LAKE HAVASU FISHERIES IMPROVEMENT PROGRAM

NATIVE FISH MANAGEMENT PLAN

ANNUAL PROGRESS REPORT FOR 1995

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Arizona Game and Fish Department
California Department of Fish and Game
Bureau of Land Management

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OCTOBER 1996

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INTRODUCTION

Razorback suckers *Xyrauchen texanus* and bonytail chub *Gila elegans* were once widespread throughout the Colorado River system. In the past 100 years, the ranges and populations of these native species have declined (Jordan and Everman 1896; Miller 1961; Minckley and Deacon 1968; Johnson and Rinne 1982; Minckley 1983). In the Lower Basin razorback suckers have been virtually extripated from riverine environments and most impoundments however, a relatively large population still exists in Lake Mohave, AZ-NV (Minckley et al. 1991). The bonytail is presently represented in the Lower Basin by a low number of senile fish in Lake Mohave and possibly other Lower Basin reservoirs (USFWS 1990).

Several researchers (Dill 1944; Miller 1946; Wallis 1951; Jonez and Sumner 1954) noted the decline of razorback suckers shortly after the impoundment of Lake Mead in 1935. Recent population declines and disappearances of razorback suckers and bonytail chub in much of their former range have been associated with relatively rapid and widespread anthropogenic changes which have altered the physical and biological characteristics of many mainstream rivers in the basin (Carlson and Muth 1989). Due to the combined effects of habitat loss, proliferation of introduced fishes and other man-induced disturbances (Miller 1961; Minckley 1973; USFWS 1987; Carson and Muth 1989) these fishes are threatened with extinction and are now listed as endangered under the Endangered Species Act of 1973.

The precarious status of the razorback sucker and bonytail chub dictates that immediate and positive efforts be initiated to prevent their extripation in the lower Colorado River. The Lake Havasu Native Fish Management Plan (Bureau of Land

Management 1992) offers a unique opportunity for the cooperative recovery of endangered species of native fish. In 1992 an interagency team consisting of biologists from the Fish and Wildlife Service (FWS), Bureau of Land Management (BLM), Bureau of Reclamation (BR), Arizona Game and Fish Department, and California Department of Fish and Game established a 10 year objective to release 30,000 razorback suckers (>300mm) and 30,000 bonytail chub (>300mm) into Lake Havasu, AZ-CA. By establishing a large population of these fish in Lake Havasu, their likelyhood of extinction would be reduced.

Fish rearing began in 1993 in two facilities on Lake Havasu. Six thousand two hundred and four razorback suckers (1993 year class) and 18,092 bonytail chub (1993 year class) were stocked into these facilities. During the 1993-1994 grow-out period, four sub-adult razorback suckers were released into the lake from this stocking. The initial attempt at rearing these fish was educational and it became apparent that research was needed to understand the factors limiting growth and survival of these fish in each pond.

By December 1994, seven grow-out coves on Lake Havasu and four ponds located on the Parker Strip at the Emerald Canyon Golf Course (ECGC), AZ, were in production. In the Fall of 1994 approximately 130,000 bonytail chub (1994 age class) and in January 1995 12,000 razorback suckers (1994 age class) were stocked into the Lake Havasu and Emerald Canyon Golf Course facilities. Ninety seven bonytail chub and four razorback suckers were released into Lake Havasu in 1995 from these stockings.

PROJECT AREA

In 1994 and 1995 seven grow-out coves on Lake Havasu (Figure 1) totaling seven surface acres were used to grow-out juvenile razorback suckers and larval and juvenile bonytail chub. In addition, through the efforts of the FWS Parker Fisheries

Resource Office (Parker FRO), fish reared in four ponds located at the ECGC (Figure 1) and bonytail chub grown-out in the Cibola National Wildlife Refuge High Levee Pond, AZ (Figure 2), were released into Lake Havasu. Legal, universal, transverse mercator, and latitude and longitude descriptions are given for grow-out facilities in Appendicies 1 and 2.

SITE DESCRIPTIONS

Pittsburgh Point Cove, AZ.

Plittsburgh Point Cove is separated from Lake Havasu by a naturally occurring sand spit. Water movement through the spit maintains the cove surface elevation approximately equal to that of the lake. The cove has a mean depth of one meter and a maximum depth of three meters near the spit. Cove morphometry is presented in Figure 3. Bottom sediments consist of a deep deposit of fine silt and organic matter. During the months of May, June, and July, a dense growth of spiny naiad *Najas marina* covers about 80% of the cove. Cattails *Typha domingensis* occur in the back of the cove and giant bulrush *Scirpus californicus* grows in scattered areas along the shoreline. Shoreline vegetation extends the perimeter of the cove and is primarily salt cedar *Tamarix sp.* and arrow weed *Tessaria sericea.* The sand spit has several native mesquites *Prosopis sp.*. Upslope vegetation is composed of creosote bush *Larrea tridentata* and cholla *Opuntia sp.* and beavertail *Opuntia sp.* cactus. Although the surrounding area is heavily used by recreationists, the cove itself is rarely visited.

Helicopter Cove, AZ.

Like Pittsburgh Point Cove, Helicopter Cove (Figure 4) is seperated from the lake by a naturally occuring sand spit. Upslope vegetation is composed of creosote bush and cholla and beavetail cactus. The cove has a surface area of about one quarter acre. Maximum depth fluctuates from 1.0 to 0.5 meters during the year. Bottom substrate consists of fine silt and organic material. Cattails are present along most of the shoreline with a large, dense growth occuring at the back of the cove.

Bulkhead Cove, CA.

Bulkhead Cove near Parker Dam, was formed by the completion of an earthern berm built during construction of Parker Dam. The cove is situated in a small deep canyon with very rocky slopes. Upslope vegetation is predominately brittle bush *Encelia farinosa* and foothill paloverde *Cercidium florida* with scattered cholla and barrel cactus *Ferocactus sp.* The cove has a surface area of 0.21 acres and a volume of 0.84 acre-feet (Figure 5). Bottom substrate is primarily bedrock and cobbles with steeply sloping banks covered with a thin layer of silt and fine organic matter. Shoreline vegetation extends the perimeter of the cove and is comprised of salt cedar, arrow weed, and honey mesquite *Prosopis juliflora*. A small growth of spiny naiad occured in the back of the cove in 1994 but has not been observed since.

Office Cove, AZ.

This 2.5 surface acre cove is located adjacent to the Bill Williams River National Wildlife Refuge headquarters. Bottom substrate consists chiefly of fine silt and organic matter. Topography of the cove bottom is relatively even (Figure 6). In July 1995, BR constructed a berm across the mouth of this cove to replace the barrier net. A large, dense growth of cattails occurs at the back of the cove. Surrounding terrestrial vegetation is composed primarily of creosote bush and salt cedar.

No Entry Cove, AZ.

The landscape surrounding the cove is steep and rocky with many outcrops and little vegetation. Underwater topography (Figure 7) is a continuation of that found upslope. Bottom substrate is primarily rock covered with a layer of silt and algae. Silt deposition occurs primarily in the old drainage channel. A sand and gravel bar has formed at the rear of the cove. Many rocky redges are found underwater which makes the topography highly variable. Surface area is approximately 0.6 acres.

Average width and depth is approximately 20 and 4 meters respectively. The depth of this cove limits macrophyte growth to a small area at the extream rear of the cove. The barrier net for for this cove was installed in April 1994.

Twin Coves North and South. CA.

These backwaters of the Colorado River are typical of the backwater habitats found in the Topock Gorge reach. They are situated in shallow ravines cut through a bajada. Surrounding upslope vegetation consists of creosote bush and cactus. Salt cedar, mesquite, and arrow weed dominate the narrow riparian community. A lush growth of cattail occurs in the back of each cove. In each cove, adjacent to the river, are dense, narrow stands of giant bulrush that extend across the mouth of each cove and, in affect, limits water movement into and out of the cove. Sparse patches of giant bulrush are also found along the shoreline. Submergent macrophytes, primarily *Potemogeton pectinatus*, begin growth in the spring, rapidly cover about 80% of each ponds surface, and persist until November. Pond bottoms are composed of fine silt and organic matter. Twin Cove North (Figure 8) and Twin Cove South (Figure 9) average about 1.5 meters in depth. Bottom topography is relatively uniform throughout each pond. Barrier nets were installed in October 1994.

Emerald Canyon Golf Course Ponds. AZ.

These four ponds, designated Pond 1, Pond 12, Pond 18 Upper, and Pond 18Lower, are located on the Parker Strip at the Emerald Canyon Golf Course about five miles south of Parker Dam. The golf course is operated by La Paz County through a lease agreement with the BLM. Utilization of these ponds as grow-out facilities was made possible through efforts spearheaded by the Parker FRO. Pond 1, Pond 12, Pond 18 Upper, and Pond 18 Lower morphologies are shown in Figures 10, 11, 12, and 13, respectively. All four ponds are surrounded by golf course greens and fairways. Cattails comprise the little emergent vegetation that exists. All ponds have sparse, widely scattered growths of *Potamogeton sp.*. Pond levels are maintained by pumping water from the Colorado River. Application of inorganic fertilizers to the golf course may help to increase productivity. Pond bottoms are clay.

METHODS

Barrier Nets

Due to the lack of suitable, naturally occuring isolated habitats availiable in the project area, barrier nets were used in four coves. These nets were individually designed and constructed to conform to site specific pond dimensions. Nets were constructed of quarter inch delta mesh dipped in plasti-coat. Suspension was provided by oval barrier floats, spaced four feet apart, and held in place using quarter inch aircraft cable. Metal "T" posts, driven into the ground at oposite ends of the net, provided anchoring points for the cable. The cable at No Entry Cove had to be attached to eyebolts anchored into rock. The tops of all nets were wrapped over the barrier float line to elevate it about 30 cm above the water surface to minimize fish escapement or entry over the net. Sand bags, installed by SCUBA divers, were used to anchor the bottom of the net. Spacing of sand bags, determined by substrate type and topography, was typically two to four feet. The net at No Entry Cove required end to end placement. To hold the sand bags in place, the bottom of the net was wrapped over the bags and tied to a seam at the back of the net with plastic "zip-ties".

Fish Capture

Considerable effort was made to capture bonytail chub and razorback suckers from all facilities to monitor growth and survival and to control piscivorus fish. A wide variety of gear was used and included trammel nets (length 91.4 m, width 1 .82m, inner mesh 2.54 cm, outer mesh 30.5 cm and length 30.48 m width 1.82 m, inner mesh 1.27 cm, outer mesh 15.24 cm), cylindrical wire minnow traps (length 91.44 cm, dia. 22.86 cm, mesh 0.64 cm, throat 2.54 cm; length 91.44 cm, dia. 30.48 cm, mesh 0.64 cm, throat 5.08 cm; and length 121.92 cm, dia. 91.44 cm, mesh 1.27 cm, throat 7.62 cm), and hoop-nets (length 1.83 m, dia. 0.91 m, mesh 0.64 cm, throat 10.16 cm). Trammel nets were set at night and ran a minimum of every two hours. Traps were set and ran during the day (soak time one to two days).

To monitor and control large non-target fish, primarily piscivorous fish, that had immigrated into No Entry, Twin Cove North, and Twin Cove South, 6.35 cm square mesh gill nets (length 60.96 m, width 1.83 m) were used extensively in these coves.

A bag seine (length 91.44 m, width 3.05 m, bag 3.05 X 3.05 m, mesh 1.27 cm) was used to sample ponds at the Emerald Canyon Golf Course. The seine is large enough to completely cover each pond in one haul. One to three hauls are made at each pond per effort-day.

A electrofishing boat was used at Pittsburgh Point Cove the night of September 27, 1995 (1178 seconds) and at Twin Cove South and North the night of September 26, 1995 (1,411 and 907 seconds, respectively).

Fyke nets (length 6.1 m, width 1.8 m, height 1.8 m, mesh 0.64 cm) with two wings (length 15.3 m, width 1.83 m, mesh 0.64 cm) were set in Twin Cove North and Twin Cove South (one in each cove) and ran continuously for 3.5 months. The effort was primarily to control piscivorous fish species.

Total length (TL) in millimeters and weight in grams were recorded for each razorback sucker and bonytail chub collected and for most other species captured. Mass weights were occasionally recorded for non-native species.

Water Quality

Water quailty stations were established at the location of the maximum depth of each pond. Frequency of site visits varied but each facility was monitored usually no less than once per month. Samples were collected between 0900 and 1500 hours. Measurements of depth (m), water temperature (deg. C), dissolved oxygen (mg/L), dissolved oxygen saturation (%), specific conductivity (mS/cm), total dissolved solids (mg/L), oxidation-reduction potential (mV), and pH were made with a Hydrolab Corporation H20 submersible data transmitter, with direct readout. These variables were measured every one-half meter from surface to bottom.

Total alkalinity (mg/L), total hardness (mg/L), and total ammonia nitrogen (mg/l) were measured using a Hach Cemical Company, Model FF-1, Fish Farmer Water Quality Test Kit. Hach Cemical Company test kits were also used to measure the concentrations, in mg/L, of ortho-phosphate (PO4), phosphorous (P), and sulfate (SO4). A standard secchi disk was used to assess visibility (m). Turbidity (NTU) was measured using a Hach Turbidimeter and turbidity in JTU's was evaluated with a Bausch and Lomb Spectronic 70 using methods described in Lind (1975). Surface and bottom samples only were analyzed with the Hach kits. A vertical Kemmerer bottle was used to collect bottom samples for the Hach kit analysis.

Monthly means of parameters measured with the Hydrolab were calculated by first determining the parameter mean of the verticle profile for each site visit. If more than one site visit was made during the month, all vertical profile means in that month were averaged to obtain the monthly mean. Monthly means of parameters measured with the Hach kits was determined by averaging top and bottom readings and, if more than one site visit was made during the month, the means were combined and averaged to produce the monthly mean.

