2003. They have been stocked as fry in Spring (average 100,000 per year) and fingerlings (average 5,000 per year) in the Fall each of the last three years.

They were represented in the fall surveys as early as 2004, comprising 8.74% of the total catch. In 2006, Tiger muskellunge comprised 44.16% of the total catch, and dominated the biomass percentage, comprising 80.16% (consisting of 94 specimens with an average weight of 2,494.90 grams).

Rainbow trout comprised an average of 6.22% of the total catch when considering survey results from 2002, 2004, and 2006. The explanation for the single, sharp increase in rainbow trout survey composition to 48.64% can be attributed to a catchable rainbow trout stocking that occurred just prior to the survey. *This assertion will be adequately defended in the "length-frequency analysis" of rainbow trout for 2002-2005.*

Figure 2. Goldfish, White Sucker, Tiger Muskellunge (2002-2006)

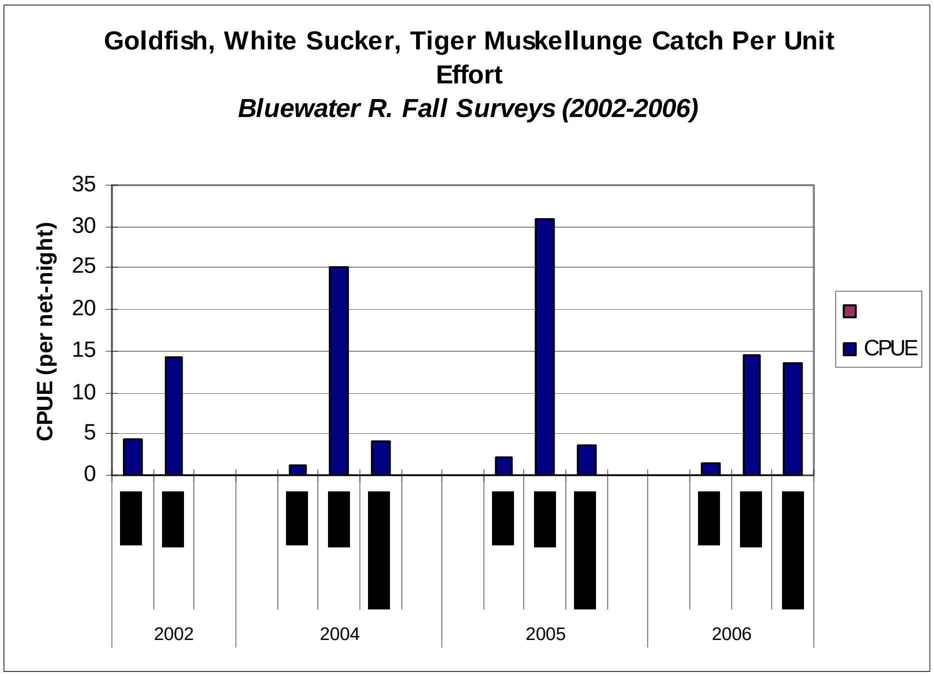


Figure 2 illustrates the Catch Per Unit Effort (CPUE) comparing goldfish, white suckers, and tiger muskellunge from 2002-2006. These results are statistically validated based on an 80% Confidence Interval (listed in parenthesis) for the following CPUE numbers. Some of the obvious changes include the decreases in goldfish and white sucker CPUE from highs of 4.33 (+/- 0.159) to 1.43 (+/- 0.020) and 39.17 (+/- 0.969) to 14.43 (+/- 0.307) fish per net night, respectively. As the non-game fish CPUE has been decreasing year to year, the tiger muskellunge CPUE has increased from 5.40 (+/- 0.260) in 2004 to 13.43 (+/- 0.142) in 2006 (fish per net night).

Spring Electrofishing Surveys

Spring electrofishing surveys have been conducted ever since 2000 at Bluewater reservoir. Typically, six (6) five minute electrofishing runs are worked. All of the fish that can be netted are collected. White sucker and goldfish numbers are collected and recorded. From this information, a CPUE is extrapolated and calculated on a fish per hour basis. The results are listed graphically below:

Figure 3. Goldfish, White Sucker CPUE Spring Electrofishing Surveys (2002-2006).

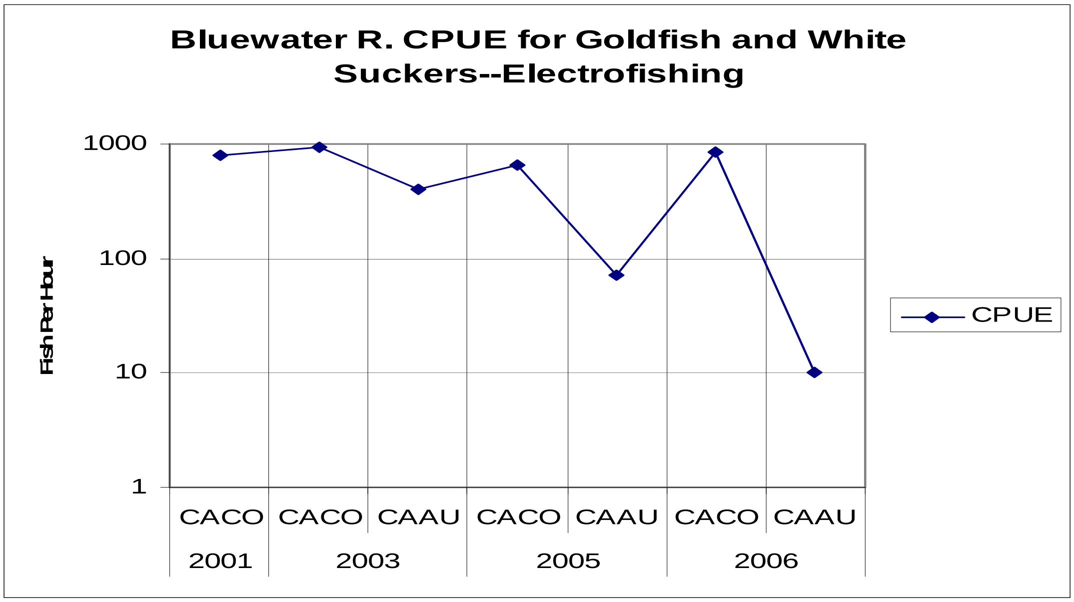
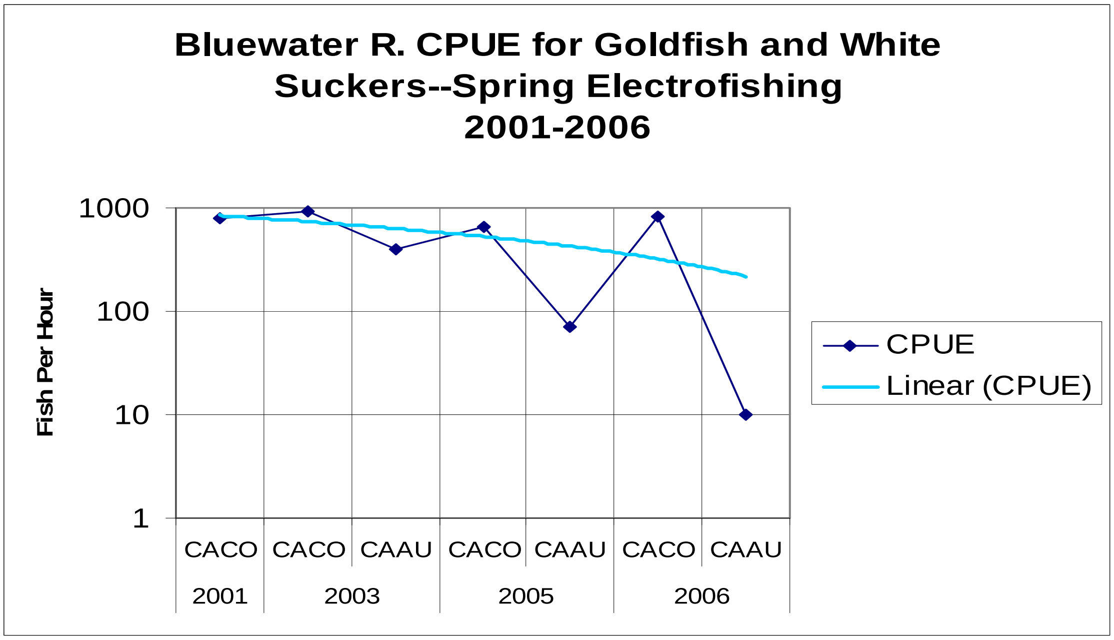


Figure 4. Goldfish/White Sucker CPUE Trend Spring Electrofishing Surveys (2002-2006).



Figures 3 and 4 illustrate a combined CPUE graph for white suckers and goldfish from 2001 to 2006. Figure 4 adds a trend line to the graph. Despite the rather consistent white sucker CPUE over these years (average 807.43 fish per hour), the trend line shows a clear downward trend in the total combined CPUE. This can be attributed to the dramatic decrease in goldfish CPUE from 396 fish per hour to 10 fish per hour.

Figure 5. White Sucker CPUE Trend Spring Electrofishing Surveys (2001-2006).

