



BAR GRADING OF ALLIGATOR GAR FINGERLINGS IN RACEWAYS

Steve E. Lochmann, Brandon W. Baker, Kyle T. Rachels, and Brett A. Timmons

Federal hatcheries raise alligator gar *Atractosteus spatula* for mitigation stocking. Universities raise them for research purposes, while alligator gar are cultured in Mexico for consumption. Alligator gar are cultured in ponds, pools, raceways, and tanks, with varying levels of growth and survival. Most culturists grade young alligator gar frequently, or risk survival rates to 250 mm in the single digit range. Grading is done visually and is time consuming and subjective. Our objective was to determine the efficacy of using floating bar graders to group like-sized fish, while raising alligator gar to 250 mm in concrete raceways. We stocked 37 days post hatch (dph) alligator gar into concrete raceways (5.2 m long x 1.2 m wide x 0.4 m deep) at a density of 0.02 fish/L. The average (SD) length and weight of alligator gar at stocking were 148 (24) mm TL and 15 (8) g. Three vats were

divided into three compartments. Fish in these vats were offered fathead minnows *Pimephales promelas* at a rate of 10% of body weight/d and graded with floating bar graders twice each week. Three vats were not divided. Fish in these vats were not graded, but were offered fathead minnows. Two vats were divided into three compartments. Fish in these two vats were graded, but were not offered fathead minnows. Fish in all vats were offered formulated feed *ad libitum* up to 10% of body weight/d. The experiment was run for 50 d, at which time alligator gar averaged 255 (36) mm TL and weighted 91 (54) g. Survival averaged 68% (17%). When we compared fish from graded and ungraded vats, weight gain was significantly greater in ungraded vats ($t=3.193$, $df=3$, $P=0.025$), but survival was significantly higher in graded vats ($t=-2.721$, $df=3$, $P=0.036$; Figure 1). When we compared fish from vats offered forage to vats not offered forage, weight gain ($t=3.002$, $df=2$, $P=0.048$) and survival ($t=6.749$, $df=2$, $P=0.048$) were both significantly greater in vats offered forage.



EFFECTS OF STOCKING HATCHERY-REARED LARGEMOUTH BASS ON WILD JUVENILE LARGEMOUTH BASS IN SMALL IMPOUNDMENTS

Kyle T. Rachels and Steve E. Lochmann

Stocking juvenile largemouth bass *Micropterus salmoides* is a common tool for managing sport fisheries. However, managers rarely evaluate the effects of hatchery-reared largemouth bass on wild conspecifics. In summer 2011, we conducted capture-



recapture abundance estimates of age-0 largemouth bass in 30 small impoundments (0.88–10.96 ha) prior to stocking at rates of 0, 60, or 180 hatchery-reared largemouth bass per hectare. Hatchery-reared largemouth bass were marked with a freeze brand 2 weeks prior to stocking, and transported to the impoundments in water < 25°C with 5 ppt salt and 25 mg/L MS-222. Capture-recapture abundance estimates were repeated in summer 2012 on the wild age-1 largemouth bass cohort in each impoundment. There were no significant differences in mortality ($P = 0.635$), growth ($P = 0.451$), or age-1 relative weight ($\chi^2 = 0.149$) of wild juvenile largemouth bass among treatments. Mean daily instantaneous mortality ranged from 0.01 to 0.14 ($n = 23$), mean daily instantaneous growth ranged from 0.004 to 0.012 ($n = 29$), and mean age-1 relative weight ranged from 84 to 106 ($n = 29$). Control impoundments were not significantly different than stocked impoundments in total age-1 largemouth bass density ($P = 0.98$). Few hatchery-reared largemouth bass were collected as age-1 fish, despite hatchery fish comprising 8–79% of the 2011 year-class immediately after stocking. Our results suggest hatchery-reared largemouth bass do not negatively affect wild largemouth bass. The nature and timing of stocked largemouth bass mortality would provide greater elucidation of the interaction between hatchery and wild fish.



IMPROVING REPRODUCTIVE EFFICIENCY OF CULTURED FINFISH

Steve E. Lochmann, Alf H. Haukenes, Matt McEntire and Adam Fuller

We measured length of white bass larvae to determine which traits in the female brood stock would result in larger fry, because elimination of the rotifer feeding stage would allow for a decrease in complexity and increase in efficiency of HSB hatchery operations. Brood stock were subjected to a 12 month photothermal regime, fed a 45% protein diet twice daily to satiation, and induced to spawn with injections of 330 IU HCG per kg body weight. The eggs were treated with tannic acid and maintained in McDonald hatching jars at 21°C. Larvae were sampled at hatch and at 5 dph, preserved in 4% buffered formalin, and later individually photographed. Lengths of larvae were determined. Statistical analysis consisted of examination of the effect of age on