1995 STOCKING

Stocking rates (No. Fish/ha) for razorback suckers were based on our assumptions of the carrying capacity of each facility. Stocking rates for bonytail chub were based on the large number of these fish available from Dexter National Fish Hatchery. It was felt that the juvenile bonytail survival would be higher in the grow-out facilities than if placed directly into Lake Mohave.

Fish distribution and stocking data for the 1995 grow-out period is presented in Table 1. Razorbacks were obtained initially as larvae or eggs from Lake Mohave stock, reared to stockable size at Willow Beach National Fish Hatchery, then stocked into grow-out facilities. All facilities received juvenile fish except Bulkhead Cove where larval bonytail chub were planted.

Table 1. Distribution of razorback suckers (RZBK) and bonytail chub (BTC) stocked into Lake Havasu and Emerald Canyon Golf Course (ECGC) grow-out facilities during the 1995 grow-out period.

Grow-out Facility	Date Stocked	Number Stocked BTC	Number Stocked RZBK	Stocking Rate (No. Fish/Hectare)
Pittsburgh Point Cove	8 Sep 94	4,248		8,169
	20 Jan 95		3,323	6,390
	10 Jul 95		355	683
Helicopter Cove	24 Oct 94	189		3,150
	20 Jan 95		100	1,667
	10 Jul 95		100	1,667
Bulkhead Cove	17 Aug 94	650		8,125
	20 Jan 95		172	2,150
Office Cove	18 Oct 94	25,575		26,366
No Entry Cove	24 Oct 94	37,152		123,840
Twin Cove North	31 Oct 94	19,829		32,507
Twin Cove South	31 Oct 94	19,829		32,507
ECGC-Pond 1	27 Oct 94	5,732		15,922
	6 Jul 95		1,465	4,069
ECGC-Pond 12	27 Oct 94	9,939		15,291
	6 Jul 95		4,423	6,805
ECGC-Pond 18U	27 Oct 94	3,156		19,725
	6 Jul 95		1,290	8,063
ECGC-Pond 18L	27 Oct 94	8,569		19,475
	6 Jul 95		1,290	2,932
Totals		134,868	12,518	

CAPTURE

Razorback sucker and bonytail chub captures (Table 2) were highly variable within sites and the number captured did not appear to correlate highly with known large population sizes. Capture efforts using minnow traps or small mesh trammel nets shortly after stocking, when populations should be high, had highly variable results in terms of the number of fish caught. Gear selectivity and placement probably accounts for much of this variability. Because of this, the use of catch per unit effort calculations are not used to assess population status.

Collected non-native fish species reflected the assembledge found in Lake Havasu (Table 2) with highest numbers and greatest diversity of fish found in facilities using barrier nets (i.e., Office Cove, No Entry Cove, and Twin Coves North and South). Piscivorous fish numbers were also highest in these coves.

In the fall of 1994, a SCUBA dive team was contracted for one year to monitor bi-weekly and repair all barrier nets as needed. Although each net was checked and repaired every two weeks, large numbers of predator fish entered these coves. It is apparent that given the constraints of funding and logistics, barrier nets cannot be designed, constructed, or maintained to exclude all fish movement. For these reasons, the barrier net at No Entry Cove was removed in the summer of 1995.

GROWTH

Bonytail Chub

Bonytail chub growth rates were highest in Bulkhead Cove (Figure 14) where releasable size fish, stocked as larvae in August 1994, were captured after a grow-out period of 12 months. Bonytails captured from this pond in December 1994 (mean TL 54 mm, n=28) showed an increase of 44% in TL. A subsequent capture in May 1995 of 14 individuals (mean TL 162 mm) had an increase of 67% over those captured in December. The first releasable size fish was captured in October 1995 (TL 301 mm,

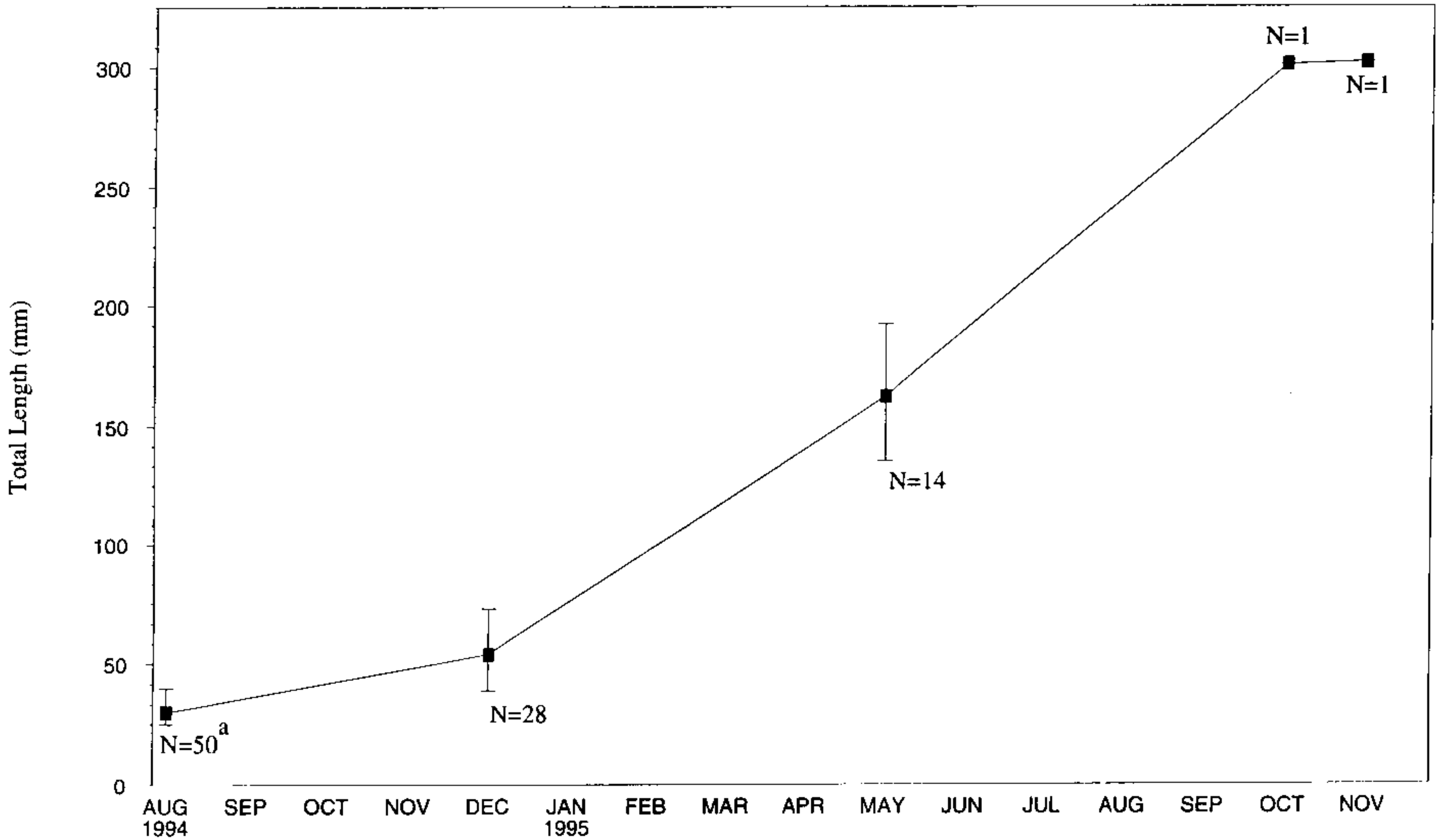
Table 2. Species, numbers, and percent relative abundance in parenthesis, of fish captured from grow-out facilities in 1995. Razorback suckers were not stocked into Office Cove, No Entry Cove, Twin Cove North or Twin Cove South in 1994 - 1995.

	Grow-out Facility *										
Taxon	PPC	HC	BC	OC **	NE	TCS	TCN	P1	P12	P18U	P18L
Threadfin Shad *Dorosoma petenense*				716 (21)					1,550 (79)	10 (5)	
Goldfish *Carassius auratus*	84 (12)										
Common Carp *Cyprinus carpio*				38 (1)	5 (2)	4 (1)	3 (<1)		6 (<1)	4 (2)	1 (2)
Bonytail Chub *Gila elegans*	518 (75)	80 (56)	2 (2)	57 (1)				2,112 (89)	300 (15)	17 (8)	33 (78)
Razorback Sucker *Xyrauchen texanus*	3 (<1)	19 (14)	27 (25)			1 (<1)		269 (11)	94 (5)	139 (69)	2 (4)
Flathead Catfish *Pilodictis olivaris*				1 (<1)	2 (<1)						
Channel Catfish *Ictalarus punctatus*				15 (<1)	24 (10)						
Yellow Bullhead *Ameiurus natalis*	88 (13)		52 (47)	2 (<1)	10 (4)	1 (<1)	5 (1)				
Mosquitofish *Gambusia affinis affinis*		43 (30)	29 (26)								
Striped Bass *Morone saxatilis*					1 (<1)						
Largemouth Bass *Micropterus salmoides*				70 (2)	35 (15)	157 (59)	274 (67)				
Green Sunfish *Chaenobryttus cyanellus*				29 (<1)	73 (31)	62 (23)	24 (6)		1 (<1)	18 (9)	3 (7)
Bluegill *Lepomis macrochirus*				2,489 (72)	84 (36)	38 (14)	97 (24)		1 (<1)	15 (7)	1 (2)
Redear Sunfish *Lepomis microlophus*				7 (<1)		2 (<1)	2 (<1)				3 (7)
Black Crappie *Pomoxis nigromaculatus*				19 (<1)			1 (<1)				
Total Number of Fish	693	142	110	3,443	234	265	406	2,381	1,952	203	43

* PPC, Pittsburgh Point Cove; HC, Helicopter Cove; BC, Bulkhead Cove; NE, No Entry Cove; TCS, Twin Cove South; TCN, Twin Cove North; P1, Pond 1; P12, Pond 12; P18U, Pond 18 Upper; P18L, Pond 18 Lower.

** Data presented are from September 22, 1995 rotenone treatment and collections made prior to berm construction in July 1995.

Figure 14. Monthly growth of bonytail chub in Bulkhead Cove in 1994-95. Verticle lines represent minimum and maximum total lengths (mm) and boxes are mean total lengths (mm) of monthly pooled data.



a. 650 larval BTC stocked in 17 Aug 94.

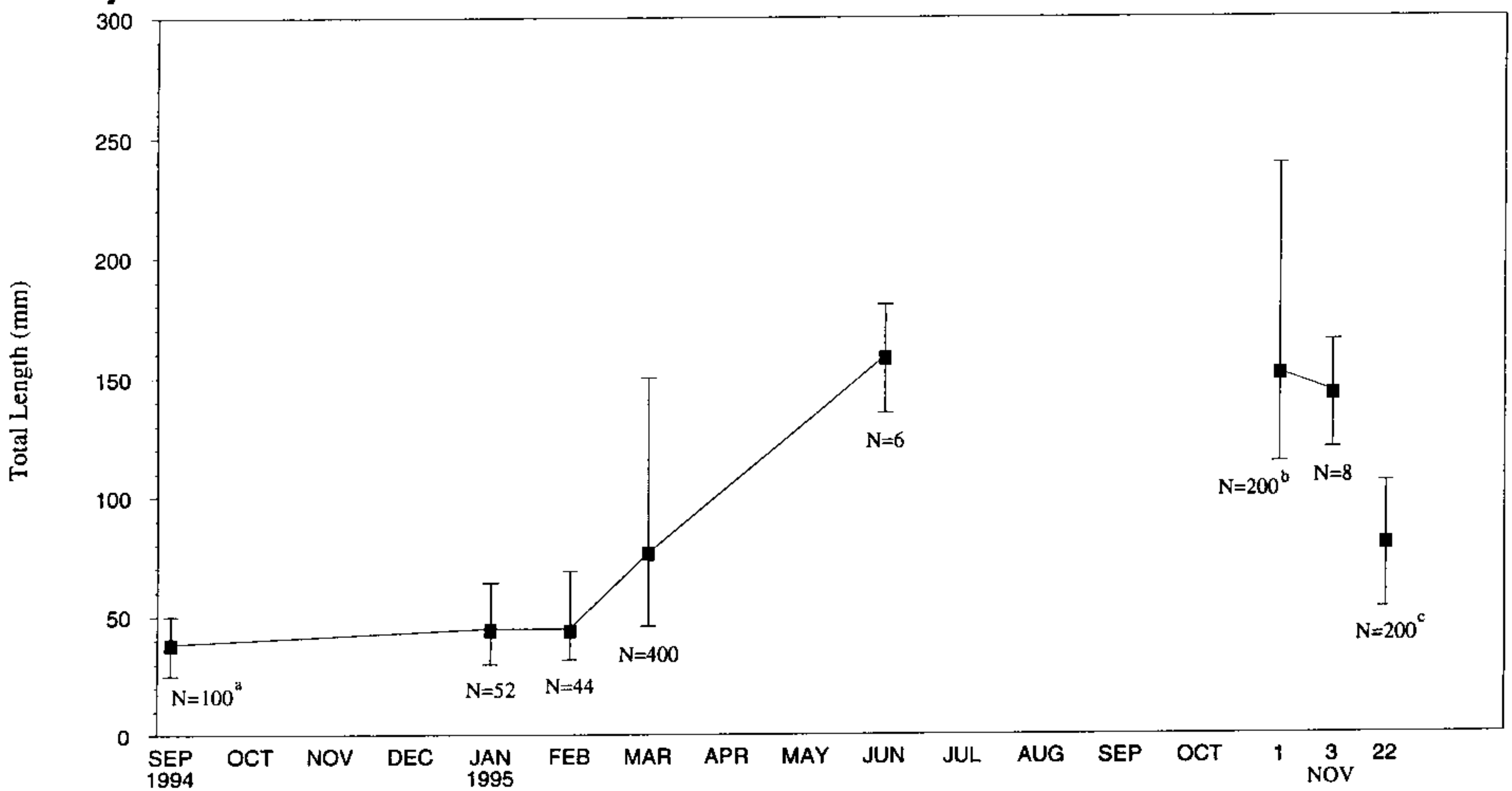
n=1). These data show a mean monthly increase of 19.4 mm TL over a 12 month period. Mean bonytail chub TL in Pittsburgh Point Cove (Figure 15) increased 14% from stocking in September (mean TL 38 mm, n=100) to February (mean TL 43.8 mm, n=44). From February to June (mean TL 157.8 mm, n=6) growth increased substantially (72%). Due to the anoxic conditions in this pond during the summer, we believe that most or all bonytail perished.