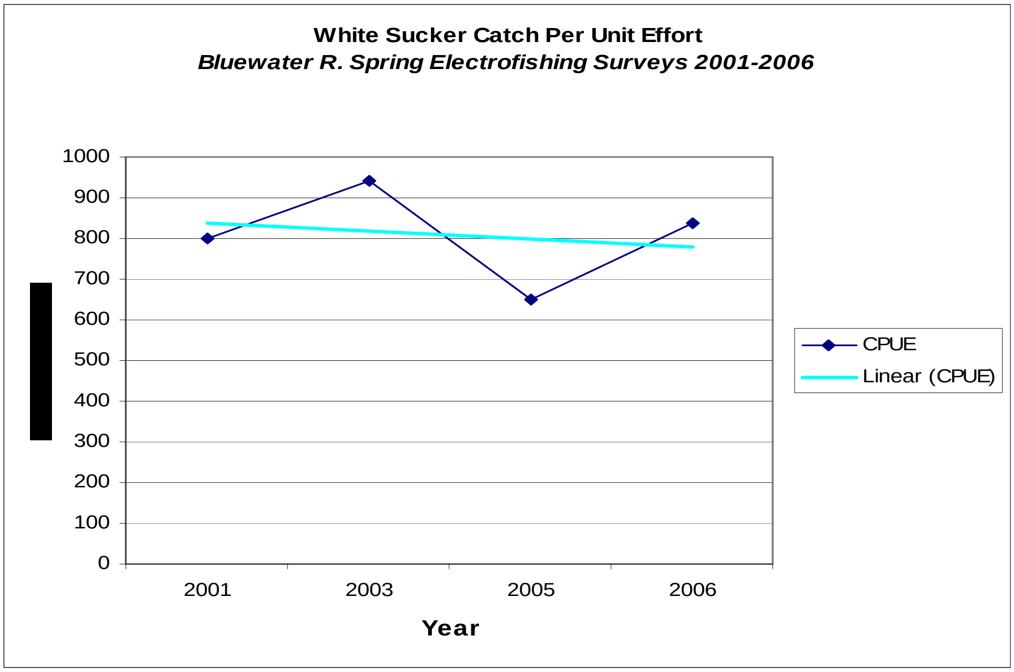


Figure 5 illustrates the white sucker electrofishing CPUE from 2001 to 2006. The trend line shows the relative consistency in the cumulative analysis, with a slight downward trend.

Figure 6. Goldfish CPUE Trend Spring Electrofishing Surveys (2001-2006).

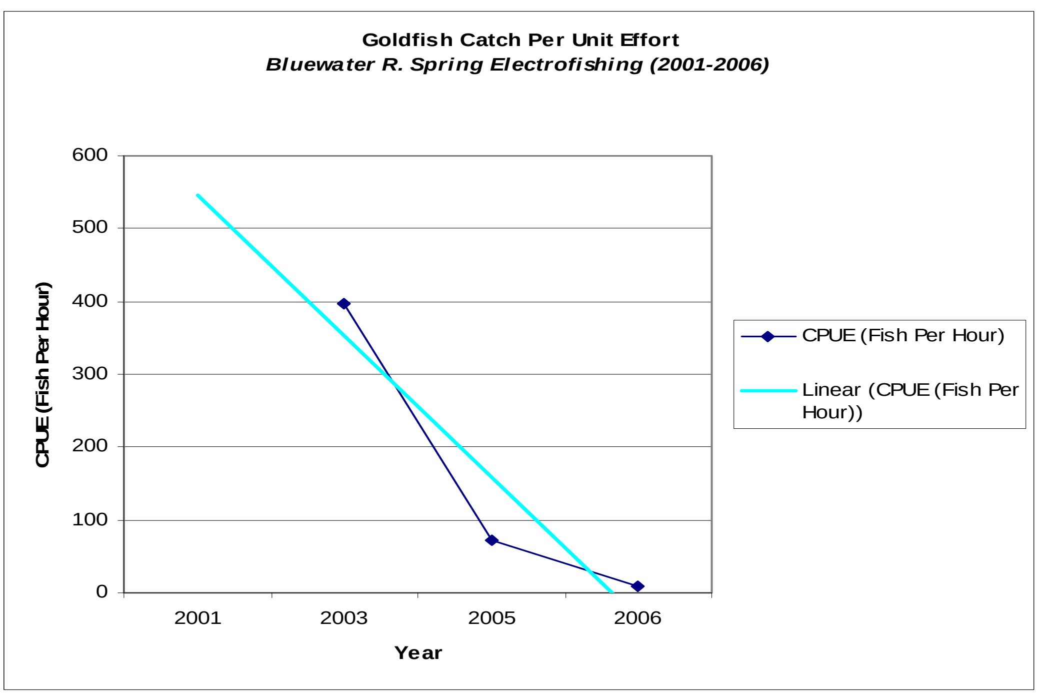


Figure 6 illustrates the clear decrease in goldfish CPUE numbers from 2003 to 2006. The is most of the reason for the overall decrease trend line in non-game fish CPUE (when combined with white CPUE) over the 5-year period.

Rainbow Trout (*Oncorhynchus mykiss*)

Table 4. CPUE/RSD/Wr for Rainbow Trout (2002-2006)

Bluewater R. Rainbow Trout				Length Frequency/ Relative weight								
					S-Q		Q-P		P-M		M-T	
Year	Number of fish	CPUE	PSD± CI	Mean Wr	RSD	Wr	RSD	Wr	RSD	Wr	RSD	Wr
2002	13	2.17	60	85.50	40		60					
2004	25	3.00	18	87.72	82		18					
2005	210	35.00	0	86.35	100							
2006	2	0.29		82.54								

Bluewater Reservoir has long been targeted by anglers targeting rainbow trout and channel catfish. However, Bluewater earned a reputation for growing large rainbow trout throughout the 1980s. In fact, the state record rainbow trout long reigned from Bluewater R. until about the late 1990's. As discussed in the introduction, Bluewater R. is managed a Put-Grow and Take water, with historic stockings consisting of fingerling rainbow trout. Table 4 delineates the rainbow trout catch from 2002-2006 and breaks the information down by year, listing the number caught, Proportional Stock Density (PSD), Mean Relative Weight (Wr), and RSD size categories. In 2002 and 2004 the CPUE for rainbow trout was 2.17 and 3.00 fish per net night, respectively. The PSD was 60% and 18%, respectively. Meaning that in 2002 60% of the rainbow trout caught were greater than or equal to the minimum "quality" length, and in 2004 only 18 were of minimum quality length. The relative sizes ranged between "Stock-Quality" (40 and 60% respectively) and "Quality- Preferred" (60 and 18% respectively).

The relative weight for those two years demonstrates a very good body condition, indicative of a healthy growing season of aquatic invertebrates in Bluewater reservoir. The 2005 data can be ignored from this table and any graphs that might include the information. The CPUE for 2005 was 35.00 fish per net night, with a PSD of zero, and the RSD size category designation is 100%. This means that most all of these 210 rainbow trout were an average of stock length (9"). These fish captured during the survey were stocked just prior to the survey timeframe. The length frequency analysis to follow will reiterate this fact. The mean relative weight was 86.35, indicating that Nm hatcheries are certainly stocking "healthy" fish with very good body condition factors. The 2006 survey only yielded a total of two (2) rainbow trout

According to the stocking schedule, Bluewater is due to receive approximately 415,000 3" rainbow trout every year. Unfortunately, whirling disease has nearly crippled our hatchery output, and all but eliminated fingerling stockings until renovation of two Department hatcheries. A summary analysis of NWA subcatchable stockings is listed below. Low stocking rates of rainbow trout over the last five years has likely contributed to the decline of the rainbow trout fishery at Bluewater. Recent angler complaints and actions by State Representatives testify to this assertion.

Table 5. Subcatchable Rainbow Trout Fish Stocking History for NWA Waters (2002-2006)

<u>NWA WATER</u>	***NUMBER OF SUBCATCHABLE RBT TO BE STOCKED ACCORDING TO STOCKING SCHEDULE (02'-06')***	***NUMBER OF RBT ACTUALLY STOCKED (02'-06')***	***NUMBER AND PERCENTAGE OF SUBCATCHABLE FISH <u>UNDER-STOCKED</u> (02'-06')***
BLUEWATER R.	2,075,000--3" RBT	1,176,715 ** (*of which 1,043,891 were 1" Fry*)	898,585 RBT—43.3% (*if you include the 1,043,891 1" RBT*) *1,942,176 RBT--93.6% (if you ignore the 1" RBT*)
ABIQUIU R.	2,450,000—3" RBT	474,575	1,975,425 RBT—80.7%
EL VADO R.	1,600,000—3" RBT	399,148	1,200,852 RBT—75.1%
NAVAJO R.	1,812,500—5" RBT	249,770	1,562,730 RBT—86.3%
SAN JUAN R. (QUALITY)	400,000—3" RBT	106,886	293,114 RBT—73.3%
SAN JUAN R. (REGULAR)	800,000—3" RBT	21,115	778,885 RBT—97.3%
HERON R.	0—3" RBT	448,227 (0.9-1.3")	0-0%
ALL LISTED WATERS	9,137,500—3" and 5" RBT	2,876,436 *(see itemized stocking summaries for a better explanation—As stocked RBT ranged from 1"-13.8")*	**6,261,064—68.5%** **This number includes all fish stocked (including undersized-1" Fry) and should be considered an <u>Extremely Conservative Estimate of Under-stocked Fish</u>*

Figure 7. Rainbow Trout CPUE—Fall Gill-Net Surveys (2002-2006).