length at hatch and length at 4 dph. Age was not a factor in the third study because all the fish were age 2. The effects of dam weight on length at hatch and length at 5 dph were examined using Proc GLM (SAS Inc.). Seventeen 2-year-old dams were spawned. Dam weights averaged 669 (124) g and ranged from 440 to 856 g. Length at hatch averaged 2.57 (0.13) mm TL. Length at 5 dph averaged 3.34 (0.21) mm TL. As in the spring year 3 study, the relationship between dam weight and length at hatch was positive and significant (Table 3). However, the relationship between dam weight and length at 5 dph was not significant. Several consistencies exist among the three studies. Regardless of whether dam weight significantly affected length at hatch, in all three studies dam weight no longer significantly influenced larval length at 5 dph. The effect of dam age on length at 5 dph could only be tested in two of the three studies. In only one of those two studies did dam age significantly affect length at 5 dph. These facts taken together suggest that dam weight and dam age have limited influences on length at 5 dph. In all three studies, one way anovas indicated that dam had a significant effect on length at 5 dph. The preponderance of evidence suggests that the maternal affect on length at 5 dph is mostly genotypic.



A POPULATION ASSESSMENT AND MINIMUM LENGTH LIMIT EVALUATION FOR WHITE BASS IN THE ARKANSAS RIVER, ARKANSAS

Brandon W. Baker and Steve E. Lochmann

White bass *Morone chrysops* are a popular sport fish throughout most of their zoogeographic distribution. We conducted a population assessment of white bass in Pool 4 of the Arkansas River. Using population metrics calculated from the assessment, responses of the white bass fishery to a 254-mm or 305-mm minimum length limit (MLL) were simulated using the Fishery Analysis and Modeling Simulator (FAMS) model. White bass ages ranged from 1-7, but 88% of white bass were less than age 5. Conditional natural mortality averaged 0.43. Total annual mortality was 54%, so exploitation was estimated at 0.15. Implementation of a 254-mm MLL would reduce the number of fish harvested by 18-32%. Average weight of harvested fish would increase

between 21% and 43%. Yield would increase or decrease by 10% depending upon natural mortality and exploitation. The portion of the cohort reaching a preferred size ranged from 5% to 26%. Implementation of a 305-mm MLL would decrease the number of fish harvested by anglers by 37-60%. Average weight of harvested fish would increase between 47% and 101%. Change in yield ranged from -30% to 12%. The percent of preferred sized white bass in the populations increases from 14% to 86%. The Arkansas River white bass population was characterized by low exploitation, moderately high natural mortality, and moderate growth rates. Yield is unlikely to change much under a minimum length limit, but size structure could be improved.





PELLET-REARED LARGEMOUTH BASS COMPETITIVE ABILITY AT VARIOUS LEVELS OF EXPOSURE TO LIVE FORAGE

Kyle T. Rachels, Gordon R. Taylor, Brandon M. Baumhoer, Sagar Shrestha and Steve E. Lochmann

Advanced-fingerling largemouth bass *Micropterus salmoides* are commonly reared using commercially available feed to reduce hatchery expense. However, they demonstrate poorer survival than largemouth

bass reared on live forage when stocked into natural systems. We investigated the effects of pellet-reared advanced-fingerling largemouth bass prestocking exposure to live forage on competitive ability using pairwise competitions with wild largemouth bass in a hatchery setting. Pellet-reared largemouth bass without exposure to live forage did not compete well ($P < 0.05$) against wild fish. Pellet-reared largemouth bass with exposure to live forage before competitions did not significantly differ from wild largemouth bass in competitive ability. Regression analysis predicted pellet-reared largemouth bass with 9 d of prestocking live forage exposure would have a similar ability to compete for food as wild largemouth bass. Providing pellet-reared largemouth bass with live forage for 9 d before stocking may provide the benefits of both pellet and live-forage rearing. Although competition for food resources can be a factor affecting poststocking mortality, other biotic interactions warrant consideration. Conditioning hatchery fish to structurally complex habitat and predators could improve overall competitive ability. Stocking program managers should consider fitness of the hatchery fish being stocked as well as interactions between stocked fish and native biota.



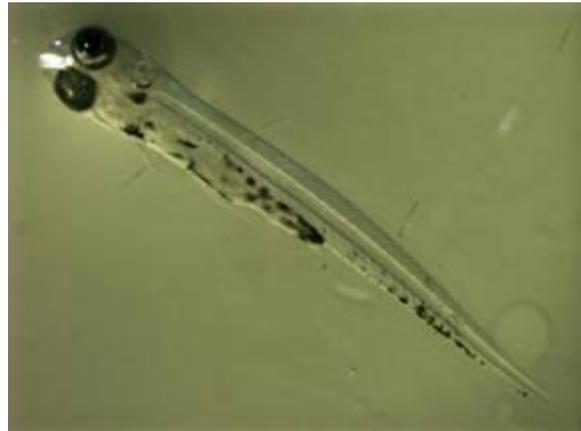


PROPAGATION AND REARING METHODS FOR YELLOWCHEEK DARTER *ETHEOSTOMA MOOREI*

Steve E. Lochmann, Lael Will, and Mitch Wine

In July of 2010, the U.S. Fish and Wildlife Service proposed endangered status for the yellowcheek darter *Etheostoma moorei*. Declines in population have been attributed to habitat loss and low water levels over the past 20 years. *E. moorei* is endemic to Arkansas, occurring only in tributaries of the Little Red River. We