Helicopter Cove (Figure 16) winter growth rates were lower than those found in Pittsburgh Point Cove. From stocking in October (mean TL 31.0 mm, n=100) to March (mean TL 53.5 mm, n=18) TL increased 42%. Growth improved from March to July most likely due to the increase in water temperature. Mean TL for June captures was 138.1 mm (n=3), a 62% increase over March. Like Pittsburgh Point Cove, this pond becomes anoxic in the summer and few or no fish are believed to survive into the fall.

Disappointing growth occurred in Office Cove (Figure 17) possibly due to the heavy predator load inside the cove (Table 2) when the barrier net was in place. In this cove, an increase in TL of 16% was seen from stocking in October (mean TL 91.0 mm, n=100) to March (mean TL 112.3 mm, n=3). Growth became virtually static from March to May (mean TL 124.4 mm, n=29) with a TL increase of only 7%. No bonytail chub were capture after May.

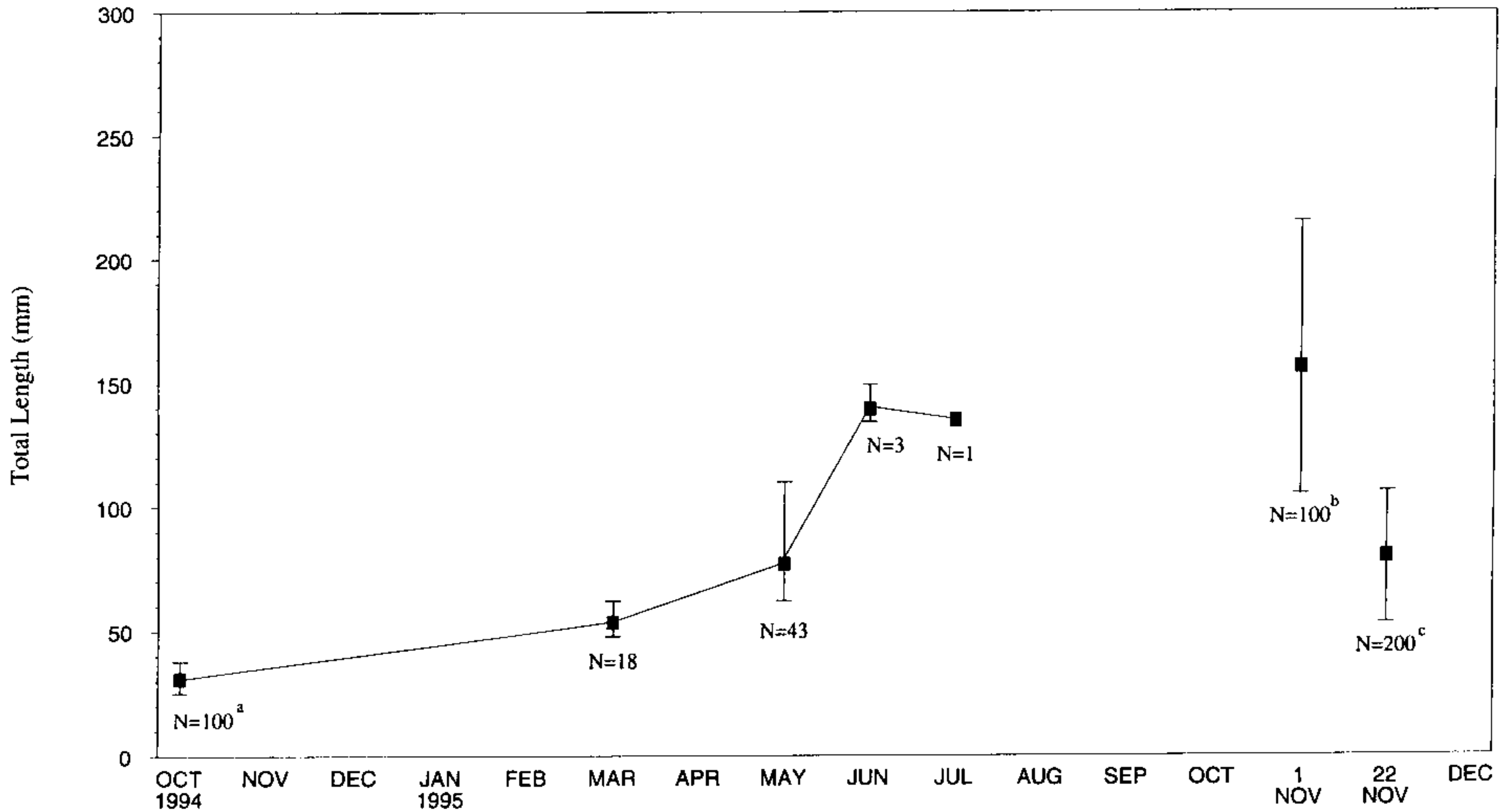
At ECGC Pond 12 (Figure 18) growth was such that fish could reach releasable size in nine months when stocked as juveniles. From a stocking mean TL of 87.5 mm (n=80) in October, to a May mean TL of 118.4 mm, (n=42), an increase of 26% was seeing during the winter. Growth accelerated with warmer water temperatures;

Figure 15. Monthly growth of bonytail chub in Pittsburgh Point Cove in 1994- 1995. Verticle lines represent minimum and maximum total lengths (mm) and boxes are mean total lengths (mm) of pooled monthly data.



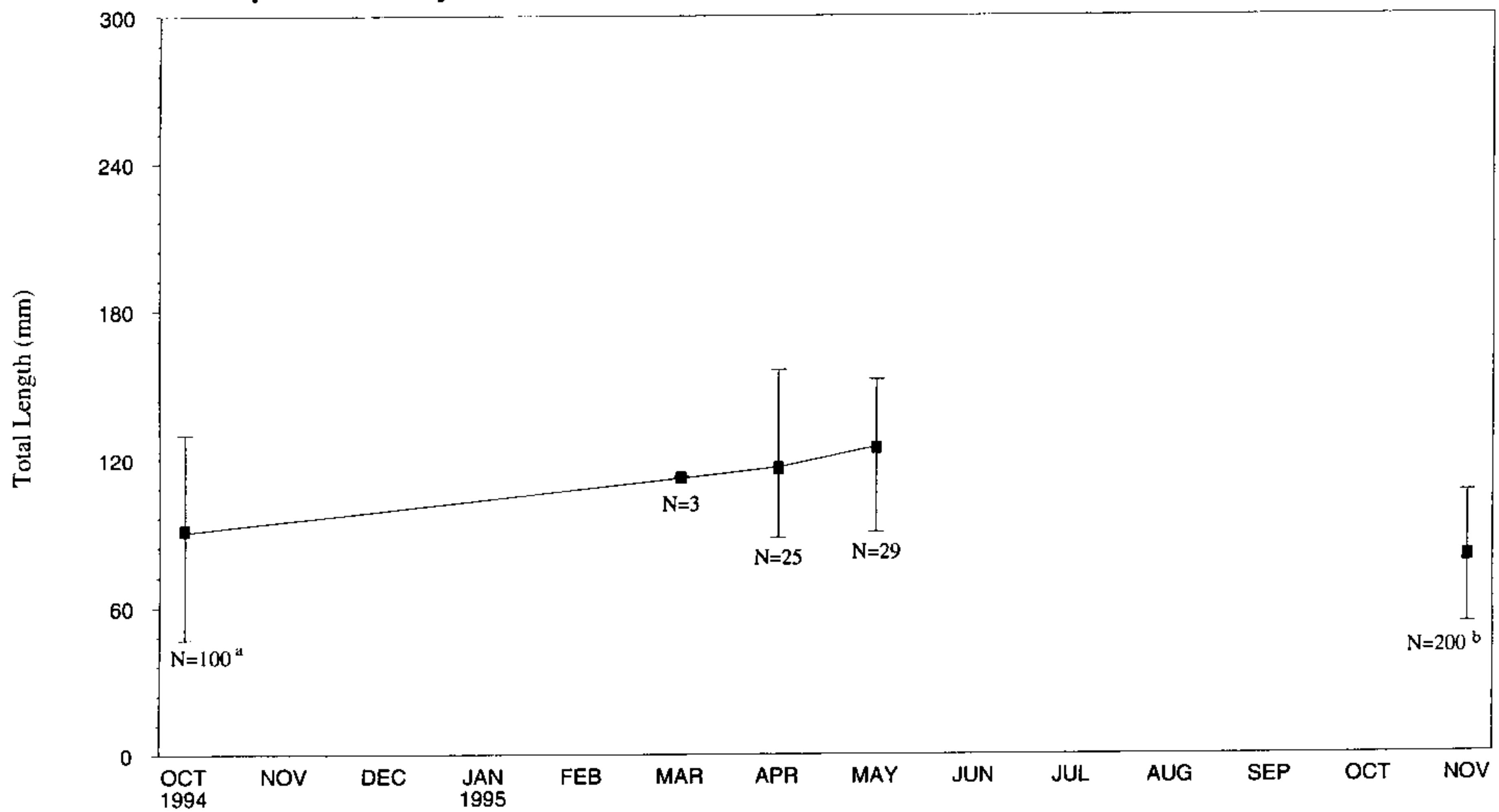
a. 4,248 BTC stocked 8 Sep 94.
b. 250 BTC stocked 1 Nov 95 (transfered from Pond 1).
c. 200 BTC stocked 22 Nov 95.

Figure 16. Monthly growth of bonytail chub in Helicopter Cove in 1994-1995. Verticle lines represent minimum and maximum total lengths (mm) and boxes are mean total lengths of pooled monthly data.



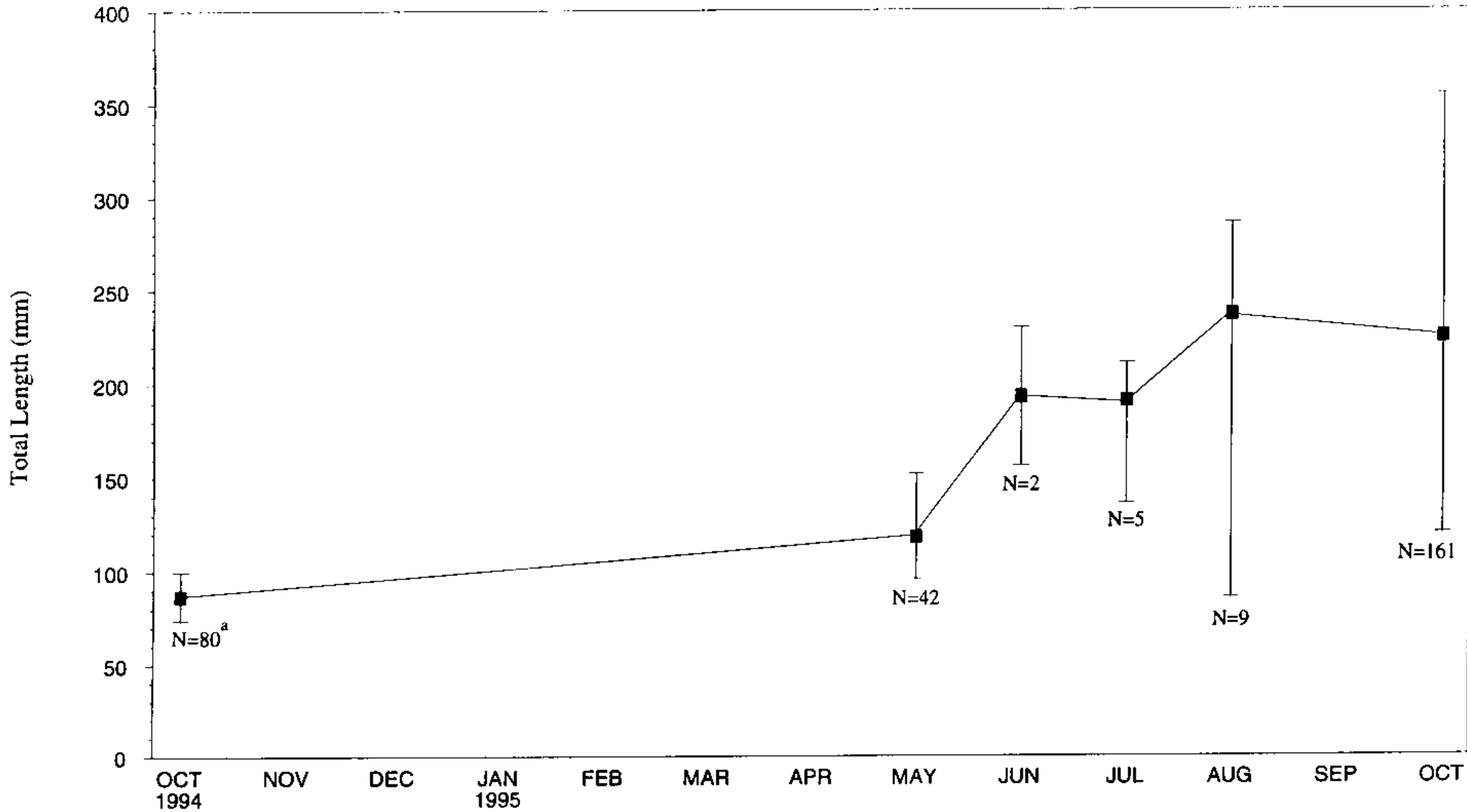
a. 189 BTC stocked 24 Oct 94.
b. 150 BTC stocked 1 Nov 95 (transfered from Pond 1).
c. 120 BTC stocked 22 Nov 95.