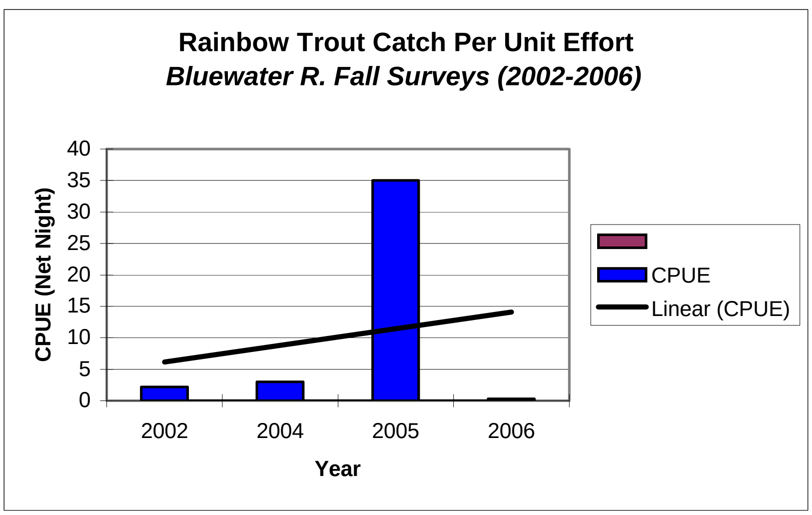
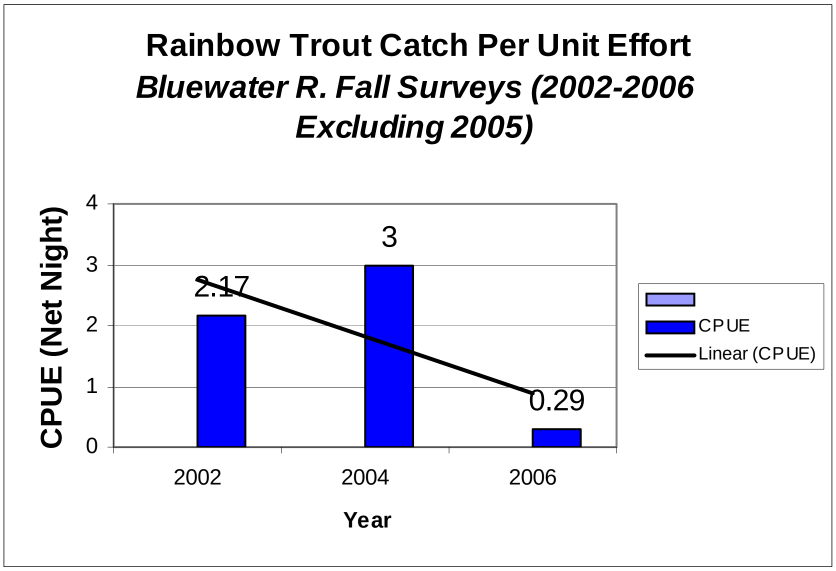


Figure 8. Rainbow Trout CPUE—Fall Gill-Net Surveys, *Excluding 2005* (2002-2006).



Figures 7 and 8 are graphic illustrations of rainbow trout CPUE from 2002-2006. Figure 7 includes the 2005 CPUE, while figure 8 excludes the 2005 data. The true representation of the current state of the rainbow trout fishery can be ascertained through examination of Figure 8.

Figure 9. Rainbow Trout Mean Relative Weight by RSD Size Category--Fall Gill-Net Surveys (2002-2006).

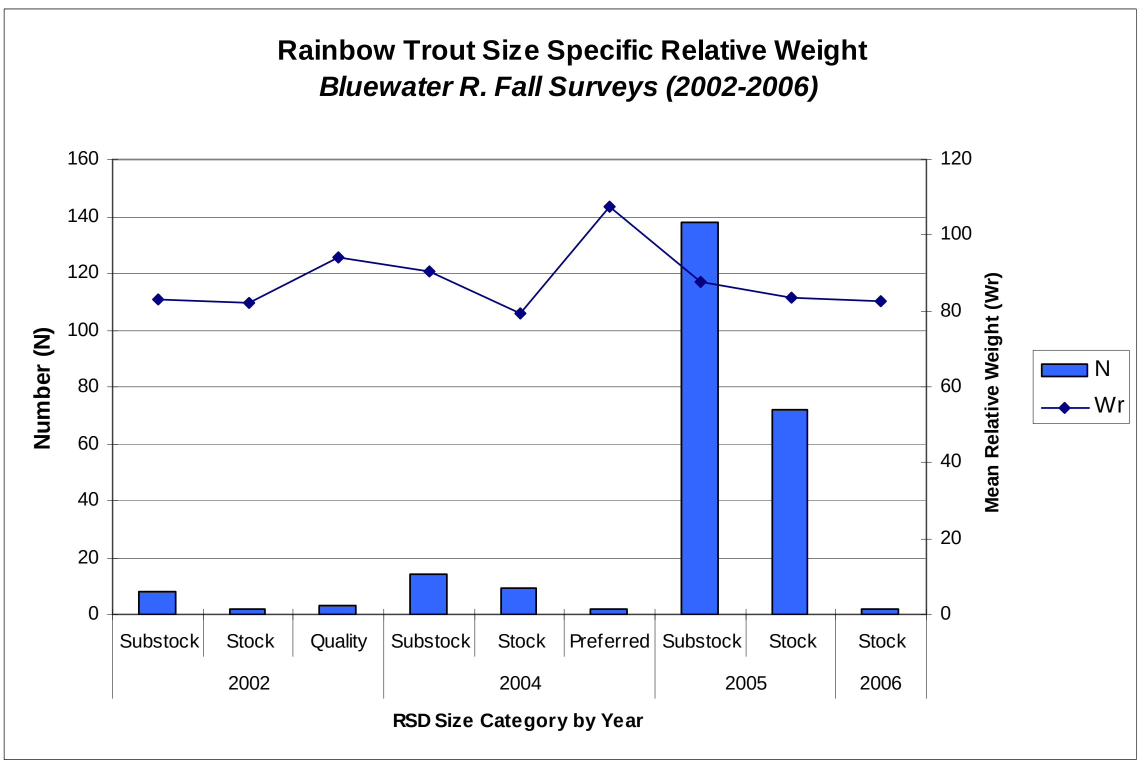
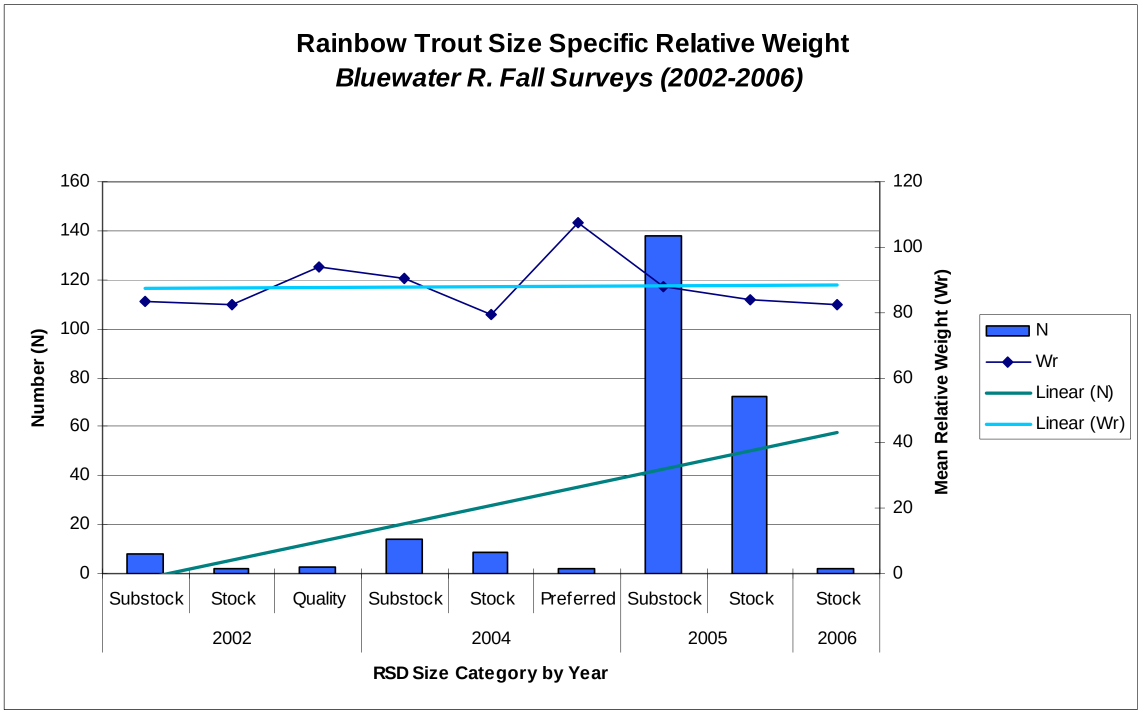


Figure 10. Rainbow Trout Mean Relative Weight by RSD Size Category Trend--Fall Gill-Net Surveys (2002-2006)



Figures 9 and 10 illustrate the mean relative weight of rainbow trout for each year of the survey period. The number caught can be tracked along the y-axis, with the Wr factor can tracked along the alternate y-axis. The Wr trend line indicates a very good body condition of rainbow trout throughout the years, regardless of the size of fish. The y-axis trend line is deceiving, because it includes the 2005 survey data, essentially analyzing 210 stocked rainbow trout.

Figure11. Rainbow Trout Mean Relative Weight by RSD Size Category (Excluding 2005)--Fall Gill-Net Surveys (2002-2006).