developed a successful propagation method and an effective feeding schedule to culture *E. moorei* larvae. Broodstock were captured from the wild and held in four 75-L recirculation tanks. Two females and one male were stocked into each tank, and were fed black worms once per day. From May 11 – July 10, we observed approximately 17 spawning events, which yielded 512 larvae. Larvae were passively collected from adult aquaria using the surface overflow as they swam up. Larvae were stocked into 5-L plastic buckets. From 1-10 dph, larvae were fed a combination of APR (Artificial Plankton Rotifer, Ocean Star International, Inc., Snowville, Utah), *Nannochloropsis* algal paste, and microworms four times/day. A peristaltic pump was used to feed a combination of APR, and *Nannochloropsis* for 3 minutes every hour during a 24-h period. At 11 dph, saltwater rotifers *Brachionus plicatilis* and microcysts *Artemia* nauplii at a rate of 10/ml/day were added to the diet. At 18 dph *Artemia* nauplii were added to the diet at a rate of 10/ml/day, and *Nannochloropsis* was discontinued. At 25 dph instar 3 *Artemia* metanauplii were added to the diet, while artificial plankton, microworms, and saltwater rotifers were discontinued. At 32 dph, instar 5 *Artemia* metanauplii and fragments of chopped black worms were added to the diet. Microcysts *Artemia* nauplii were discontinued. Juveniles began exhibiting benthic behavior at 20 dph and were transferred to 5-L buckets with an undergravel filter. We estimate survival to 45 dph to be 50%. Growth rates to 70 dph averaged (SD) 0.19 (0.04) mm/d. Compared to previous years, spawning occurred more frequently and larval mortality was much lower. These methods proved successful for the propagation and rearing of *E. moorei*.





CHANGES IN SPORT FISH CHARACTERISTICS AND BIOMASS OF AQUATIC VEGETATION BEFORE AND AFTER BIOLOGICAL CONTROL OF VEGETATION IN SOUTHERN ARKANSAS

Brett Timmons and Steve E. Lochmann

The Ouachita and Saline Rivers, creeks, sloughs, lakes, and swamps cross Felsenthal National Wildlife Refuge (FNWR). The FNWR developed an aquatic vegetation problem that hindered angler access and reduced public visits. Fish sampling was performed in 2008 prior to vegetation

control, and repeated in 2009 and 2010. Largemouth bass *Micropterus salmoides* and bluegill *Lepomis macrochirus* were sampled with a boat electrofisher. Vegetation was sampled in 2008 prior to vegetation control and again in 2010. Twenty-meter transects and 1-m² quadrats were used to determine vegetation cover and biomass. Grass carp *Ctenopharyngodon idella* were stocked in late 2008 and early 2009 at a rate of 11 fish/ha. ANOVAs were used to compare fish population characteristics. A least significant difference test was used to compare differences in the mean pre-stocking and post stocking. Pre-stocking and post-stocking vegetation percent cover and biomass were compared using a percent similarity index. The pre-stocking mean (SE) CPUE of largemouth bass was 11 (0.9) fish/hr and the mean CPUE of bluegill was 40 (9) fish/hr. Post stocking mean CPUE of largemouth bass were 28 (4) and 30 (2) fish/hr for 2009 and 2010, respectively. Post stocking mean CPUE of bluegill were 81 (17) and 53 (4) fish/hr for 2009 and 2010, respectively. Post stocking relative abundance was significantly different for largemouth bass. Post stocking relative abundance for bluegill differed significantly in 2009. The pre-stocking mean percent cover was 12 (28)% and the mean biomass was 62 (163) g/m². The post-stocking mean percent cover was 34 (45)% and the mean biomass was 138 (346) g/m². The most abundant aquatic vegetation pre-stocking were American Lotus *Nelumbo lutea*, Hydrilla *Hydrilla verticillata*, and Egeria *Egeria densa*. The most abundant aquatic vegetation species post-stocking were American Lotus, Water Lily *Nymphaea odorata*, and Coontail *Ceratophyllum demersum*.