Figure 17. Monthly growth of bonytail chub in Office Cove during 1994-95. Vertical lines represent minimum and maximum total lengths (mm) and boxes are mean total lengths (mm) of monthly pooled data. Earthen berm completed 21 July 95.



a. 25,575 BTC stocked 18 Oct 94.
b. 11,000 BTC stocked 21 Nov 95.

Figure 18. Monthly growth of bonytail chub in Emerald Canyon Golf Course Pond 12 during 1994-1995. Verticle lines represent minimum and maximum total lengths (mm) and boxes are mean total lengths (mm) of monthly pooled data.



a. 9,939 BTC stocked 27 Oct 94.

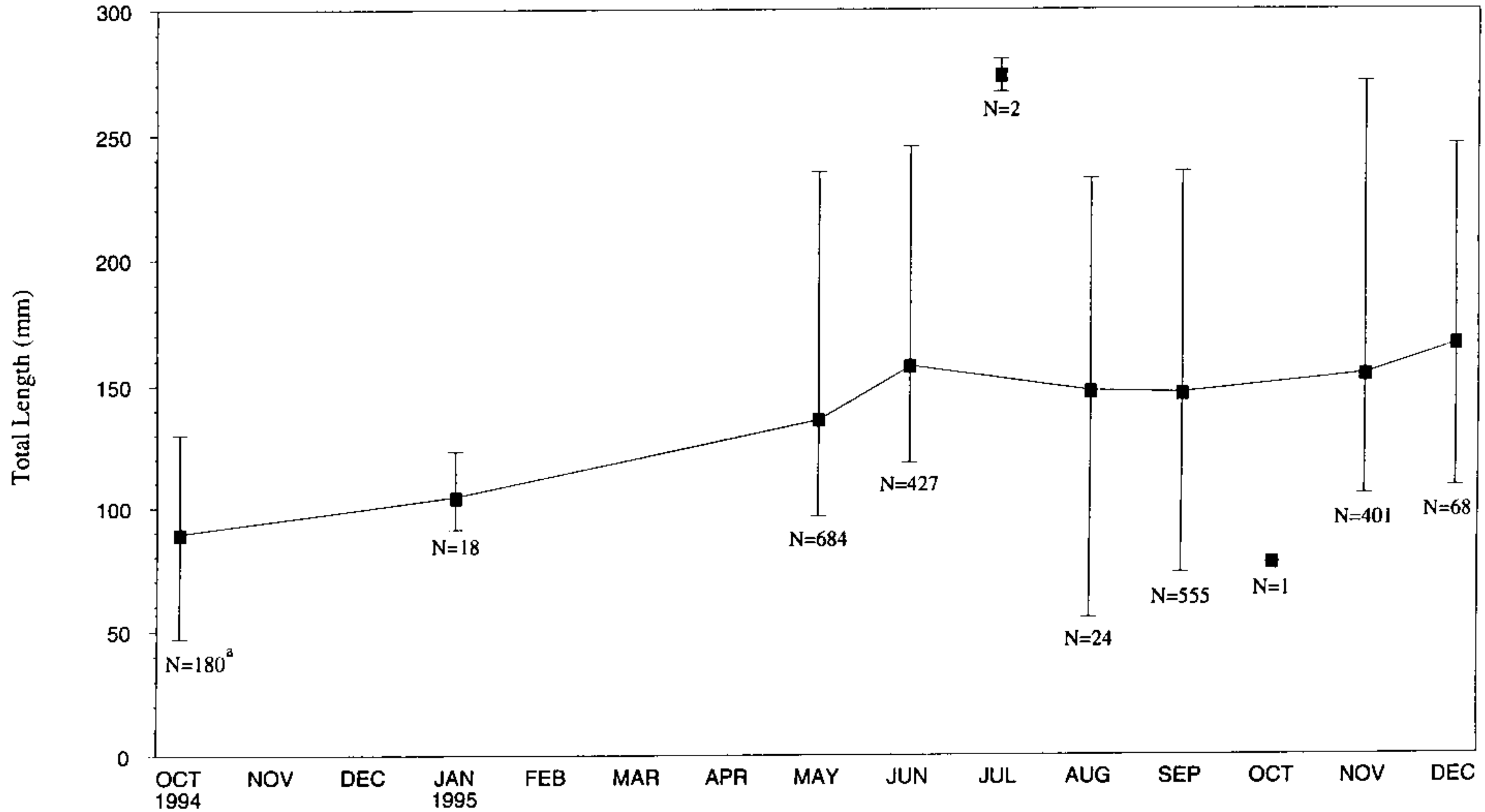
from May to June these fish grew an average of 74.6 mm (39%). Growth was nearly static from June through October with only an increase of 31 mm (19%). Apparently, the carrying capacity of the pond was near maximum.

ECGC Pond 1 bonytails also had very low growth rates (Figure 19) attributable to over-population. An increase in TL of 34% was seen from stocking in October (mean TL 89.0 mm, n=180) to May (mean TL 135.7, n=684). Summer and fall rates were relatively static with an increase of 12% from May to November (mean TL 153.4 mm, n=401). It appears that some individuals were better able to utilize the limited food resources because in July, eight months after stocking, two bonytails were capture from Pond 1 and released into Lake Havasu.

ECGC Pond 18U (Figure 20) and ECGC Pond 18L (Figure 21) produced releasable size fish in July after a eight month growth-out period. Similar growth was seen between these two ponds. In Pond 18U, bonytails grew 56% from October 1994 stocking (mean TL 87.0 mm, n=80) to October 1995 (mean TL 199.9 mm, n=15). An increase of 55% was seen for bonytails grown-out in Pond 18L over the same time period.

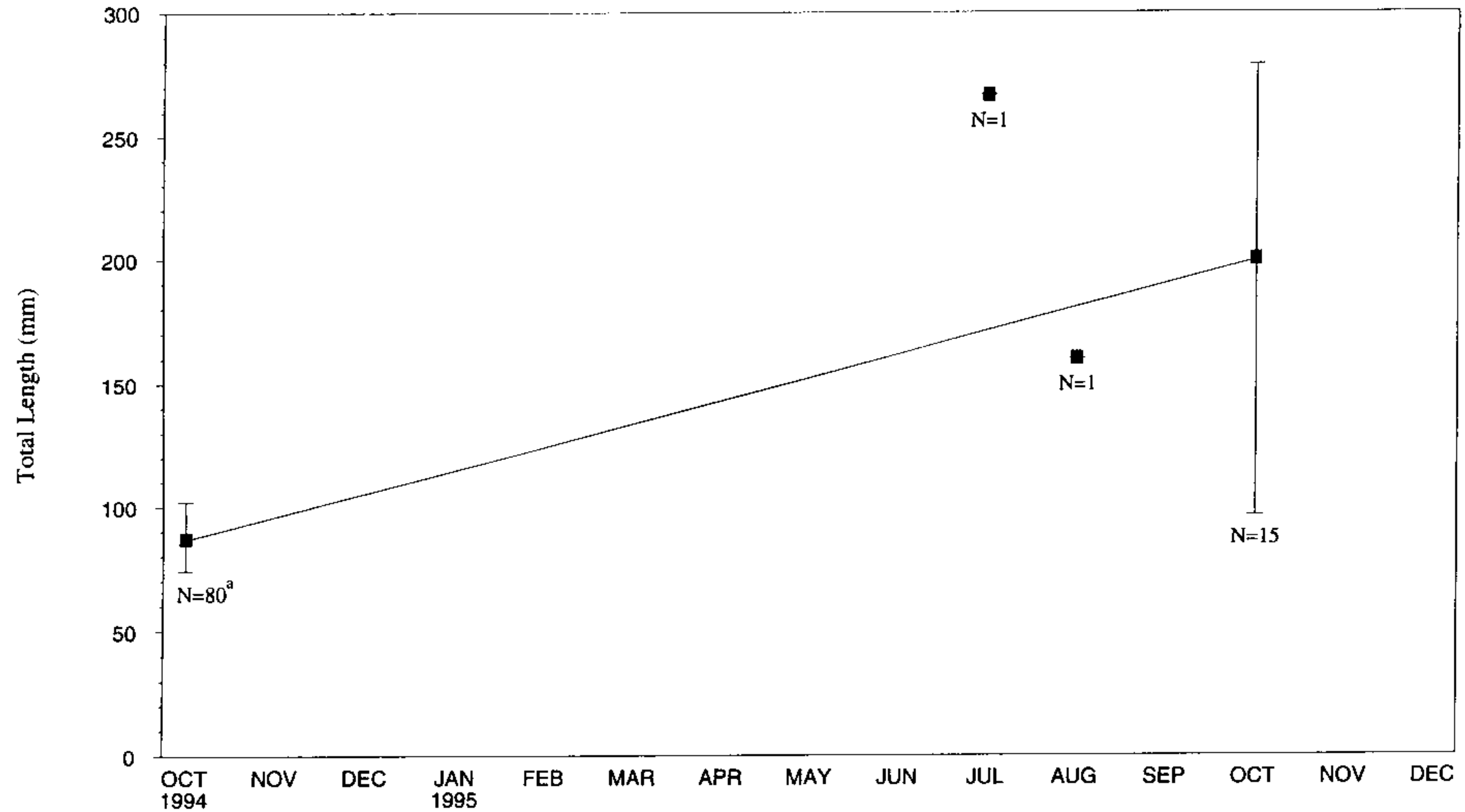
No bonytail chub was captured from Twin Cove North, Twin Cove South, or No Entry Cove after the initial stocking. We believe their disappearance was due to the inability of the barrier nets to exclude piscivorous fish and contain stocked bonytails.

Figure 19. Monthly growth of bonytail chub in Emerald Canyon Golf Course Pond 1 during 1994-1995. Verticle lines represent minimum and maximum total lengths (mm) and boxes are mean total lengths (mm) of monthly pooled data.



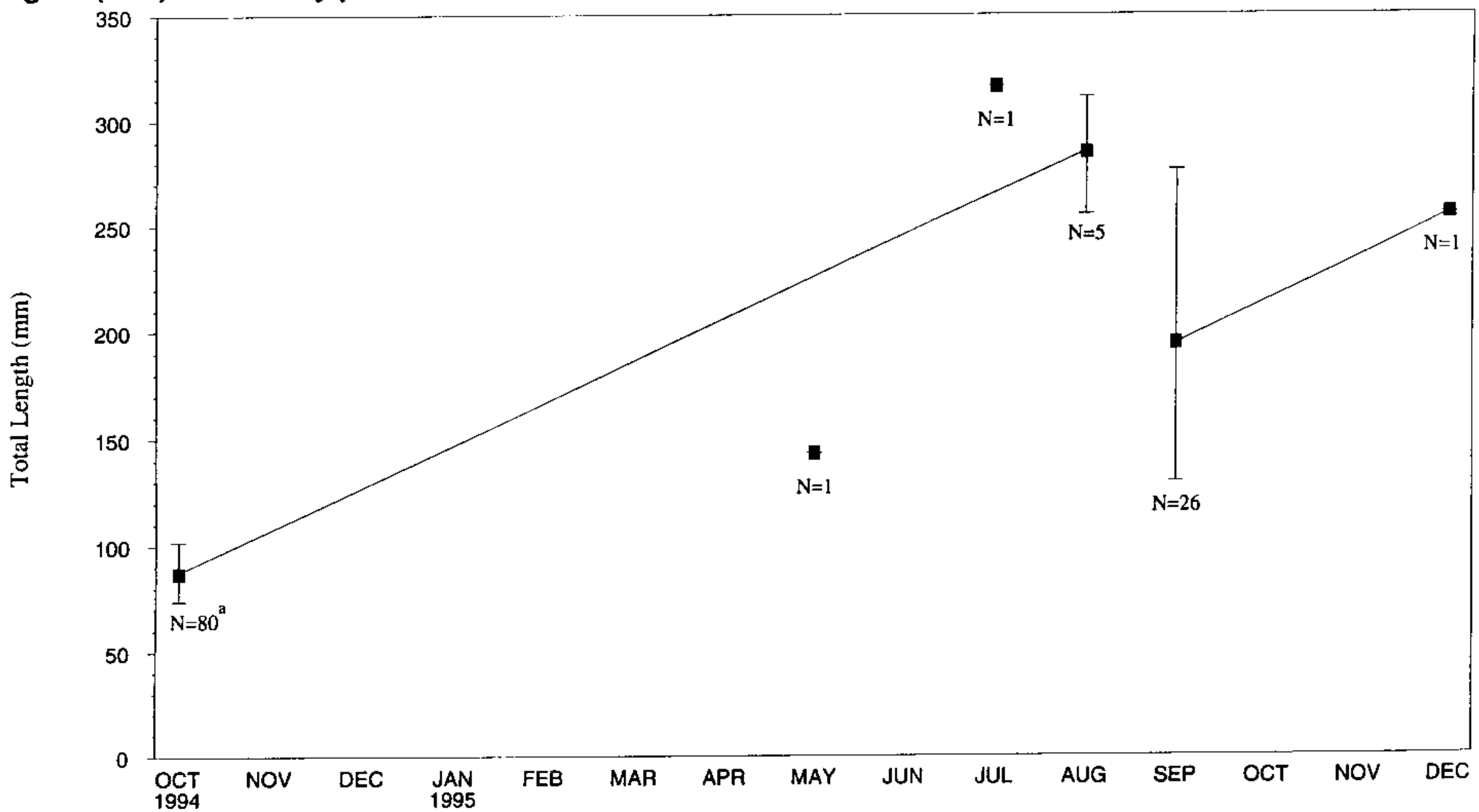
a. 8,757 BTC stocked in October 1994.