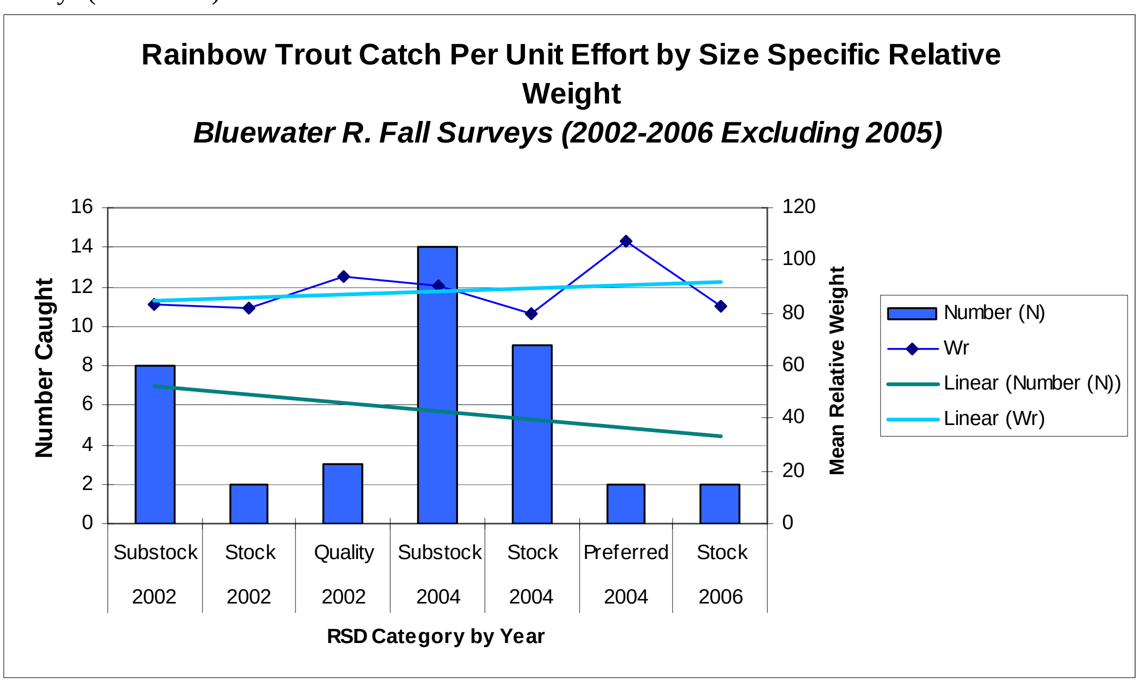


Figure 11 illustrates rainbow trout survey catch numbers from 2002 to 2006, and is broken down by RSD size category.   This Figure represents a more valid “picture” of the current state of rainbow trout population trends from 2002 to 2006. The trend line for the mean relative weight shows a slight increase from 2002 to 2006, indicating a very healthy body condition (maintaining at about 90). Conversely, the number caught trend line shows a steady decrease across RSD categories from 2002 to 2006, reaching the lowest catch rate of two fish (a CPUE of 0.29 fish per net night).

Figure 12. Rainbow Trout Length-Frequency Analysis Fall Gill-Net Surveys (2002-2006).

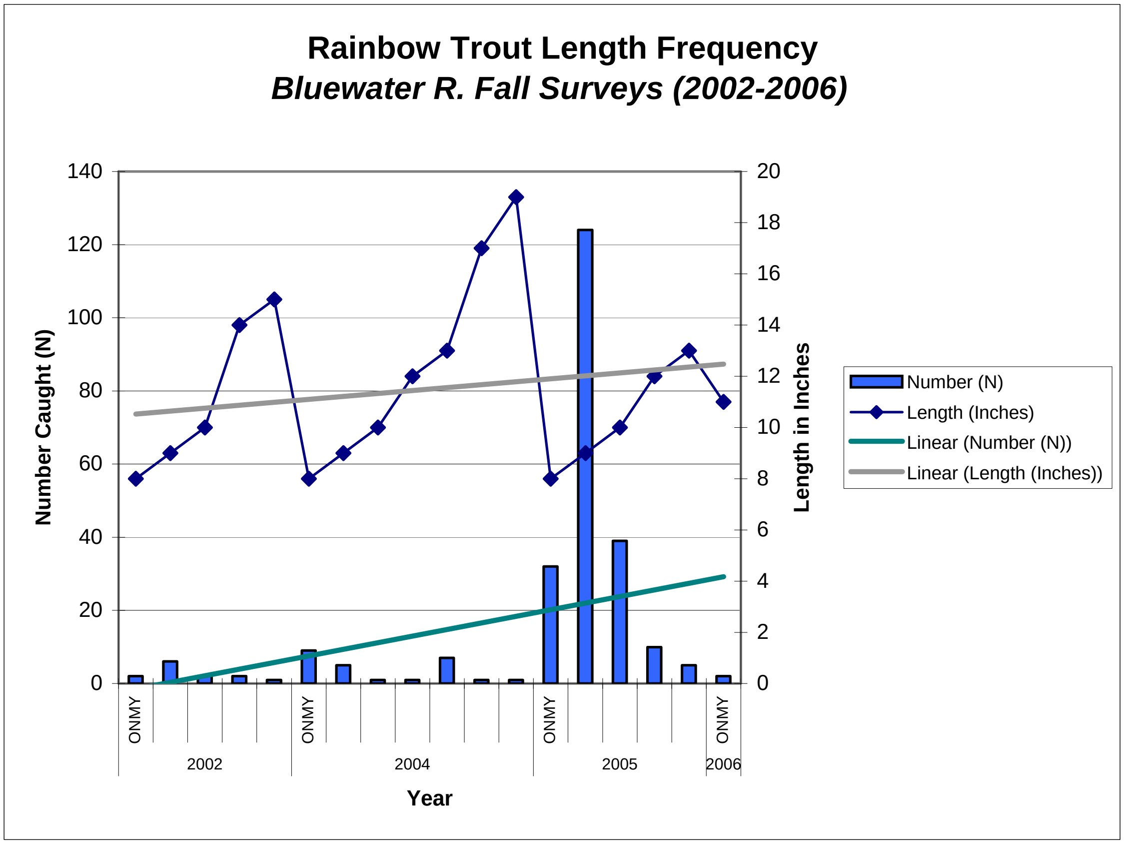
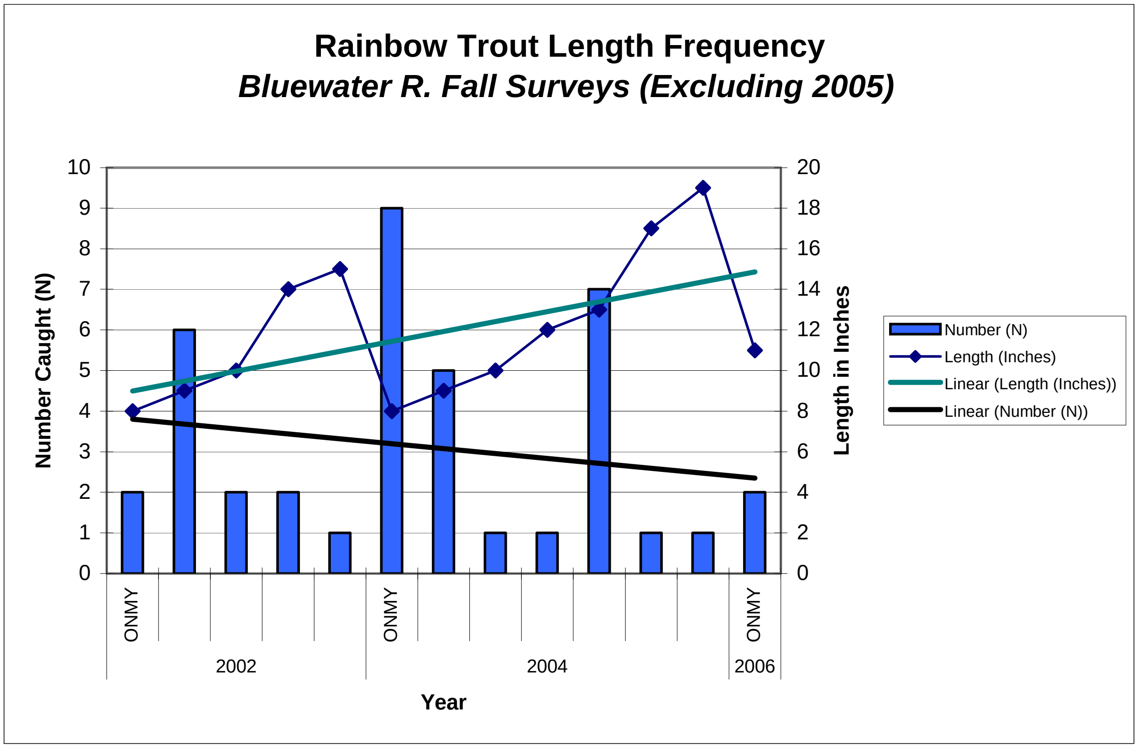


Figure 12 illustrates the rainbow trout length frequency analysis from 2002-2006, including the 2005 data. The number of rainbow trout can be tracked along the y-axis while the length can be tracked along the alternate y-axis, measured in inches. This graph is the final proof for excluding the anomaly data for 2005. When you examine the length-frequency throughout most years, the graph clearly shows that most rainbow trout ranged in the 8-10 inch range. This presents that obvious fact that in recent years, Bluewater has been stocked almost exclusively with catchable rainbow trout. When examining just the 2005 length frequency, ninety-three percent (*93% or 195 of the 210 fish caught*) of the rainbow trout were between 8 and 10 inches in length.

Figure 13. Rainbow Trout Length-Frequency Analysis (Excluding 2005) Fall Gill-Net Surveys (2002-2006).



As with Figure 11, Figure 13 illustrates a more valid "picture" of rainbow trout length frequency from 2002 to 2006, *because it excludes 2005*. The average length trend line, tracked along the alternate y-axis illustrates a steady increase in length, due in large part to the 13-19 inch rainbow trout caught in 2004. Again, when considering the data, one must be cautious to assign much to this trend, because this graph deals with a small number of fish caught over three years. Given the small numbers, just a few fish "Quality" size or larger can shift the trend line significantly. Based on an 80% CI, the rainbow trout caught in 2004 were valid to within +/- 0.141 fish per net night (*CPUE of 4.17, with 25 specimens*). However, the trend line across the primary y-axis reiterates the catch decline from 2002-2006 across RSD size categories. This decline is not as drastic a decline as illustrated by the CPUE analysis, because this graph analyzes the trend across RSD categories, considering each RSD an independent value.