EFFECT OF FEED TYPE ON GROWTH RATE OF HYBRID STRIPED BASS

Steve E. Lochmann, Lael A. Will, Candice L. Williams, Maya L. Warner, Avrion J. Williams, and Brett A. Timmons

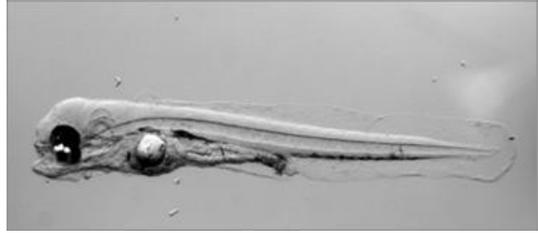
The growth rate of hybrid striped bass may be a reflection of their feed type. Over the course of two one-week studies, large hybrid striped bass larvae were exposed to daily diets of formulated feed alone, smaller hybrid striped bass larvae alone, or both feed and

larvae. Growth was examined at the end of each study. In study one, large larvae were 22 dph, averaging (SD) 12.8 (1.1) mm TL. Fifteen 3.87-L glass jars were filled with 3 L of dechlorinated water. Aeration was provided by individual aquarium pumps. Larvae were stocked at a density of four large larvae per jar in every jar. In jars with feeding treatments of larvae only or feed and larvae, ten smaller larvae were stocked. The number of smaller larvae was daily replenished to remain at a density of ten larvae per jar. Jars with treatments of feed only, and both feed and larvae, were fed twice daily ad libitum. Tank bottoms were siphoned and water quality was monitored daily. Salinity was kept at 1 ppt. In study two, large larvae were 31 dph, averaging 30.1 (2.2) mm TL. Only one large larva was stocked in each jar, with three smaller larvae stocked in jars according to the same treatments as study one. In study one, growth rates ranged from 0.02 to 0.84 mm/d at 29 dph. There was no significant difference in growth among treatments ($F = 1.18$, $df = 11$, $P > 0.05$). In study two, growth rates ranged from 0.07 to 1.11 mm/d at 38 dph. There were significant differences among the treatments ($F = 5.28$, $df = 11$, $P < 0.05$). The growth rate of the feed and larvae treatment was 0.59 mm/d faster than the feed only treatment. Cannibalism in the larvae only treatment usually accounted for losses of 1-2 larvae/cannibal/day. Cannibalism had a positive effect on growth rate. Large larvae exhibit faster growth because of efficient feeding and cannibalism. Overall losses to cannibalism are small relative to other sources of mortality. It is not clear that removing cannibals should be an important part of phase one fingerling production.



INFLUENCES OF MATERNAL PHENOTYPE AND AGE ON LARVAL PRODUCTION CHARACTERISTICS OF WHITE BASS

Steve E. Lochmann, Matt McEntire, and Adam Fuller



A combination of 3, 4, and 5 year old white bass were subjected to a 12-month photothermal regime. During the 12-month period, fish were fed a 45% protein diet twice daily to satiation. At the end of the 12-month period, fish were induced to spawn with hormone injections. Fish were injected with 330 IU HCG per kg body weight. Eggs from one female white bass were divided equally between two plastic containers. Eggs from a second female were also divided equally between two more plastic containers. Eggs in each of the containers were fertilized using milt from one of two different males, producing a 2 x 2 cross. This process was repeated nine times, such that a total of 18 females and 18 males were used during the spawning effort. Eggs were placed in individual McDonald hatching jars and treated with a 150 mg/L solution of tannic acid to reduce adhesion and minimize clumping. After treating with tannic acid for 10 min, the eggs were rinsed with well water. After 3 h of water hardening, a sample of eggs from each female was removed from the McDonald hatching jar and placed into a glass Petri dish. Individual eggs were examined with a dissecting stereomicroscope to determine fertilization rates. Fertilized eggs were placed individually into 6-ml vials filled with well water. The eggs in 6-ml vials were incubated at approximately 22-24° C. The remaining eggs were maintained in the McDonald hatching jars and incubated at 22-24°C. Eggs in vials were examined every 6 h until hatching was complete. Hatching percents were determined from the results of hatching in vials. After approximately 30 h, most embryos had either hatched or died. A qualitative assessment of hatching success in McDonald hatching jars was undertaken. On the day of hatch, approximately 40 larvae from each cross were preserved in 4% buffered formalin. At 5 days post hatch (dph), approximately 40 larvae from each cross were preserved in 4% buffered formalin. Preserved larvae were photographed individually. Standard



length and fin fold length were added to determine larval total length (TL). The effect of female age on length at hatch was examined using an analysis of covariance with female weight utilized as the continuous covariate. The same statistical approach was used to examine the effect of female age on length at 5 dph. Female weights averaged (SD) 614 (146) g and ranged from 400 to 890 g. Fertilization rates averaged 6 (6)% and ranged from 0% to 25%. Hatch rates were fairly low (< 10%) for most crosses. A total of 11 females had enough hatching to collect adequate sample sizes for length at hatch estimates. Length at hatch averaged 2.40 (0.27) mm. Length at 5 dph averaged 3.07 (0.31) mm. Neither female weight or female age significantly influenced length at hatch or length at 5 dph.