Figure 20. Monthly growth of bonytail chub in Emerald Canyon Golf Course Pond 18 Upper during 1994-1995. Verticle lines represent minimum and maximum total lengths (mm) and boxes are mean total lengths (mm) of monthly pooled data.



a. 3,156 BTC stocked 27 Oct 94.

Figure 21. Monthly growth of bonytail chub in Emerald Canyon Golf Course Pond 18 Lower during 1994-1995. Verticle lines represent minimum and maximum total lengths (mm) and boxes are mean total lengths (mm) of monthly pooled data.



a. 8,569 BTC stocked 27 Oct 94.

Razorback Suckers

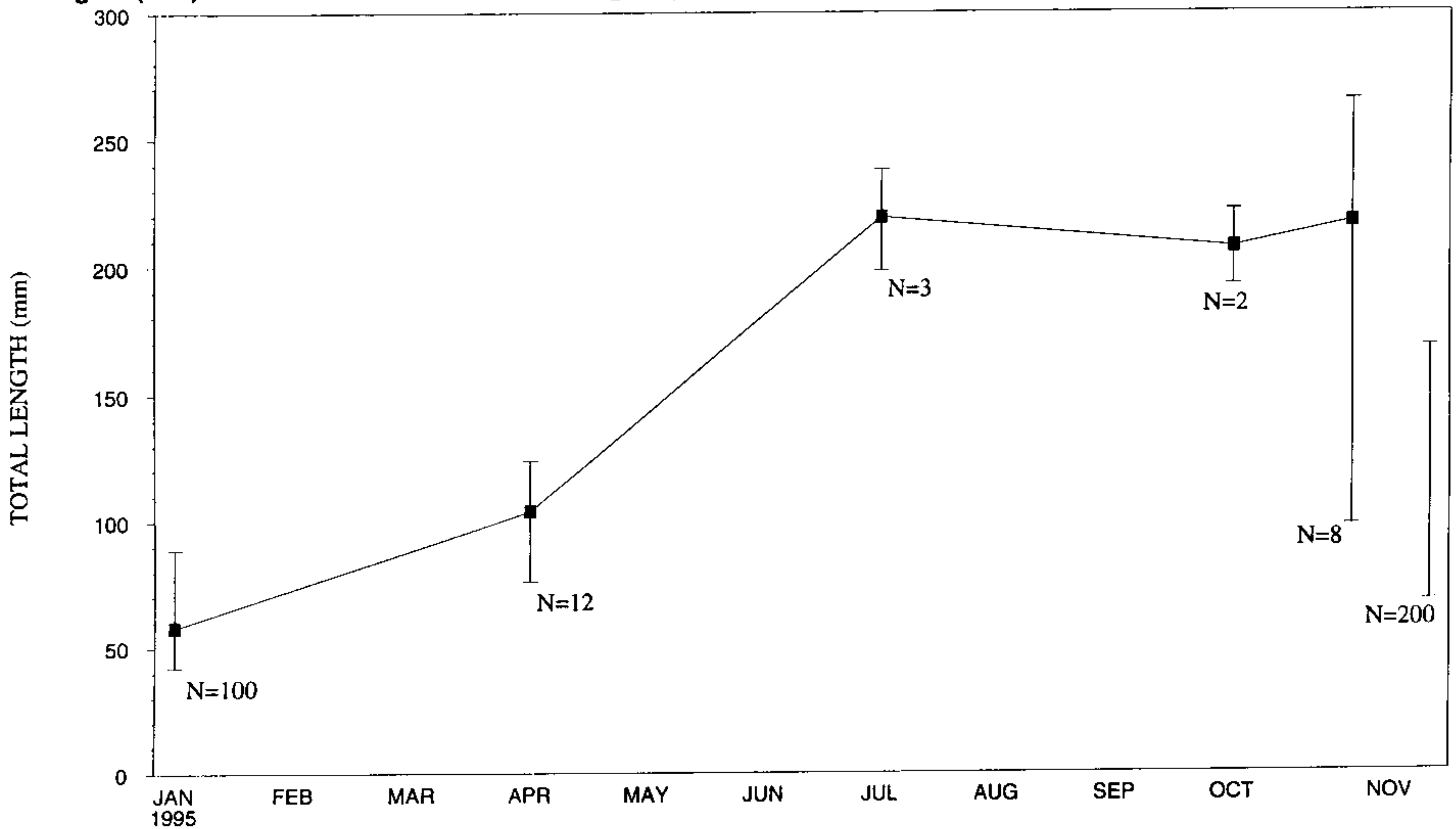
The first capture of releasable size razorback suckers from Bulkhead Cove (Figure 22) occurred in November after a nine month grow-out period. Good growth was seen from stocking in January (mean TL 58.0 mm, n=100) to July (mean TL 219.0 mm, n=3), an increase of 74%. Growth became static during the summer and fall, however sample sizes are small and data may be misleading. Three releasable size fish were captured from this pond in November.

Few razorbacks were collected after initial stocking from Pittsburgh Point and Helicopter Coves. Growth in Pittsburgh Point Cove (Figure 23) from stocking in January 1995 (mean TL 62.0 mm, n=200) to March (mean TL 85.0 mm, n=2) was 11.5 mm/month (27%). In October a single fin clipped fish was captured that measured 100 mm TL. Interestingly, this individual was fin clipped earlier in March and was able to survive presupposed lethal summer conditions.

Mean razorback TL was essentially unchanged in Helicopter Cove (Figure 24) between January (mean TL 67.0 mm, n=100) and March (mean TL 69.7 mm, n=15). No other fish from the January stocking were captured after March. In July 100 razorbacks were stocked (mean TL~30mm, n=40) with four of these fish captured a few weeks later (mean TL 52 mm). Although the sample size is small, these data show an increase of 42% in TL.

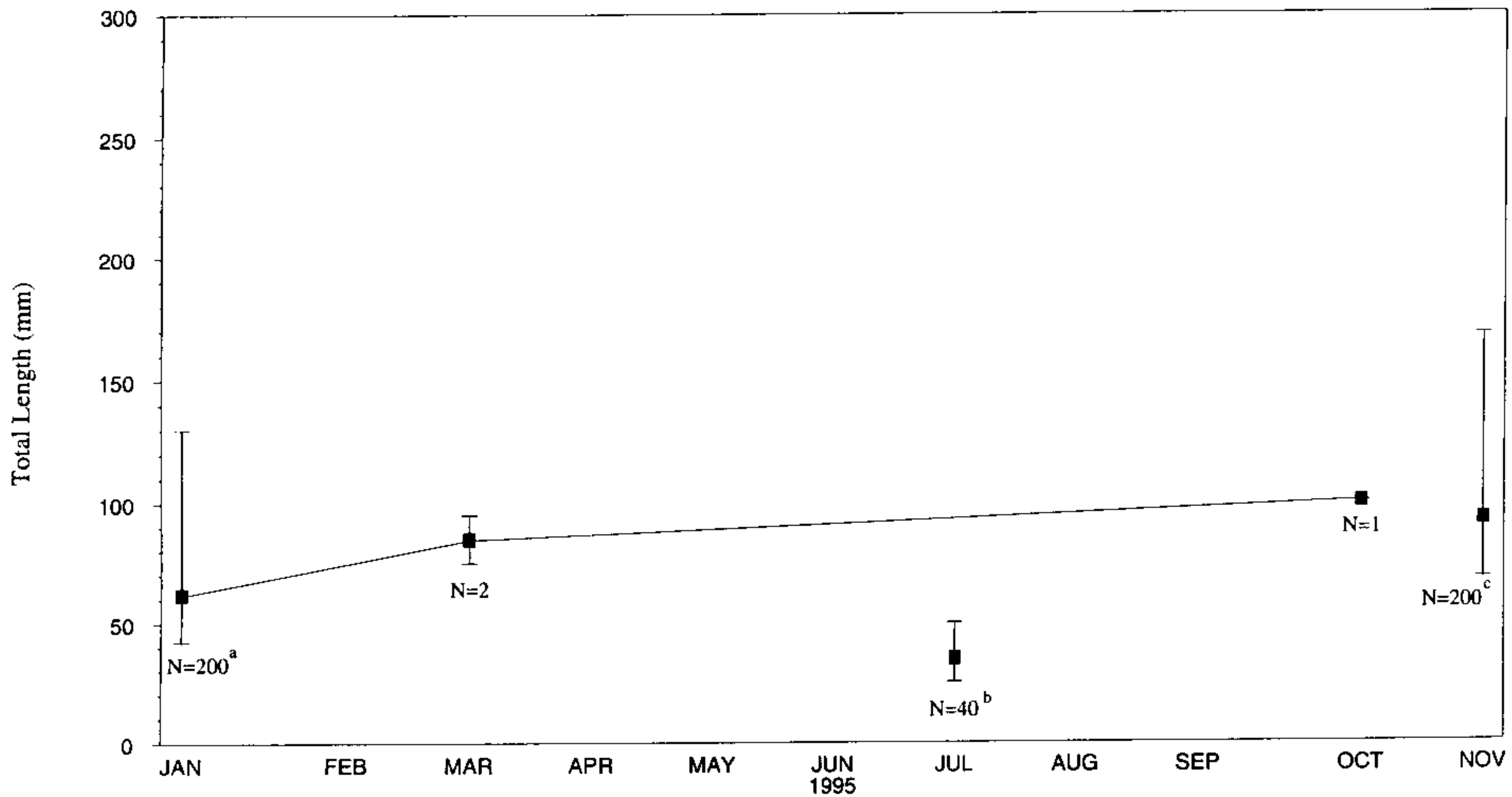
At ECGC Pond 1 (Figure 25) razorbacks grew from a mean stocking TL of 46mm (n=406) in July to a length of 135.2 mm (n=35) in August, a phenomenal increase of 66% in one month. However, captures in September (mean TL 111.4 mm,

Figure 22. Monthly growth of razorback suckers in Bulkhead Cove in 1995. Vertical lines represent minimum and maximum total lengths (mm) and boxes are the mean total lengths (mm) of monthly pooled data.



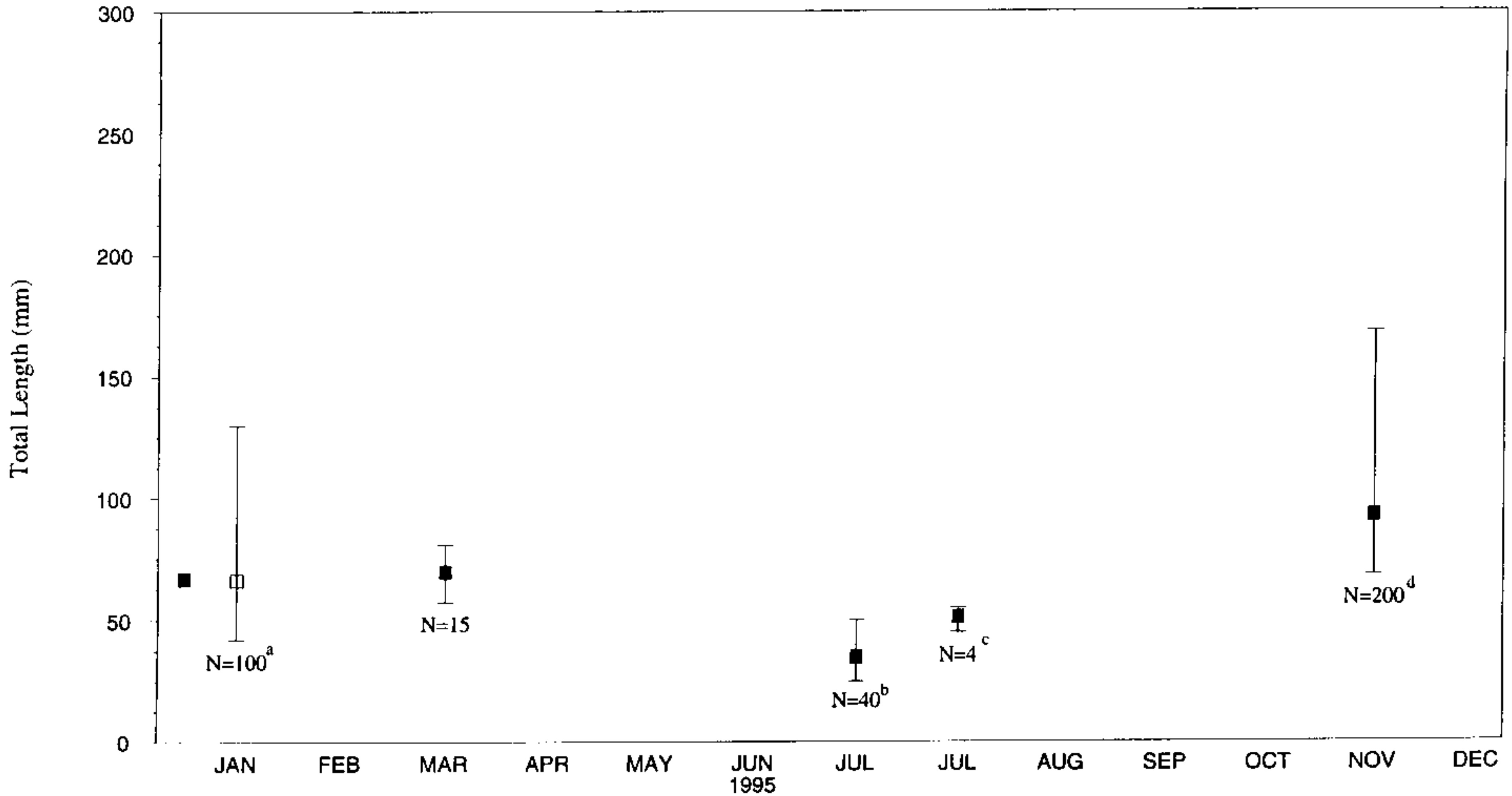
172 RZBK stocked on 20 Jan 95.
1,083 RZBK stocked on 27 Nov 95.