<u>Tiger Muskellunge (*Esox lucius x Esox masquinongy*)</u>

Table 6. CPUE/RSD/Wr for Tiger Muskellunge (2002-2006)

Bluewater R. Tiger Muskellunge					**Length Frequency/ Relative weight**							
					S-Q		**Q-P**		**P-M**		**M-T**	
Year	**Number of fish**	**CPUE**	**PSD± CI**	**Mean Wr**	**RSD**	**Wr**	**RSD**	**Wr**	**RSD**	**Wr**	**RSD**	**Wr**
2002	Not Stocked Until 2003											
2004	27	4.50	96	111.80	4	122.38	96	111.38				
2005	21	3.50	53	109.73	47	117.23	11	101.45	42	97.07		
2006	94	13.43	99	109.09	1	98.60	77	110.82	17	105.06	5	99.13

As discussed in the introduction, Tiger muskellunge were first stocked into Bluewater in 2003. They have been stocked as fry (average 100,000 per year), and fingerling (average 5,000 per year) each year through 2006. Tiger muskies were stocked with a dual management goals: First, to add a keystone, yet sterile, predator to a water body infested with large number of goldfish and white suckers in an effort to decrease those numbers to a point that angler complaints diminished (see NMDGF data tables and graphs throughout this summary); And two, to add another game fish to the reservoir while hopefully accomplishing the first task, thus adding to angler opportunity for success (*see Bluewater Reservoir Long Range Plan*).
Table 6 gives total picture of Tiger muskellunge survey data from 2002 to 2006. Being first stocked in 2003, Tiger muskies were not represented in the survey catch until 2004. They represented a moderate CPUE of 4.50 (based on 27 specimens). The average CPUE variance based on an 80% CI was calculated to be +/- 0.16 fish per net night.

The overall mean relative weight for the overall Tiger muskie catch is impressive, and clearly indicative of an abundance of food available in Bluewater reservoir. The average Wr for 2004-2006 was 110.20, which indicates an "excellent" body condition and overall healthy fish (amongst those caught during the survey). The PSD was 96, meaning that all but 4% were equal to or larger than the minimum "Quality" length (20+"). The mean relative weight of 111.80 indicates an extremely healthy body condition, and infers an abundance of food and a very good growing season at Bluewater reservoir. The mean relative weight across the board is impressive, with the "best" body condition found in the 21-33" size range.

Some concerns prior to stocking Tiger muskie into Bluewater were: Lack of vegetation suitable "esocid habitat." And a water clarity that was often less than 10 inches visibility with a Secchi disk, since Tiger muskie are known as "ambushers." Koupal 1999 states: "Information from prelimary data collection revealed a relationship between water clarity and the successful establishment of tiger muskies in a reservoir. Tiger muskies feed more efficiently in clearer water; this advantage is believed to outweigh the added risk of being detected by predators. Appreciable amounts of living and non-living cover have been found in Colorado reservoirs that successfully establish tiger muskies, suggesting that cover is important to the success of this fish. A sagittiform body shape and other physical adaptations predicates that the most efficient strategy for esocids is as a lie-in-wait predator."

Although Bluewater has marginal cover, the water clarity has been extremely poor ever since the water level dropped significantly in 2002. Given the fact that tiger muskies have established quite well in Bluewater reservoir, water clarity and adequate cover seem to be of lesser importance than an adequate and abundant food base. Dr Koupal actually evaluated Bluewater reservoir in 1998 for suitability of Tiger muskie introduction. Bluewater was considered a "low to medium" candidate for successful introduction based mainly on the lack of cover and water clarity. He based this assessment on a battery of conditions that are typically indicative of esocid success.

Figure 14. Tiger Muskellunge Mean Relative Weight by RSD Category Fall Gill-Net Surveys (2002-2006).

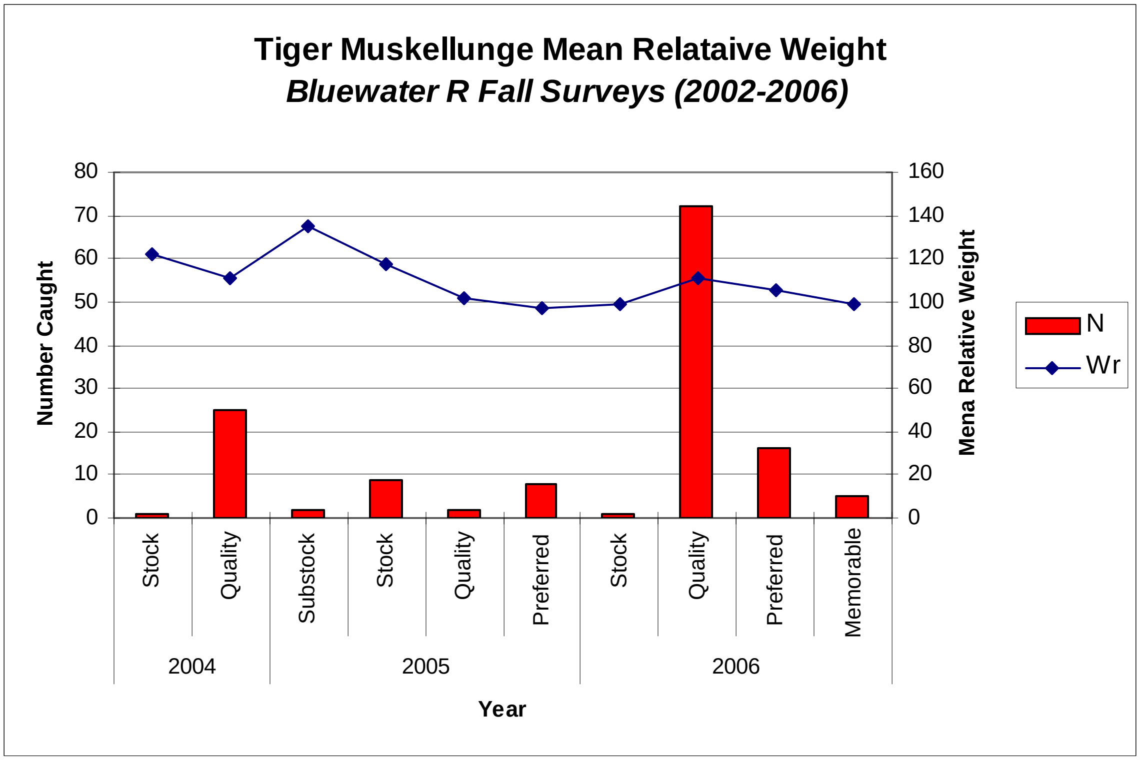
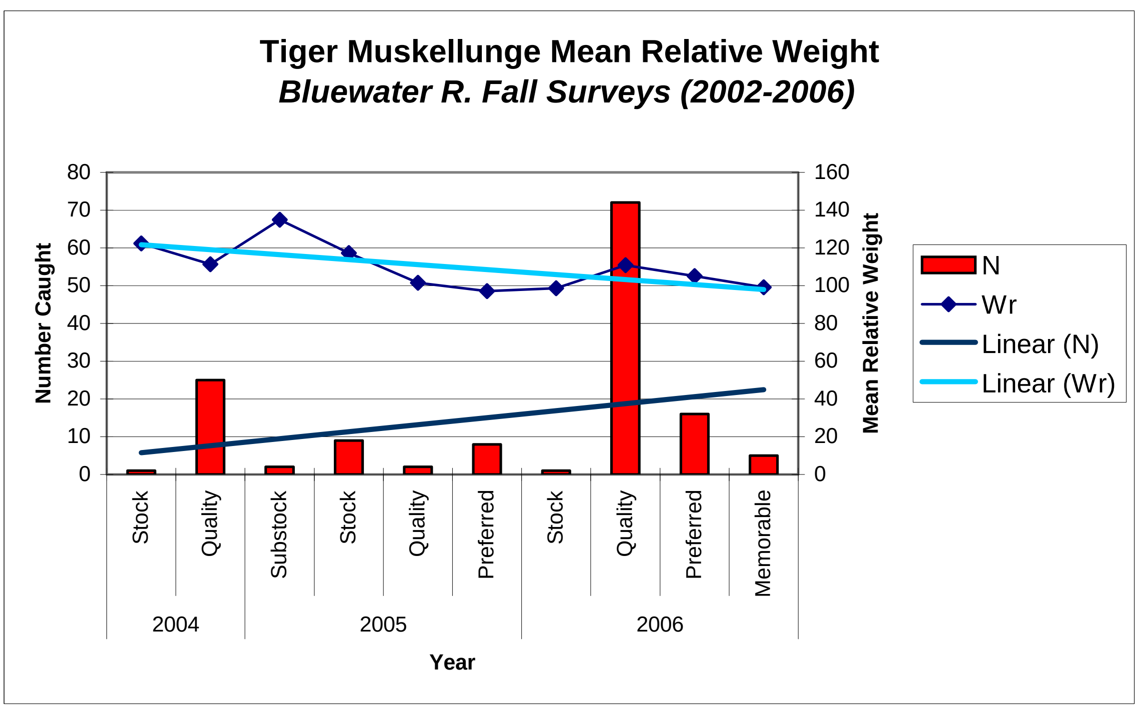


Figure 15. Tiger Muskellunge Mean Relative Weight Trends by RSD Category----Fall Gill-Net Surveys (2002-2006).



Figures 14 and 15 illustrate the Mean Relative weight of tiger muskies from 2004 to 2005, with Figure 15 adding a trend line to each axis. The Wr trend shows a slight decrease from 2004-2006, mainly because of some "Stock" size tiger muskie caught in 2004-2005 that had Wr conditions of 122.38 and 134.93. As discussed relative to Table 6, the total Wr condition for Tiger muskie is impressive, with an average Wr of 109.80 for all RSD categories delineated in Figures 14 and 15. Given the variety and volume of non-game fish in Bluewater, these results should not be so surprising.

Figure 16. Tiger Muskellunge Length-Frequency *Trend* Analysis Fall Gill-Net Surveys (2002-2006).