SPAWNING DISTRIBUTION AND POPULATION CHARACTERISTICS OF WHITE BASS IN POOL 4 OF THE ARKANSAS RIVER

Brandon W. Baker and Steve E. Lochmann

Spawning behaviors and dynamics of white bass *Morone chrysops* in the Arkansas River have not been documented. An assessment of the population would be integral to generating a science-based management strategy. We sampled white bass during their spawning season in the 10 primary tributaries found within Pool 4 in the Arkansas River. The pool was divided into three segments (upper, middle, lower). Each segment had three tributaries. Each tributary was sampled every third week during the spawning season to determine spatial variability. One tributary (Caney Bayou), known to be occupied by white bass during the spawning season, was sampled weekly to document temporal variability of the spawn. White bass were collected by boat-mounted electrofishing. The catch per unit effort (CPUE) averaged (SD) 6.2 (16.9) fish/h across the pool. The CPUE for Caney Bayou averaged 8.5 (20.3) fish/h. Caney Bayou was the most utilized site, but other sites were also utilized during the spawning season. Precipitation and temperature appear to influence spawning effort. Once water temperature reached 13°C, white bass activity near tributaries increased. In addition, there was a positive relationship between precipitation and the occurrence of white bass in a tributary. Overall gender ratio was 1 ♂:2 ♀, while the gender ratio in Caney Bayou was 1♂:3♀. Two indices of population



size structure were calculated. The PSD was 68.9 and the PSD_p was 53.7. Average relative weight across all cohorts was 103 (23.5). The average TL for age-1 white bass was 204 (31.5) mm, and for age-3 white bass was 353 (21.3) mm. The oldest white bass collected was a 7-year-old. Total annual mortality was 49.3% using a catch curve regression. As habitat alterations occur and water allocations and releases are modified, understanding the critical habitats and conditions supporting favorable spawning and recruitment is imperative.



ADULT AND JUVENILE PADDLEFISH IN FLOODPLAIN LAKES ALONG THE LOWER WHITE RIVER, ARKANSAS

Sandra J. Clark-Kolaks, John R. Jackson, and Steve E. Lochmann

Eleven floodplain lakes in the lower White River, Arkansas were sampled using a boat electrofisher and gill nets during periods of river connection (April–May 2004) and disconnection (June–July 2004 and 2005). Environmental

characteristics, including water quality and lake morphometrics were concurrently measured in each lake. Average measures of connectivity were calculated for the preceding 5-year period. Of the 11 lakes sampled, 7 lakes contained paddlefish. A total of 44 paddlefish were observed during the study, but only one was observed during the period of river connection. Eye-fork lengths ranged from 348–1040 mm ($n = 38$). Paddlefish ranged in age from 3–19 years ($n = 27$). Paddlefish were more likely to be found in long narrow floodplain lakes which connected to the river early in the year. Paddlefish catch per unit effort increased as lake surface area and dissolved oxygen increased. Catch per unit effort increased as the variability in the start date of connection increased. Our research indicated that both juvenile and adult paddlefish use White River floodplain lakes, despite the risk of being isolated in lakes for long periods or during spawning seasons.



TANK CULTURE OF SUNSHINE BASS FINGERLINGS WITHOUT USING ROTIFERS

Gerald M. Ludwig and Steve E. Lochmann

A previously reported protocol for culture of sunshine bass (female white bass *Morone chrysops* X male striped bass *M. saxatilis*) larvae to fingerling size in tanks involved an initial feeding of rotifers for several days before the larvae were weaned to *Artemia* nauplii and prepared feed. Maintaining rotifer cultures requires space, time, equipment, supplies, and trained culturists. The rotifer cultures are often unstable, which increases risk of poor sunshine bass fingerling production in tanks. Elimination of the use of rotifers would greatly enhance the feasibility of reliable tank culture of fingerlings and should reduce production cost. This experiment compared three treatments with three replicates per treatment. In one treatment larvae were initially fed rotifers (*Brachionus plicatilis*) and then weaned to *Artemia* nauplii (0.48 mm X 0.19 mm). In a second treatment larvae were fed *Artemia* nauplii throughout the experiment. In a third treatment larvae were fed microcyst *Artemia* nauplii (0.43 mm X 0.18 mm) for the entire experiment. Sunshine bass larvae, 4 days post hatch (dph), were stocked into 100-L tanks at 75 larvae/L. Larvae were fed according to the three treatments to 14 dph. Survival was significantly higher for larvae fed rotifers and *Artemia* nauplii and larvae fed microcyst *Artemia* nauplii (93.6% and 37.9%, respectively) than for survival (4.3%) of larvae fed only *Artemia* nauplii. Larvae (7.13 mm standard length (SL)) fed rotifers and *Artemia* nauplii and larvae (7.26 mm SL) fed microcyst *Artemia* nauplii were significantly longer than larvae (6.86 mm SL) fed *Artemia* nauplii. This experiment is the first time that sunshine bass have been cultured to 14 dph on *Artemia* nauplii without rotifers at first feeding.