Figure 23. Monthly growth of razorback suckers in Pittsburgh Point Cove in 1994-1995. Verticle lines represent minimum and maximum total lengths (mm) and boxes are mean total lengths of pooled monthly data.



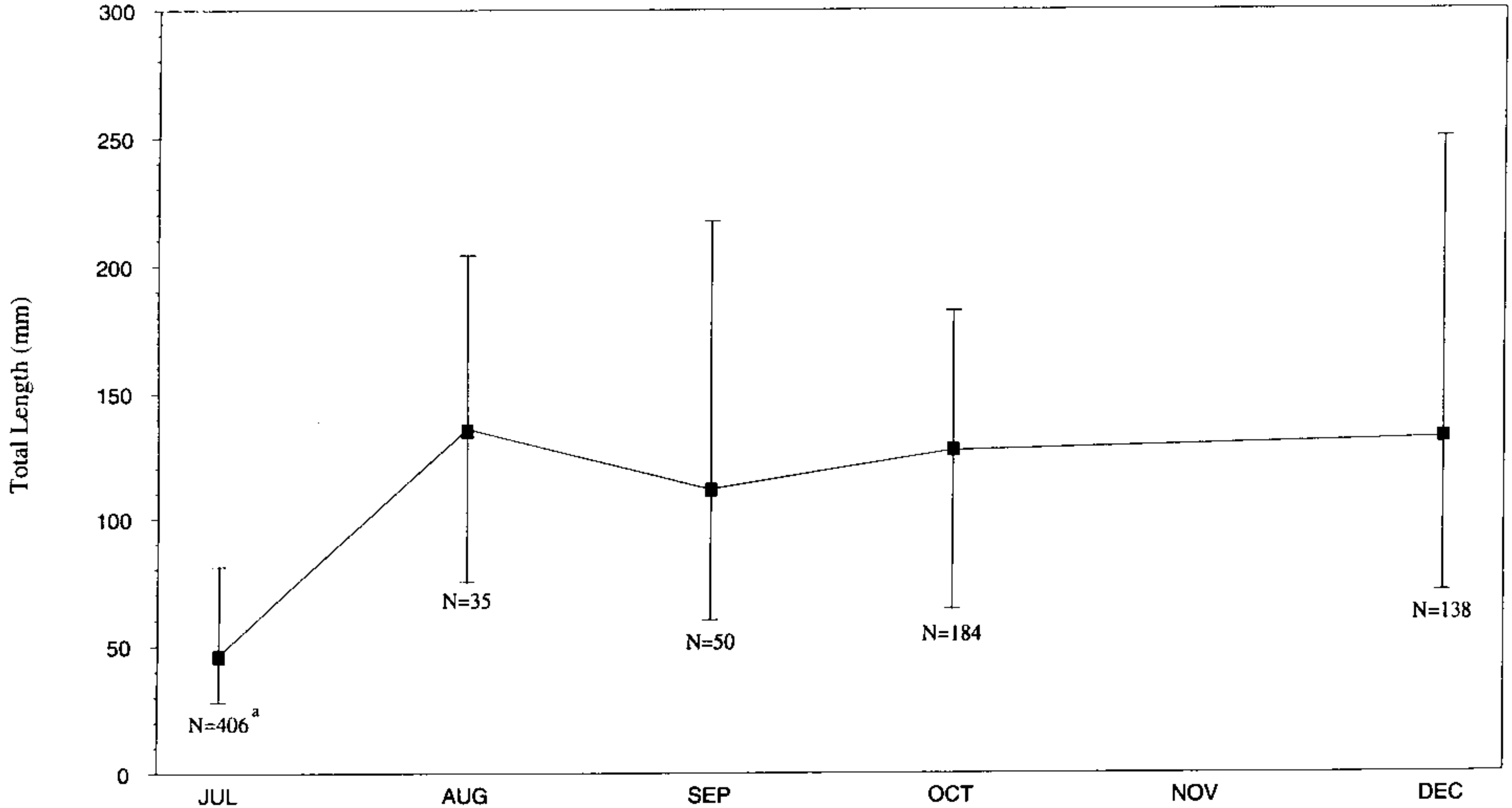
a. 3,323 RZBK stocked 20 Jan 95.
b. 355 RZBK stocked 10 July 95.
c. 300 RZBK stocked 22 Nov 95.

Figure 24. Monthly growth of razorback suckers in Helicopter Cove in 1995. Verticle lines represent minimum and maximum total lengths (mm) and boxes are mean total lengths of pooled monthly data.



a. 100 RZBK stocked 20 Jan 95.
b. 100 RZBK stocked 10 July 95.
c. Fish captured after 10 July stocking.
d. 200 RZBK stocked 22 Nov 95.

Figure 25. Monthly growth of razorback suckers in Emerald Canyon Golf Course Pond 1 during 1995. Verticle lines represent minimum and maximum total lengths (mm) and boxes are mean total lengths (mm) of monthly pooled data.



a. 1,465 RZBK stocked 6 July 95.

n=50) and October (mean TL 127.3 mm, n=184) suggest a decrease in growth and probably indicates the carrying capacity of the pond had been exceeded.

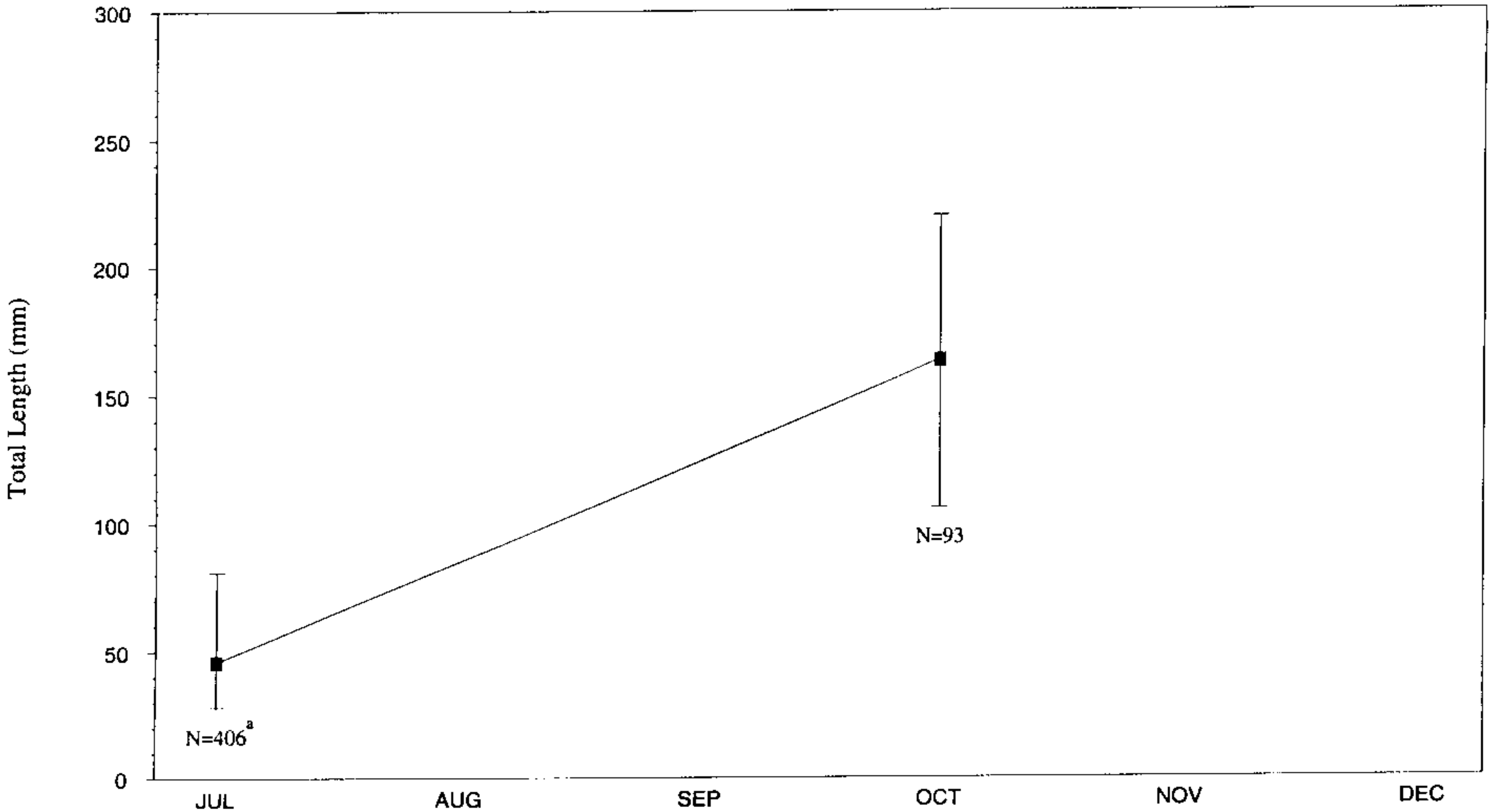
Razorback sucker growth in ECGC Pond 12 (Figure 26) was encouraging. Fish stocked in July (mean TL 46.0 mm, n=406) grew 72% by October (mean TL 163.0mm, n=93). In February 1996, the first releasable size razorbacks were captured from this pond.

Slightly lower growth rates were seen in ECGC Pond 18U (Figure 27). Razorbacks were stocked with a mean TL of 46 mm (n=406) in July and recaptured in October at 126.1 mm mean TL (n=138), an increase of 64% in three months. Growth information for ECGC Pond 18L (Figure 28) is vague because of small sample sizes. None-the-less, razorbacks stocked in July (mean TL 46.0 mm, n=406) showed an increase in TL of 57% when sampled in September (mean TL 106.0 mm, n=2). In December three razorbacks were captured (mean TL 140 mm) having increased 24% in TL since September.

From these length data it is apparent that most facilities have the ability to produce releasable size bonytail chub and razorback suckers in 10 months or less. By controlling predators, optimizing stocking rates, feeding, and stocking in a month that provides these fish with suitable water quality throughout the grow-out period, all facilities have the ability to produce releasable size fish in 12 months or less.

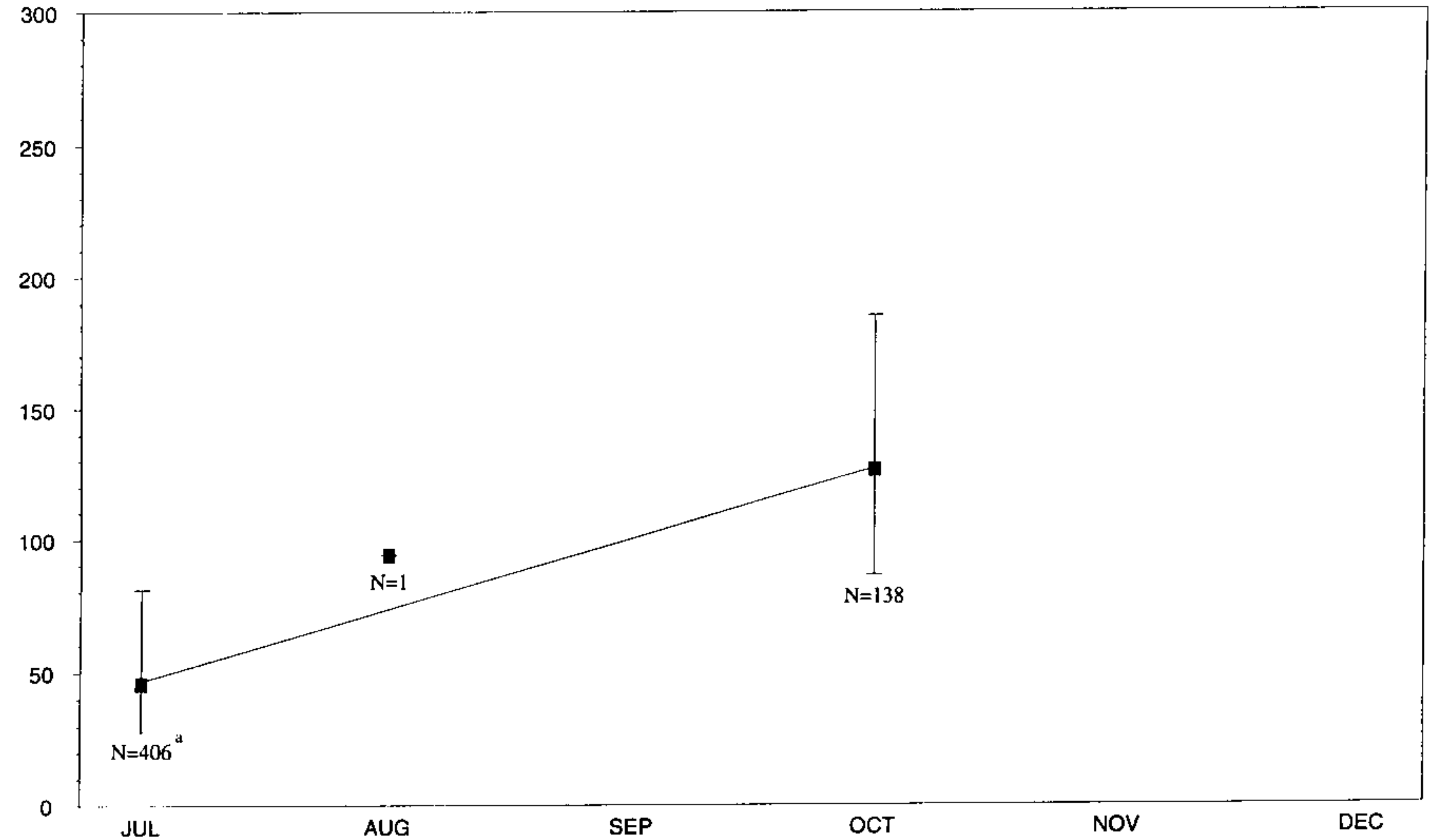
There are some facilities though that exhibit lower than desirable growth rates. Pittsburgh Point Cove and Helicopter Cove become anoxic during the summer and fish survival is very low. Emerald Canyon Golt Course Pond 1 fish had static growth

Figure 26. Monthly growth of razorback suckers in Emerald Canyon Golf Course Pond 12 during 1995. Verticle lines represent minimum and maximum total lengths (mm) and boxes are mean total lengths (mm) of monthly pooled data.