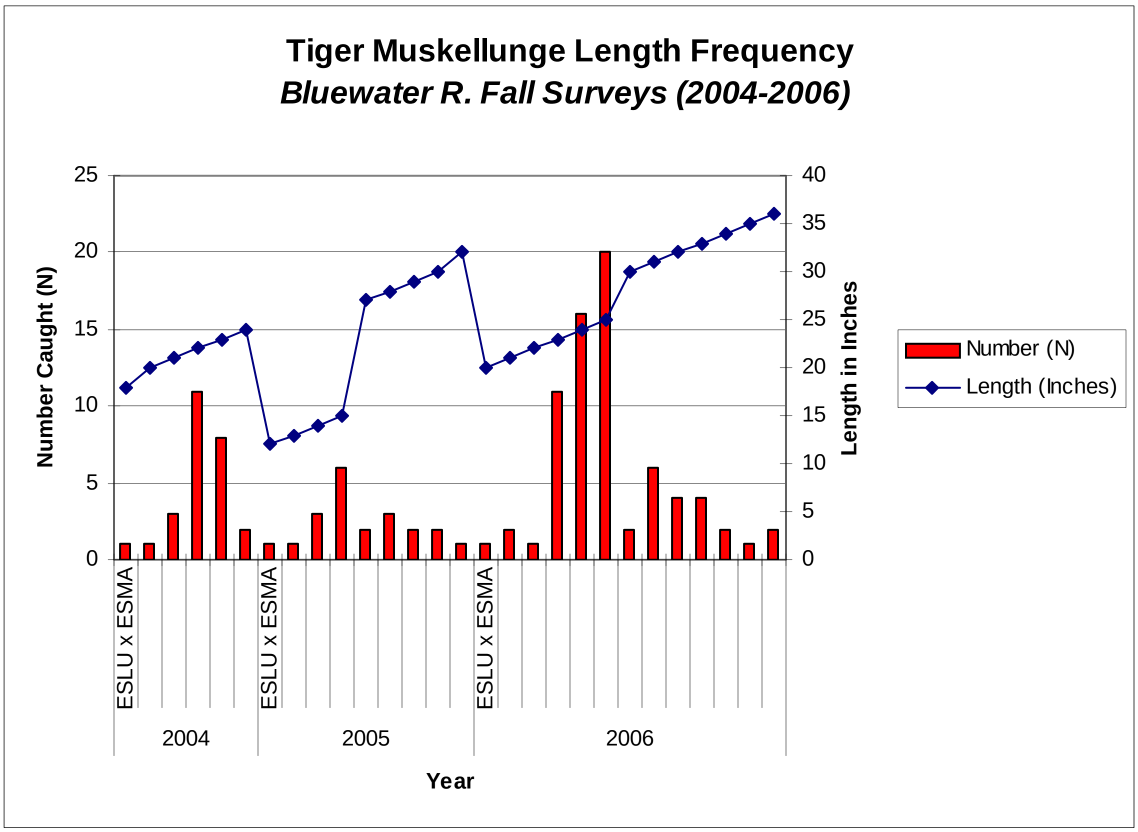


Figure 16 illustrates a Length-frequency analysis of Tiger muskellunge caught from 2002-2006. It reveals a rather clear clear delineation line between the size groups for each year for 2005 and 2006. This makes perfect sense, given the fact that there are four age groups that currently occupy Bluewater R. With a growth rate of just greater than twelve inches per year, the largest length fish are most likely among those stocked in 2003-2004. Further studies at Bluewater will delineate age through a cleithral analysis. The largest size group captured in 2006, was those in the 23-25 inch size range, and comprised nearly half of the total catch. Of note in Figure 16 is the large increase in the number of Tiger muskies caught during the 2006 survey (94 specimens). This seems to be a clear indication that these Pennsylvania Tiger muskie are recruiting into the population in large enough numbers to be accounting for the impacts the data are indicating. These fish are "durable" enough to survive the trip to New Mexico, whether stocked as fry (shipped next day air in insulated boxes), or traveling in hatchery trucks (as fingerlings) across several states. Having been involved in many of these stockings, the mortality rate prior to tempering and stocking is extremely low.

Stomach Contents of Mortalities

The 2006 Fall Gill Net Surveys at Bluewater R. yielded a total of 94 tiger muskies. These fish were weighed and measured. Of the 94 caught, 52 died in the nets or thereafter. Of these 52 tiger muskies, stomach contents were analyzed in the field and breakdown as follows:

- EMPTY 29 (55.8%)
- WHITE SUCKER 18 (34.6%)
- RAINBOW TROUT 1 (1.9%)
- GOLDFISH 1 (1.9%)
- UNKNOWN 3 (5.8%) **Severely decomposed, but at least* 1 *was likely a central stoneroller*

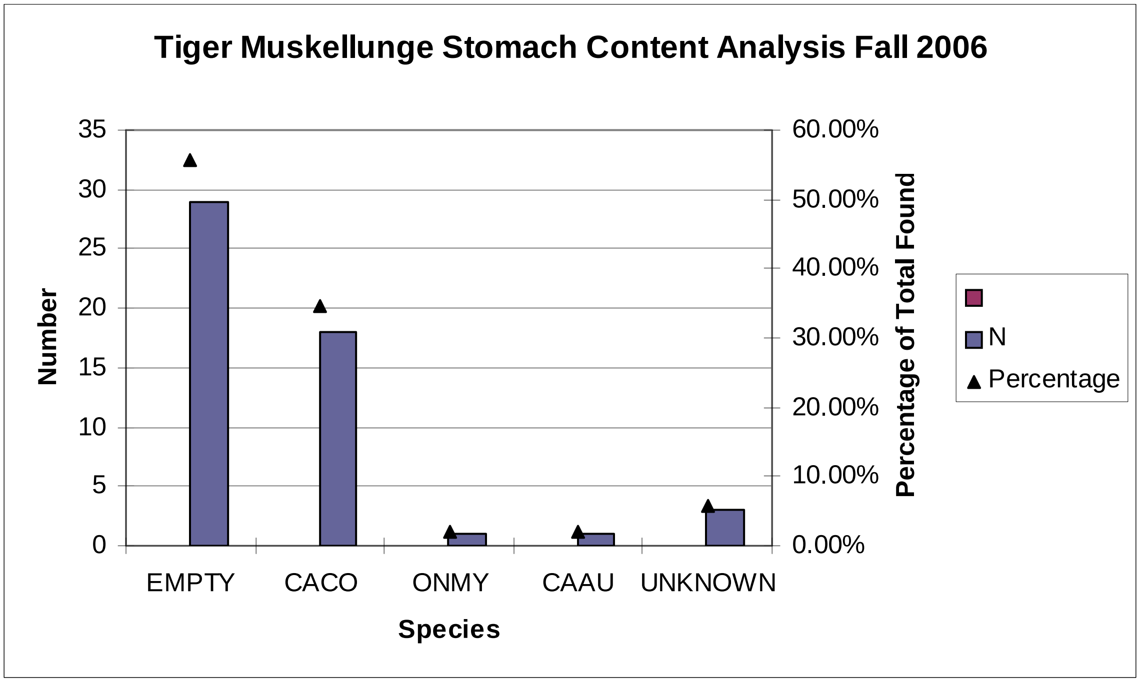


Figure 4. Tiger Muskellunge Stomach Content Breakdown Taken Incident to Survey Mortality. Bluewater R. Fall Gill-Net Survey--2006

Of the 52 tiger muskie mortalities incident to this survey, 29 of them (55.8%) had nothing tangible in their stomachs. Stomach contents of the remaining mortalities seem to indicate that the most predated forage fish is the white sucker (comprising 34.6% of the stomach contents). These results seem to closely correlate with the most abundant species found in Bluewater (sort of a regression by species abundance). White suckers are by far the most abundant fish species in Bluewater. Also, knowing that tiger muskies are opportunistic predators, the stomach contents seem to perfectly compliment everything that our data has shown since 2002.

White Sucker (*Catostomas commersoni)*

Table 7. CPUE/RSD/Wr for White Suckers (2002-2006)

Bluewater R. White Suckers				Length Frequency/ Relative weight								
					S-Q		Q-P		P-M		M-T	
Year	Number of fish	CPUE	PSD± CI	Mean Wr	RSD	Wr	RSD	Wr	RSD	Wr	RSD	Wr
2002	85	14.17	55	75.32	45	74.61	26	72.45	29	78.94	0	
2004	235	25.17	97	93.24	3	106	26	93.31	70	92.59	1	97.08
2005	185	30.83	66	92.73	34	89.38	28	92.12	38	96	1	103.25
2006	101	14.43	96	88.19	4	114.00	25	85.21	70	87.81	1	86.57

Table 7 presents the white sucker surveys data gathered from fall gill net surveys from 2002-2006. The CPUE has fluctuated over the years, but decreased from a high of 30.83 in 2005. Also evident, is the PSD for 2006 being so high (96%). This means that only 4% of the suckers captured were smaller size categories. This may be an indication of younger Tiger muskie predation on recruiting white suckers, or it could be a function of survey bias with net configuration, etc. The overall body condition factor (Wr) is consistently high for all the survey years and even shows an increase from 2004-2005 as you move up the RSD categories to the "Memorable-Trophy" categories. The lowest condition factor numbers are clearly the 2002 numbers (Mean Wr of 75.32), which can indicate a large volume of suckers, and a limited amount of food resources to support the large number of fish.

White suckers have increased substantially and heavily populated Bluewater R. since the early 1990s. "The white sucker inhabits lakes, streams, and rivers in New Mexico, usually above 1,372-m elevation. Temperature preference ranges from 22 to 27 C (Cincotta and Stauffer 1984, Reutter and Herdendorf 1975). Spawning occurs in spring to early summer in water depths of less than 30 cm over a variety of substrates, beginning when the water temperature reach about 10 C (Sublette et al.1990). White suckers reproduce naturally in Bluewater Reservoir. The species is a bottom insectivore, taking principally chironomid larvae as well as zooplankton, small crayfish, and other invertebrates along with plant material and organic detritus (Brown 1963; Eder and Carlson 1977). It has been observed feeding on the head and viscera of rainbow trout that have been discarded by fishermen. Feeding occurs mostly at night (Sublette et al.1990).

Figure 17. White Sucker Length-Frequency Analysis Fall Gill-Net Surveys (2002-2004).