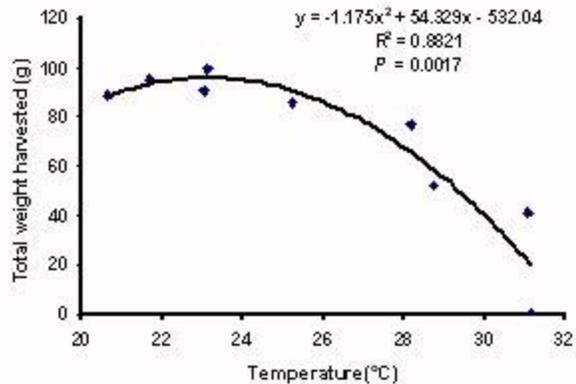


EFFECT OF TEMPERATURE ON LARVAL SUNSHINE BASS GROWTH AND SURVIVAL TO THE FINGERLING STAGE

Gerald M. Ludwig and Steve E. Lochmann

Determining the optimum conditions for tank culture of sunshine bass fingerlings will facilitate a year-round supply of seed for the production cycle of this increasingly popular food fish. This study determined the relationship between temperature and larval sunshine bass growth and survival to the time when fish were trained to accept commercial feeds. Four-day post-hatch (dph) larvae were stocked at five temperatures from 20-32°C at 3°C increments. There were two replicates of each temperature. The larvae were fed rotifers through 8 dph. Conversion to an *Artemia* nauplii diet began at 6 dph and training to dry starter feed began at 20 dph. At harvest, average total length and average weight of the fish increased in a linear relationship with temperature while relative survival and number of fish harvested decreased

linearly with temperature. Tank yield had a curvilinear relationship with temperature. The temperature that provided maximum yield was 23.1°C. Although growth was faster at warmer temperatures, relative survival and yield were not. These relationships between tank culture conditions and production characteristics support optimization of tank culture to meet specific production goals. This should eliminate some of the logistical constraints to expanded tank culture of sunshine bass fingerlings.





THE EFFECTS OF STOCKING HATCHERY REARED LARGEMOUTH BASS ON THE 2007 YEAR CLASS OF WILD LARGEMOUTH BASS IN BACKWATERS OF THE ARKANSAS RIVER

Jeffrey R. Horne and Steve E. Lochmann

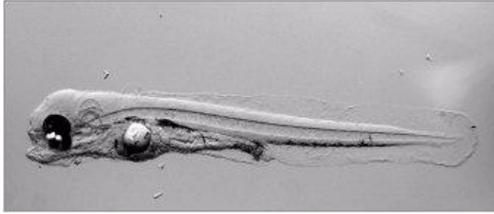
In fall 2007, Jolly-Seber mark-recapture studies were conducted to estimate abundance of wild age-0 largemouth bass in 10 backwaters of the Arkansas River. Hatchery-reared largemouth bass were stocked at 60 fish/ha into 5 backwaters. In fall 2008, Jolly-Seber studies were conducted to estimate abundance of wild age-1 largemouth bass. At stocking, there were no differences in weight ($T=-0.32$, $df=8$, $P=0.76$), length ($T=0.46$, $df=8$, $P=0.66$), or condition ($T=-0.62$, $df=8$, $P=0.56$) of wild and hatchery-reared largemouth bass. No significant difference was found between daily instantaneous mortality rates of wild largemouth bass from stocked and unstocked backwaters ($T=-0.08$, $df=7$, $P=0.94$). There was no significant difference in relative weight ($T=0.62$, $df=7$, $P=0.55$) or growth ($T=0.06$, $df=7$, $P=0.95$) between wild age-1 largemouth bass from stocked and unstocked backwaters. In this case, stocking hatchery-reared largemouth bass did not appear to affect the wild year class.

FISH ASSEMBLAGES ON GRAVEL BARS IN THE ARKANSAS RIVER

Lael Will and Steve E. Lochmann

We examined temporal and spatial variability of fish assemblages on 18 gravel bars in the Arkansas River. The influence that specific environmental variables, such as water quality and substrate composition, have on fish assemblage structure was also examined. Gravel bars were stratified by depth and distance from an upstream lock and dam. Fish assemblages on each gravel bar were sampled six times. Each sample consisted of duplicate trawls using a 3-m Herzog Armadillo trawl. Water quality parameters were measured in conjunction with fish sampling. Substrate samples were collected on each gravel bar using a standard Ponar dredge. The fish assemblages on gravel bars in the Arkansas River are primarily dominated by juvenile Ictalurids, Cyprinids, and Centrarchids. Of those, juvenile blue catfish, channel catfish and silver chub were the most abundant. Fish species richness was significantly different between shallow and deep gravel bars ($P < 0.0001$) and among the seasons ($P < 0.0001$). Catch per unit effort (CPUE) for the three most abundant species was analyzed for differences among depths, distance strata, and seasons. There were differences in CPUE among depths ($P = 0.03$) and seasons ($P < 0.0001$) for blue catfish. There were differences in CPUE among depths ($P = 0.01$, $P < 0.0001$), distances ($P = 0.04$, $P < 0.0001$), and seasons ($P < 0.0001$, $P < 0.0001$) for channel catfish and silver chub. The spatial and temporal variability in fish assemblage structure suggests that shallow gravel bars during the summer and fall seasons may be important habitat for some fish species.