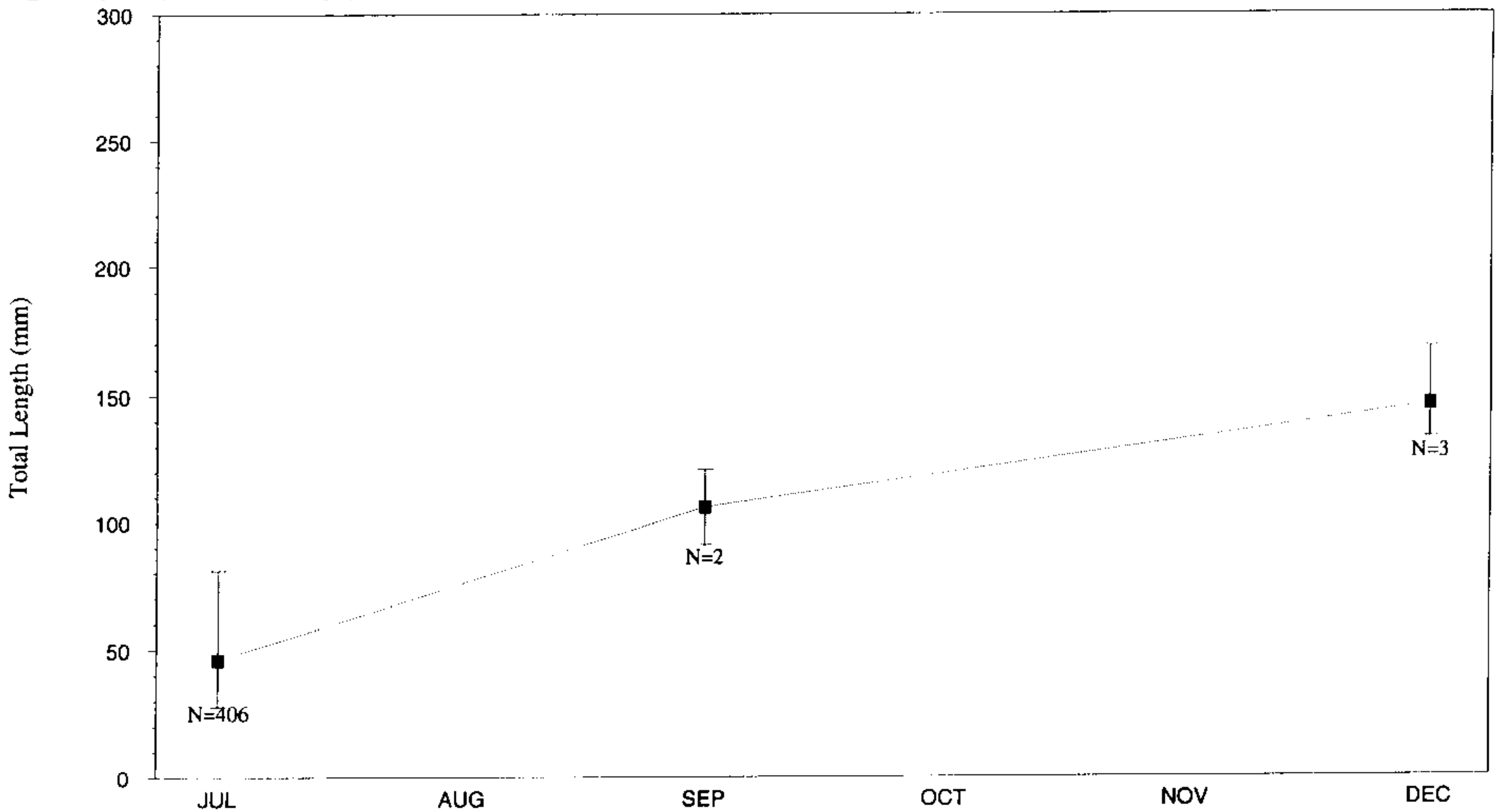
a. 4,423 RZBK stocked 6 July 95.

Figure 27. Monthly growth of razorback suckers in Emerald Canyon Golf Course Pond 18 Upper during 1995. Verticle lines represent minimum and maximum total lengths (mm) and boxes are mean total lengths (mm) of monthly pooled data.



a. 1,290 RZBK stocked 6 July 95.

Figure 28. Monthly growth of razorback suckers in Emerald Canyon Golf Course Pond 18 Lower during 1995. Verticle lines represent minimum and maximum total lengths (mm) and boxes are mean total lengths (mm) of monthly pooled data.



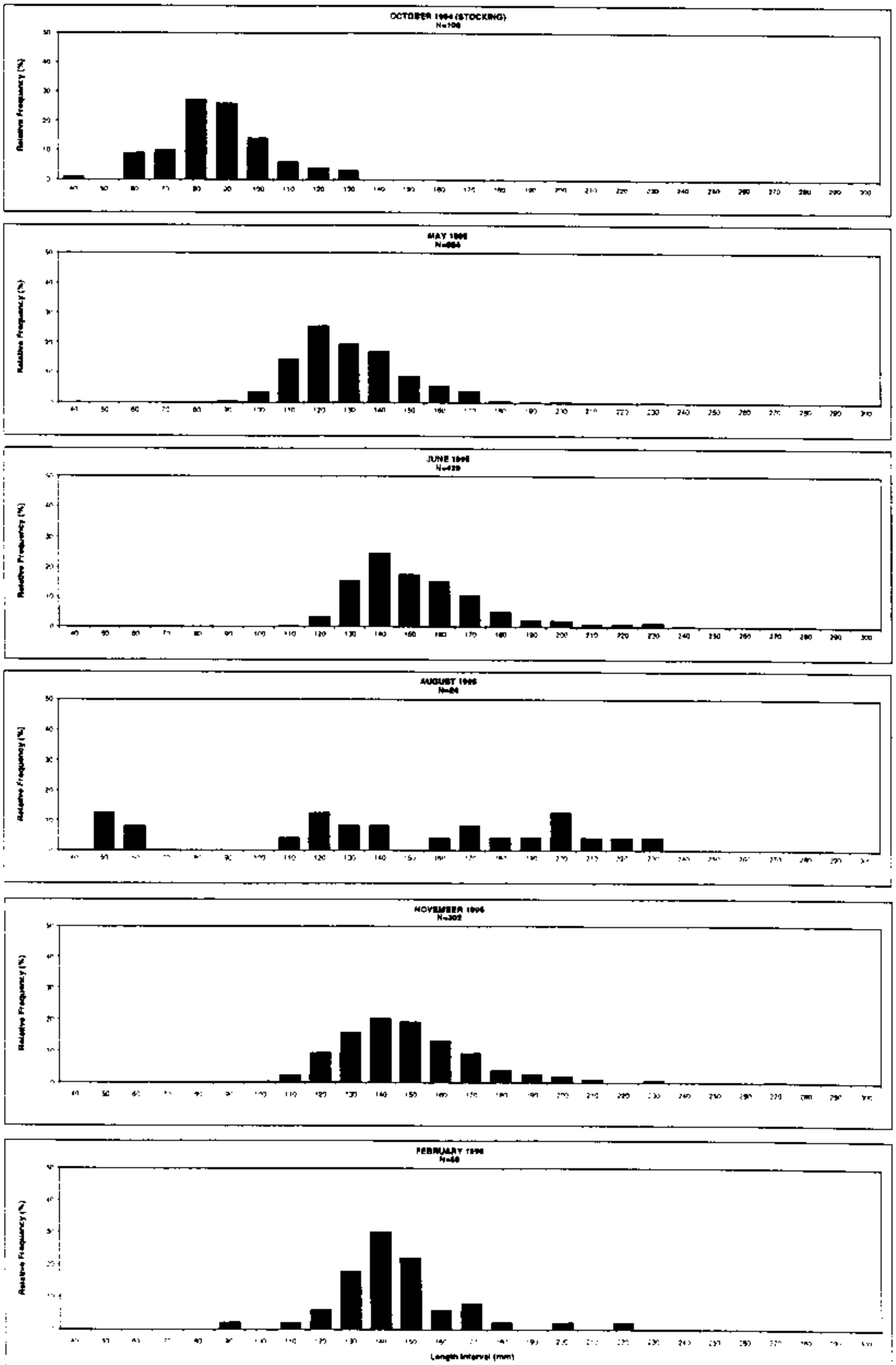
a. 1,290 RZBK stocked 6 July 95.

because of over population which we believe was due to the bonytail chub successfully spawning in the spring. Facilities using barrier nets had large predator fish populations which to some degree reduced stocked fish numbers. Consequently, few or no fish were sampled from these coves and growth rates could not be evaluated with any certainty.

SPAWNING

During a seining effort of Pond 1 at the Emerald Canyon Golf Course, size classes of smaller fish were captured that were not represented in past captures or in the subsample taken during initial stocking of this pond. Total length frequency distribution histograms (Figure 2) completed for each capture effort suggest that the 1994 cohort of bonytails produce at Dexter, and stocked October 24, 1994, shows an expected increased in growth over time. The 40-49 mm and 60-69 mm size classes were first observed during the October stocking. These sizes classes are absent in the May and June histograms. In the August histogram 50-59 mm and 60-69 mm size classes appear, indicating the presence of a 1995 year class. This year class was also found in the November 1995 capture effort, however, as the intent of the seining was to crop only individuals greater than 100 mm for stocking into Pittsburgh Point and Helicopter Coves, they were not measured and, therefore do not appear in the data presented. The February 1996 histogram shows the 1995 year class moving into larger age 1 size classes. The static growth found in this pond is best attributed to over population due to spawning, whereby the standing crop approached or equaled the carrying capacity.

Figure 29. Comparison of the total length frequencies of bonytail chub at stocking and captured by seining and trapping in Emerald Canyon Golf Course Pond 1 in 1994, 1995, and 1996.



RELEASES

In 1995, 97 bonytail chub (Appendix 1) and four razorback suckers (Appendix 2) were released into Lake Havasu. Thirty-four percent of the bonytail chub released into Lake Havasu (Table 3) were reared in the Cibola National Wildlife Refuge High Levee Pond and 51% from the Emerald Canyon Golf Course Pond 12. The remaining releases came from Emerald Canyon Golf Course Pond 18 Lower (7%), Emerald Canyon Golf Course Pond 1 (3%), Emerald Canyon Golf Course Pond 18 Upper (3%), and Bulkhead Cove (2%). Three of the four razorbacks released (Table 3) were grown-out in Bulkhead Cove. The other individual came from Emerald Canyon Golf Course Pond 1. Capture data indicates that fish still remain in Bulkhead and Office Coves and all Emerald Canyon Golf Course Ponds from earlier stocking (Table 1) and we expect to capture additional releasable size fish from these facilities in 1996.

WATER QUALITY

Water quality was found to vary seasonably within sites. Greatest variability occurred in facilities physically separated from the lake by sand spits or earthen berms. In all coves, and especially those with barrier nets, most parameters measured (Appendix 3) were found to be within acceptable limits for warmwater fish (Boyd 1990) throughout the year. Of the parameters measured, those found to limit fish growth and survival were dissolved oxygen (DO) and water temperature.