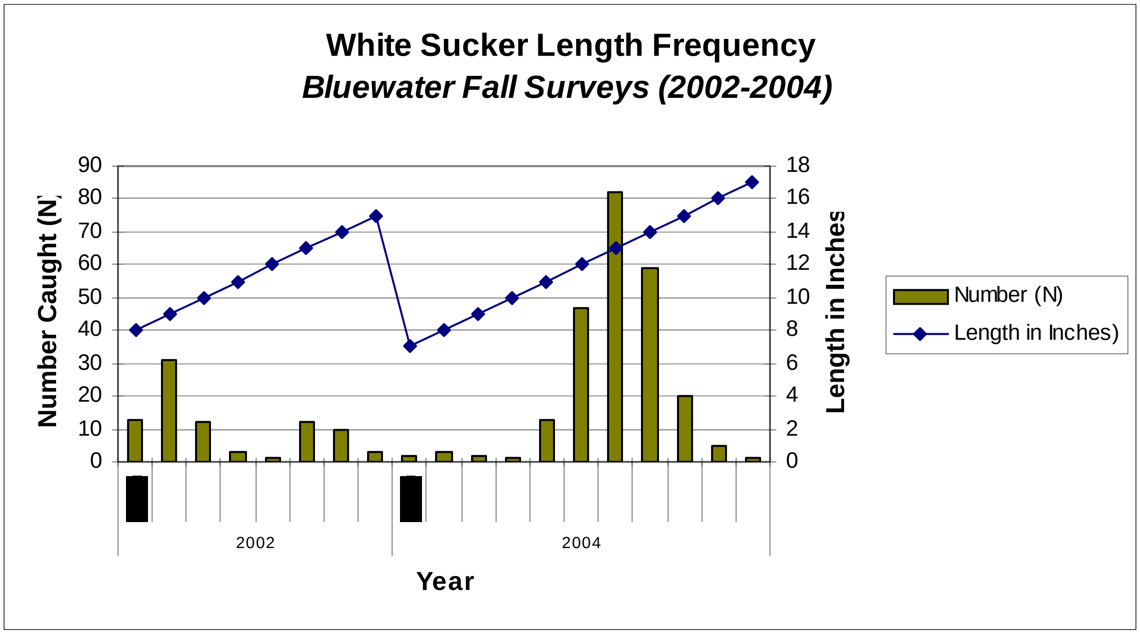


Figure 17 illustrates a length-frequency analysis of white suckers from the 2002-2004 fall surveys. The average length can be tracked along the alternate y-axis, while number caught can be referenced along the primary y-axis. One potential reason for the low catch rate in 2002 might be attributed to a fewer set of nets than subsequent years. This was the first year that this survey protocol was implemented, and the parameters were new to most of the crew. However, the average length shows a nearly uniform and almost parallel distribution in size ranges between the two years (ranging from 7-8" to 15-16 inches). The 2004 data shows a great preponderance of the suckers ranging in the 12-14" size range. Again, this may be a function of Tiger muskie predation on younger suckers, or it might simply be a function of unrealized sampling bias.

Figure 18. White Sucker Length-Frequency Analysis Fall Gill-Net Surveys (2005-2006).

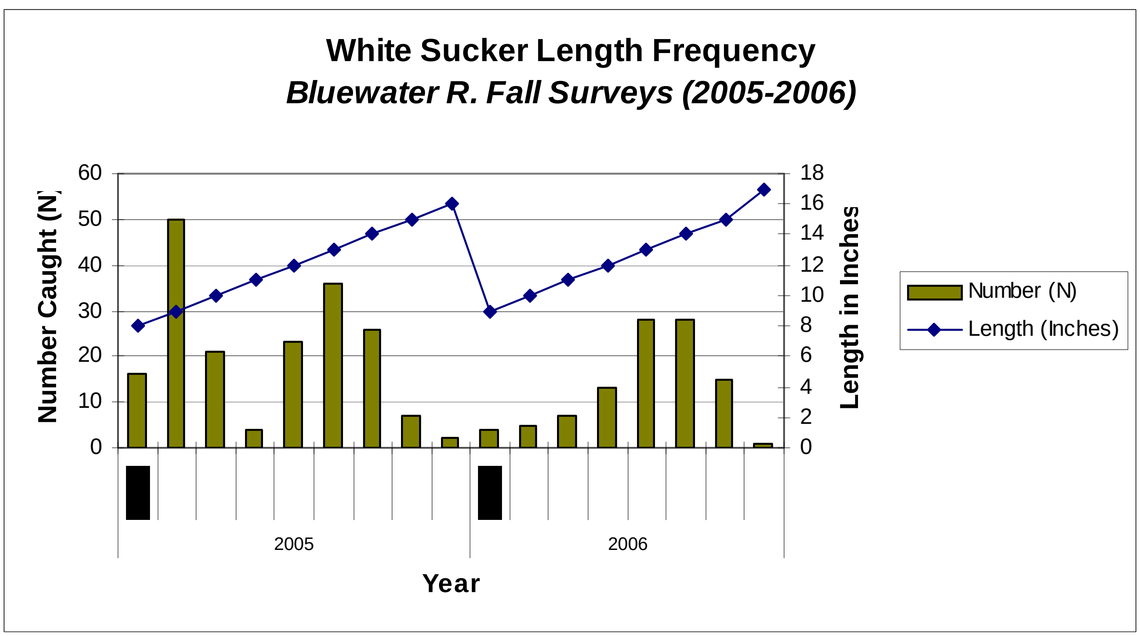


Figure 18 illustrates a Length-Frequency analysis for white suckers from 2005-2006. Figure 18 almost perfectly tracks with Figure 17. The two graphs can almost be superimposed with very little difference detectable. Consistent survey techniques and crews from 2002-2006 might be one reason, although using experimental gill nets would seemingly offset any unrealized sample bias. The reason for such consistency in the survey results will require further investigation, but it can likely be attributed to the previously discussed survey bias, although unrealized. The only real differences between the surveys are the number of white suckers caught during the surveys.

Figure 19. White Sucker Length-Frequency *Trend* Analysis Fall Gill-Net Surveys (2002-2004).

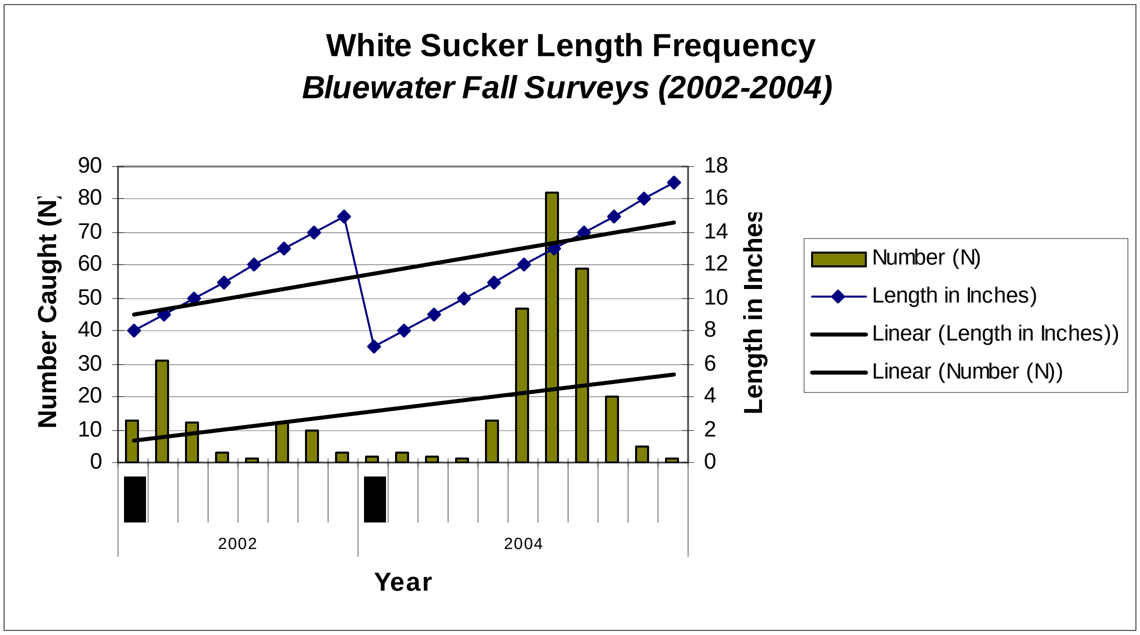
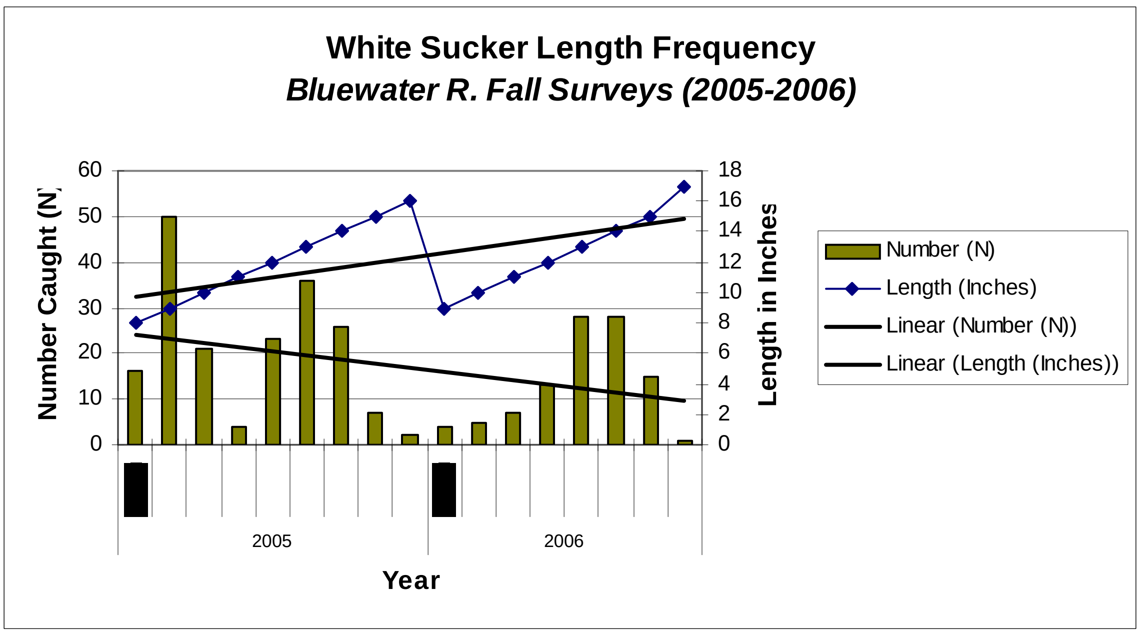


Figure 20. White Sucker Length-Frequency *Trend* Analysis Fall Gill-Net Surveys (2005-2006).