MATERNAL AND PATERNAL INFLUENCES ON LARVAL PRODUCTION CHARACTERISTICS OF WHITE BASS

Steve E. Lochmann, Kelly J. Goodwin, Matt McEntire, and Adam Fuller

Domestication of white bass *Morone chrysops* makes selective breeding programs possible. Selection could be based on favorable larval characteristics, such as size at hatch or size at yolk absorption. We conducted a diallelic study using five female and five male white bass. Eggs from each cross were examined for fertilization. Twenty fertile eggs from each cross were placed into individual vials and incubated at 18 °C until hatching. Temperatures of the vials were measured daily. Fertilization and hatch rates were calculated for each cross. The remaining eggs from each cross were placed in individual McDonald hatching jars and allowed to incubate at 18 °C in recirculating systems. Water quality (DO, pH, TAN, and hardness) of the recirculating systems and the vials was tested daily, and temperature was taken every 6 h in the systems until hatching was complete, then once daily thereafter. Fifty yolk-sac larvae from each cross were photographed within 3 h of hatching. The remaining larvae were allowed to develop in 75-L aquaria for 5 d. Fifty larvae from each cross were photographed at 5 dph. Fertilization rates ranged from 39% to 100%. All eggs from one female failed to hatch, so hatch rates ranged from 0% to 50%. Average (SD) temperature of the vials was 18.5 (0.3) °C. There were no significant differences in temperature among the vials. Average temperature of the recirculating systems was 18.6 (0.8) °C. There was no significant difference in temperature, dissolved oxygen, pH, or hardness among the recirculating systems. The TAN varied significantly ($F=4.03$, $df=4$, $P<0.05$) among recirculation systems, but un-ionized ammonia was only 0.001 mg/L. Standard length of larvae ranged from 2.66 to 2.94 mm at hatch, and from 3.47 to 4.22 mm at 5 dph. Length at hatch varied significantly among female brood stock ($F=113.52$, $df=3$, $P<0.001$) and male brood stock ($F=3.46$, $df=4$, $P=0.008$). The interaction term was also significant ($F=4.49$, $df=12$, $P<0.001$). Length at 5 dph varied significantly among female brood stock ($F=363.85$, $df=3$, $P<0.001$) and the interaction between males and females was significant ($F=21.05$, $df=12$, $P<0.001$). There was a 0.7 mm difference in length between the fastest growing cross and the slowest growing by 5 dph. These results suggest improvement in larval characteristics might be possible through brood stock selection.

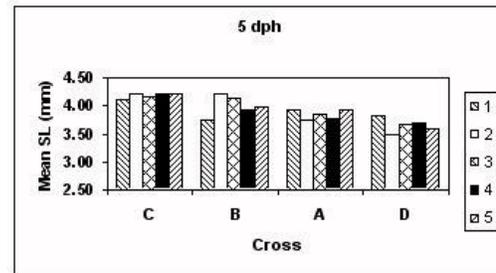
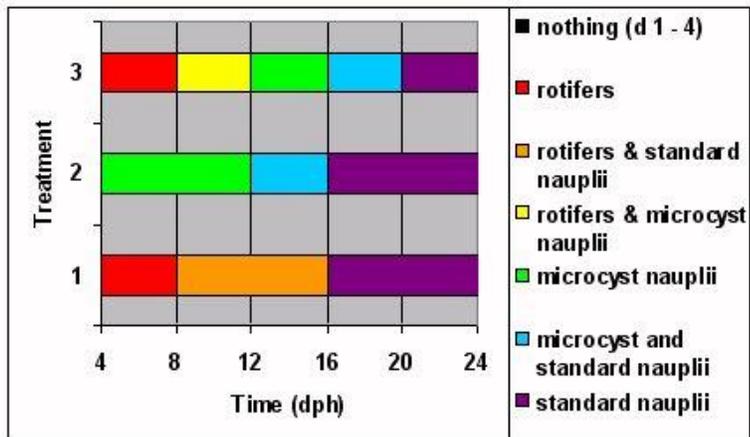


Figure 1. Mean SL of white bass at 5 dph



OPTIMIZING FEEDING STRATEGIES FOR TANK CULTURE OF SUNSHINE BASS USING MICROCYST ARTEMIA NAUPLII AS AN INTERMEDIATE STEP BETWEEN ROTIFERS AND STANDARD ARTEMIA NAUPLII