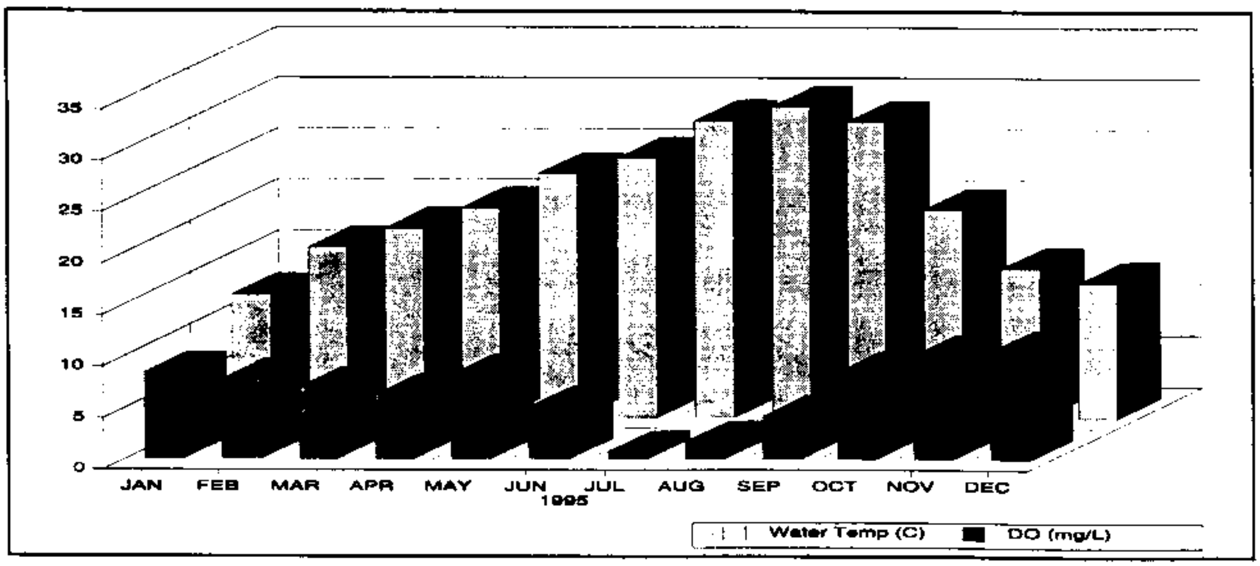
Table 3. Number of bonytail chub (BTC) and razorback sucker (RZBK) reared in LakeHavasu, Emerald Canyon Golf Course (ECGC), and Cibola High Levee Pond grow-outfacilities and released into Lake Havasu in 1995. Percentage is based on number offish initially stocked. RZBK reared at Cibola NWR were released into Prettywater AZ.

	Releases into Lake Havasu			
	BTC		RZBK	
Facility	Number	Percent	Number	Percent
Pittsburgh Point Cove	0	0	0	0
Helicopter Cove	0	0	0	0
Bulkhead Cove	2	0.31	3	1.74
Office Cove	0	0	--	--
No Entry Cove	0	0	--	--
Twin Cove North	0	0	--	--
Twin Cove South	0	0	--	--
Pond 1-ECGC	3	0.10	1	0.07
Pond 12-ECGC	49	0.49	0	0
Pond 18U-ECGC	3	0.10	0	0
Pond 18L-ECGC	7	0.08	0	0
High Levee Pond	33	0.01	--	--
Totals	97	0.06	4	0.03

Pittsburgh Point Cove

Beginning in late April, a extensive growth of spiney naiad begins to emerge in this cove. This macrophyte grows rapidly until it reaches the surface, typically in late May. DO concentrations during this period (Figure 30) are well above lower limits set for warmwater fish (Boyd 1990). Shortly after the plants reach the ponds surface they begin to decompose increasing the biochemical oxygen demand (BOD). DO levels begin to drop dramatically to 0.0 mg/L at the bottom to as low as 0.5 mg/L at the surface (Figure 30) and the entire water column essentially becomes anoxic. At this time the pond supports only yellow bullhead, goldfish, and common carp.
Coinciding with the decrease in DO concentration during the summer is the increase of water temperature (Figure 30). Temperatures over 30 C have been recorded during August. The increased respiration rates caused by the higher water temperatures combined with the lack of DO produces an environment few, if any, razorback suckers or bonytail chub can survive in.

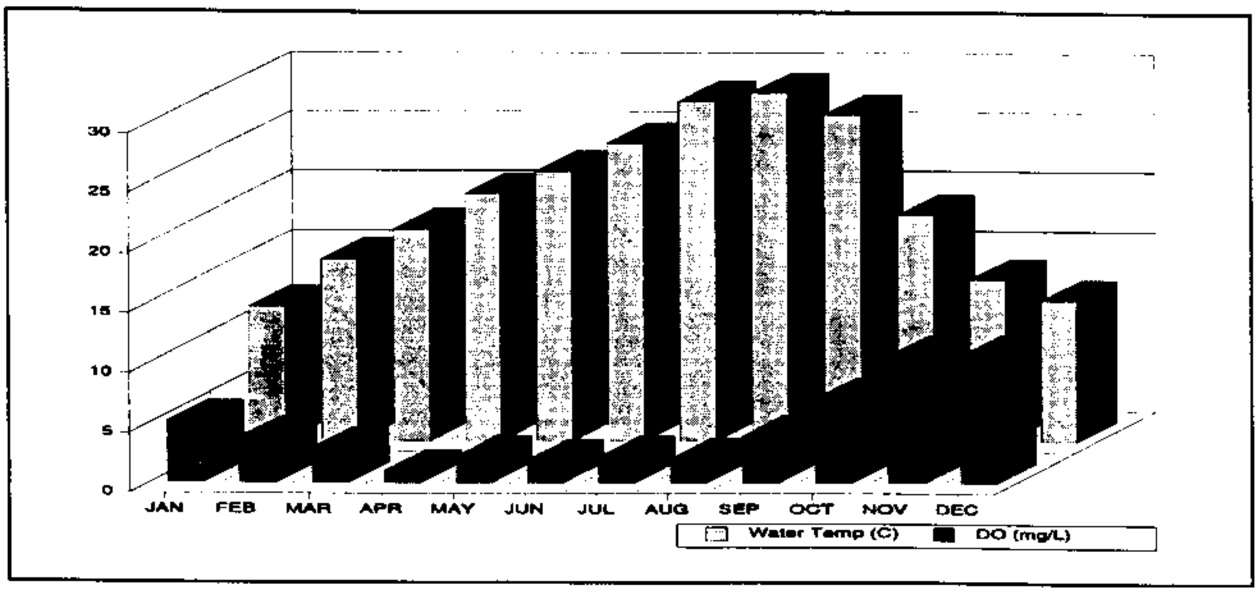
Figure 30. Mean monthly water temperatures and dissolved oxygen concentrations at Pittsburgh Point Cove, AZ, in 1995.



Helicopter Cove

Water temperatures and DO concentrations in this facility do not appear to become as lethal as in Pittsburgh Point Cove. Never-the-less, DO drops to possibly lethal limits from late spring through the summer (Figure 31). Water temperature was found to approach 30 C in August which may contribute to increased mortality. Although DO levels do not become as low as in Pittsburgh Point Cove, they do remain below five mg/L from February until September with readings of one to two mg/L observed during April and July. Slightly higher DO was observed in May and June due to light phytoplankton blooms.

Figure 31. Mean monthly water temperatures and dissolved oxygen concentrations at Helicopter Cove, AZ, in 1995.



Bulkhead Cove

Water temperatures and DO levels in this cove appear to be acceptable for rearing razorback suckers and bonytail chub during most months except for August where the DO profile was found to average 2.97 mg/L. Readings during other months were at or above 4.0 mg/L with a December 1994 mean of 9.34 mg/L. Water temperature fluctuated form a high of 30.7 C in August 1994 to a low of 10.28 C in December. Monthly means of all parameters measured are shown in Appendix 3.

PUBLIC AFFAIRS

The Bureau of Land Management and project partners are making efforts to elevate public awareness and promote public and agency support. A project video has been produced that has been sent to project partners, and is available to any interested public. It is also shown regularly on the local television network. Informational posters and brochures, as stipulated in the biological opinion, have been printed and distributed to fishing tackle dealers and resorts around the lake. Throughout the year the Bureau of Land Management promotes the Lake Havasu Native Fish Plan and provides educational talks regarding big river fishes at several regional and local events, conferences, and meetings.

The Bureau of Land Management is dedicated to the education of local students about public lands. Our outreach program included over 10 visits to local elementary and High Schools to give talks on the native fish of the Colorado River. In addition to classroom visits, we have been working with the local High School for the past two years in the study of Pittsburgh Point Cove aquatic habitat. Selected students from biology, chemistry, and geology classes visit the cove weekly and, through hands-on experience, conduct research on aquatic ecology. This special class provides students the opportunity to learn about Lake Havasu's ecosystem, and broadens their knowledge of the lake their community is dependent on.

DISCUSSION

Although few fish were produced from grow-out facilities during 1995, a great deal of information was gathered on site specific parameters effecting growth and survival of these native fish. This information is used to modify management actions and rearing techniques to grow out larger numbers of fish. Many modifications are site specific, however, several have or will be applied to many of the other facilities as well.

Boyd (1990) recommends that DO levels be maintained at or above five mg/L to maximize production of warmwater fish species in aquaculture facilities and he reports that extended exposure to levels below that will result in decreased growth and ultimately death if exposure to less than two mglL is prolonged. Given the number of months that the DO concentration in Pittsburgh Point, Helicopter, and Bulkhead Coves is below five mg/L, remedial action is required. We plan to accelerate growth rates, modify stocking, and install an aerator to overcome lethal summer conditions.

To grow-out larger numbers of releasable size fish in these coves we have begun a supplementary feeding program to hopefully shorten the grow-out period one to two months. Also, to circumvent the low DO period, we plan to stock fish at an earlier date (at a larger size if possible) and harvest all fish in April.

Although electricity is not available at Pittsburgh Point or Helicopter Coves, power is available at Bulkhead Cove. In 1996 we plan to install an aerator to maintain DO levels above five mg/L in this cove.

Due to the large number of predator fish captured in Office Cove, No Entry, and Twin Coves North and South (Table 2) it is apparent that this method of isolating coves is not feasible. Predator fish populations within these coves were impossible to manage even though each cove was treated with a fish toxicant (rotenone) prior to stocking and several hundred hours of capture effort was directed towards removing larger predator fish after stocking.

Also, a SCUBA dive team was contracted to monitor and repair all barrier nets. Each net was visited biweekly and repairs were made as needed. Although each net was maintained in good condition, small tears developed in these nets between site visits which gave predator fish access to the grow-out facility. Also, native fish could have exited the cove as well.

Given the amount of labor, time, and logistics involved in maintaining barrier nets, we feel that their applicability to providing isolated habitats, free of predation, is not possible. For these reasons the net at No Entry Cove was removed and the cove will no longer be used to rear endangered fish under our plan. The net at Office Cove was replaced with an earthen berm in July 1995.

At Twin Coves North and South we believed that the bonytails stocked there could have escaped to some extent by jumping over the net. Also, we surmised that since the overall size of the predator fish captured in these coves was small (mean <100 mm), razorback suckers, which by habit would not jump over the net, could be planted and grow to releasable length.

In 1996 we plan to increase growth rates in all facilities by feeding. It is hoped that increasing growth rates will provide more releasable size fish from each pond by shortening the grow-out period and thereby reducing mortality.

To optimize production in ECGC Pond 1, an aeration system will be installed in 1996. Although DO levels in this pond are not known to become lethal (Appendix 3), an aeration system will guarantee levels are at or above five mg/L throughout the year.

Predation by piscivorous birds is thought by some to be a concern. Artificial structures have been installed in Bulkhead and Helicopter Coves to provide escape cover and reduce mortality. It is unknown at this time if these actions are lowering mortality, however, due to the simplicity of installation, more structures will be installed in other facilities as appropriate.

It is clear that to attain our objective of releasing 60,000 native fish into Lake Havasu we must find other facilities and utilize varied management techniques. An abandoned catfish farm, located on the Colorado River Indian Tribes reservation, has been identified as a facility that could very well meet our production goals. The Parker Fisheries Resource Office has spear-headed efforts to acquire the use of this facility and verbal agreement has been reached to allow the FWS rear big river fishes there. Once the Memorandum of Understanding has been signed by affected parties, the BLM will commit labor and funds, as time and capabilities permit, to renovate and operate the facility. Once fully operational, this facility should provide many thousands of razorback suckers and bonytail chubs for release into Lake Havasu.

A facility being considered for rearing razorback suckers is the Arizona Game and Fish Department (AGFD) Bubbling Ponds near Sedona, AZ. AGFD is planning to rear fish here for release into Lake Havasu in 1996.

The use of net pens to rear fish is a common practice in the Pacific Northwest and appears to have many advantages over grow-out coves. Advantages include not having to use rotenone to eradicate predator fish, ability to capture all fish in a short time as needed, logistical simplicity, and ability to locate in water with suitable water quality. Initially, on an experimental basis, we plan to install a small net pen, rear fish for several months, and evaluate it's effectiveness. If successful, the net pen scheme will be expanded and become a integral part of our native fish rearing plan.

Our search for more suitable facilities has identified the tertiary treatment pond at the Lake Havasu City's waste water treatment plant as a likely prospect. Negotiations with city officials has been encouraging and early indications are that the pond is available for rearing native fish. Coordination is continuing with all affected agencies and, barring any unforeseen circumstances, the facility will be used for rearing fish in late 1996.

The Lake Havasu Native Fish Management Plan is an important tool for augmenting populations of razorback suckers and bonytail chub in the lower Colorado River. However, to reach the plans objective, better facilities must be located that have the ability to rear large numbers of these fish. Also, those facilities currently in production must be improved to increase productivity. Efforts are ongoing to locate facilities that are more productive and easier to manage. Research is continuing to identify constraining factors to fish production at existing facilities and further information will be evaluated and management actions altered accordingly to improve growth and survival.

ACKNOWLEDGMENTS

I would like to thank the Arizona Game and Fish Heritage Fund for awarding Grant-in-Aid funds to out project. These funds were used to contract labor that conducted valuable field work providing us with data needed to evaluate site specific parameters effecting fish growth and survival.

Special thanks go out to C.O. Minckley, Ph. D., Mitch Thorson, and Mia LaBarbara of the Parker Fisheries Resources Office, and Tom Pradetto, ECO Associate, working for the Bureau of Land Management. Without their dedication to the project fewer numbers of razorbacks suckers and bonytail chub would have been released into LakeHavasu. Several individuals from many agencies have also contributed their time and expertise to the project. Among these are Tom Burke and Joe Kahl of the Bureau of Reclamation, Lower Colorado Region Office; Chris Hayes and Will Kohn of the California Department of Fish and Game, Blythe Field Office; Brad Jacobson of theArizona Game and Fish Department; and Ben Greenfield and Gayle Martin, Americorp employees working at the Parker Fisheries Resource Office.

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