Figures 19 and 20 expound on 17 and 18 by adding trend lines to the parameters. The Number caught can be referenced along the primary y-axis, while the Length in inches can be tracked along the alternate y-axis. The trend line tracking the average length show a steady increase for both graphs to larger size fish (from a about 11” to 14”). Although some larger suckers were caught in 2004 and 2006, the trend may or may not be significant based on the modest number of these 15-17” fish caught.

Goldfish

Table 8. CPUE/PSD/RSD/Wr for Goldfish (2002-2006)

Bluewater R. Goldfish				**Length Frequency/ Relative weight**								
					S-Q		**Q-P**		**P-M**		**M-T**	
Year	**Number of fish**	**CPUE**	**PSD± CI**	**Mean Wr**	**RSD**	**Wr**	**RSD**	**Wr**	**RSD**	**Wr**	**RSD**	**Wr**
2002	26	4.33	100	84.49	0		15	84.53	69	77.45	12	60.40
2004	8	2.33		120.01				120.36		119.75		
2005	13	2.17	100	90.55	0		0		23	105.71	69	68.25
2006	10	1.43		94.08				104.37		89.66		

Goldfish were detected in Bluewater Reservoir in or about 2000. Their presence is likely is likely due to a “bait bucket” introduction since they don’t appear in prior survey years. Over a two-three year period, the number of goldfish increased exponentially, and was tracked closely through spring electrofishing surveys and fall gill net surveys. Apparently Bluewater R. contains at least “adequate” habitat required by goldfish to survive and successfully recruit new members into the population each year. According to Sublette 1990, Goldfish prefer warm water, shallow water with abundant aquatic vegetation. Spawning begins in the spring when the water temperature reaches 15.6 C, continuing until the water temperature falls below that level (Becker 1983). When overcrowding occurs, there is a cessation of reproductive activity. The adhesive eggs are laid over aquatic vegetation and fertilized immediately. From 200 to 4,000 eggs are laid with spawning often occurring several times a year (Heudfelder and Fuiman 1982). Goldfish feed on aquatic vegetation and a variety of aquatic invertebrates (Sublette 1990). Evidence gathered in 2001 and 2002 clearly indicated that goldfish are not only able to successfully reproduce in Bluewater Reservoir, but can more than quadruple their numbers in just a couple of years (NMDGF Unpublished data 2001-2002).

Table 8 presents that goldfish statistics attained from the 2002-2006 fall surveys. Only 2002 and 2005 yielded enough specimens to trigger a PSD by RSD size designation breakdown. The majority of the captured goldfish ranged in the larger size categories of “Q-P, P-M, and M-T.” In fact, the 2005 results showed that 69% of the catch ranged in the M-T size category. Although the body condition of these goldfish can be considered fair, at best. This may simply be an effect of some sort of sampling bias. It might also indicate a significant decrease in the number and abundance of smaller goldfish. The latter theory would coincide with the spring electrofishing results (analyzed earlier in this summary).

Figure 21. Goldfish Length-Frequency Analysis Fall Gill-Net Surveys (2002-2006).

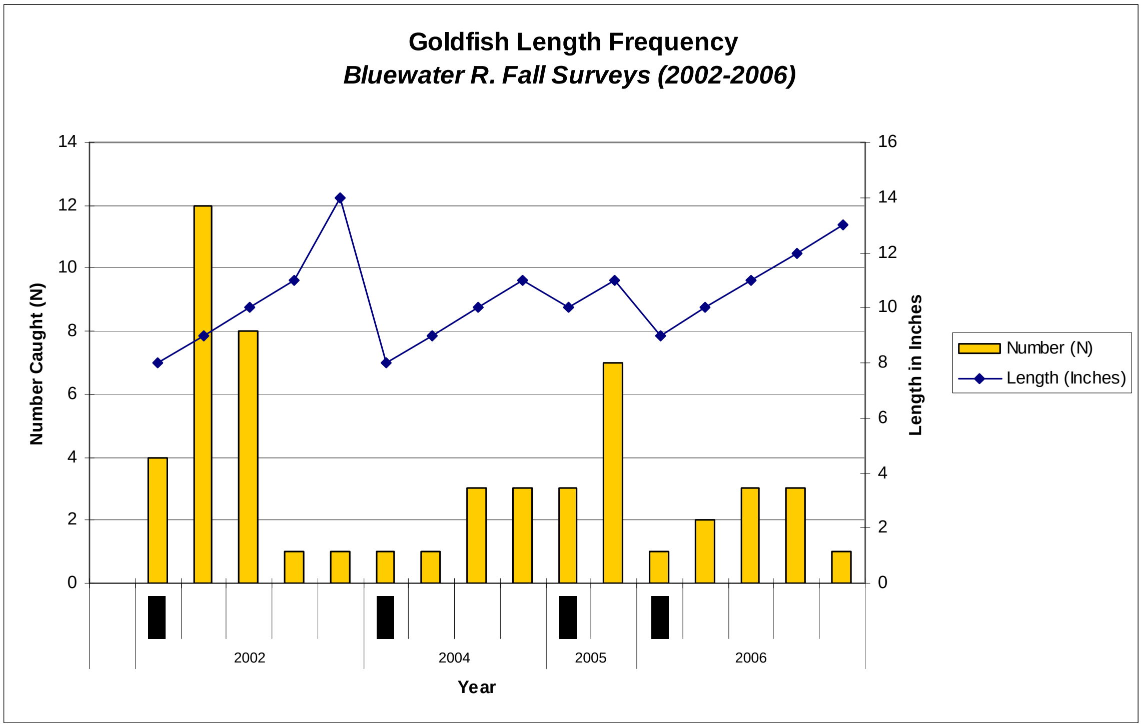
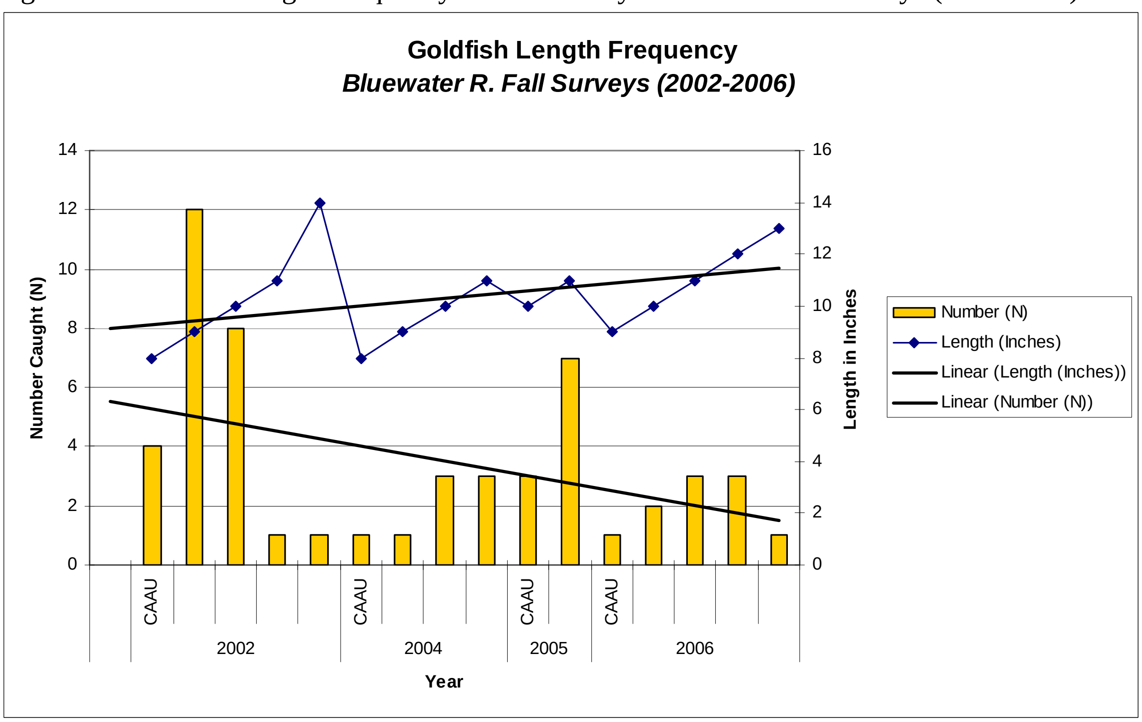


Figure 22. Goldfish Length-Frequency *TREND* Analysis Fall Gill-Net Surveys (2002-2006).



Figures 21 and 22 illustrate the goldfish length-frequency analysis for 2002-2006. Figure 22 simply adds a trend line the same information contained in Figure 21. The average length shows a gradual increase over the years, with most of the goldfish in the 10-11" size range. The trend line tracking the number caught is significant. Beginning with the smaller gill net survey of 2002 (*which yielded 26 specimens*), the trend shows a steady decrease in the goldfish caught (*as the number of nets set each year increased*). This trend is compatible with the spring electrofishing survey results (2001-2006) already discussed in this report.

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