Steve E. Lochmann and Gerald M. Ludwig

Tank culture of sunshine bass larvae has typically required rotifers at the time of first feeding. Recently, sunshine bass

larvae have been cultured without rotifers, by using *Artemia* nauplii from microcysts at first feeding. Survival rates of 43% have been reported culturing sunshine bass larvae on microcyst *Artemia* nauplii alone. We wanted to see if survival and growth of sunshine bass larvae would be improved by including rotifers (*Brachionus plicatilis*), microcyst *Artemia* nauplii, and standard *Artemia* nauplii in sequence during a production run. This experiment was comprised of three treatments with three replicates per treatment. Sunshine bass larvae, 4 dph (4.0 ± 0.1 mm SL), were stocked into 100-L recirculating tanks at a rate of 75 larvae/L. The first feeding treatment was rotifers (40/mL) followed by standard *Artemia* nauplii (8/mL). The second feeding treatment was microcyst *Artemia* nauplii (20/mL) followed by standard *Artemia* nauplii (8/mL). The third feeding treatment was rotifers (40/mL) followed by microcyst *Artemia* nauplii (4/mL) followed by standard *Artemia* nauplii (8/mL). By day 8, all of the feeding treatments were fed standard *Artemia* nauplii only. Water quality (DO, pH, TAN, and hardness) of the recirculating systems was tested daily. Fingerlings were harvested on day 21 of the experiment. Survival was determined gravimetrically. Thirty larvae from each tank were photographed at the end of the study. Standard lengths of larvae were determined using image analysis software. We compared survival and growth among treatments using single factor analyses of variance. Average (SD) individual standard length of larvae was 9.08 (1.43) mm and ranged from 6.46 to 15.05 mm. Average length of larvae did not vary among treatments ($F=0.81$, $df=2$, $P=0.489$). Variability in survival among tanks was high (Table 1). Survival ranged from 9% to 96%, and varied somewhat among treatments ($F=3.41$, $df=2$, $P=0.102$). The lowest two survival rates (9% and 12%) occurred in treatment two and the highest two survival rates (70% and 96%) occurred in treatment three.

	Treatment		
	1	2	3
Survival (%)	31	23	68
Length (mm)	9.1	9.6	8.5



FIRST-YEAR CONTRIBUTION TO THE YEAR CLASS AND GROWTH OF LARGEMOUTH BASS STOCKED AT 50 MM AND 100 MM INTO THE ARKANSAS RIVER

N. Elizabeth Heitman, Christopher L. Racey, and Steve E. Lochmann

Few evaluations of largemouth bass stockings have been conducted in rivers. Oxytetracycline-marked largemouth bass *Micropterus salmoides*, averaging 50 or 100 mm TL, were stocked into backwater areas of pool 4 of the Arkansas River, in the summer of 2003, at densities of 309 and 62 fish/ha, respectively. Contributions to the year class of 50-mm (13.2%) and 100-mm (13.8%) stocked largemouth bass were not significantly different in fall 2003. Stocking contributions of 50-mm (17.6%) and 100-mm (17.2%) largemouth bass were also not significantly different in spring 2004. Contributions were not significantly different between seasons. Mean (SD) total lengths for 50-mm stocked, 100-mm stocked, and wild fish were 164 (38), 172 (39), and 162 (43) mm, respectively, in fall 2003, and 187 (37), 185 (43), and 179 (44) mm, respectively in spring 2004. There were no significant differences among mean lengths for stocked or wild fish in either season. Stocking five times as many 50-mm as 100-mm largemouth bass yielded similar contributions. Largemouth bass stocked into the Arkansas River had one-year stocking contributions similar to largemouth bass stocked into reservoirs and lakes.





VARIABILITY IN EGG CHARACTERISTICS AMONG WHITE BASS AND THE EGG VOLUME: LARVAL STANDARD LENGTH RELATION IN SUNSHINE BASS

Steve E. Lochmann*, Christopher L. Racey, Kelly J. Goodwin, and Christopher C. Green

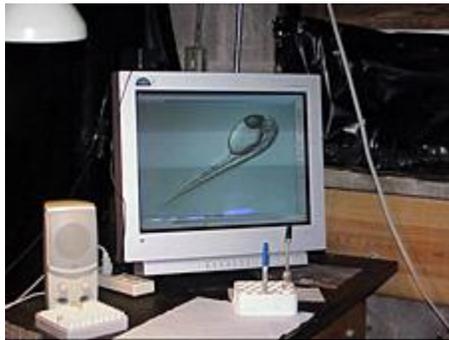
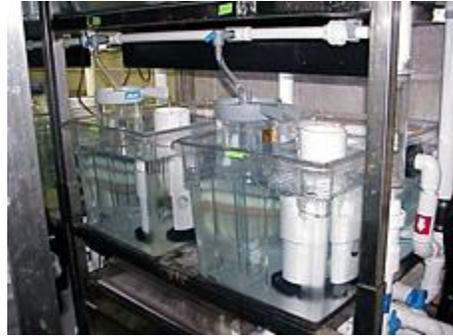
Besides fast growth or favorable feed conversion, selection of white bass *Morone chrysops* brood stock could be based on favorable egg or fry characteristics. Eggs from 12 white bass, used to produce sunshine bass fry, were individually photographed and incubated. Average egg volume ranged from 0.316 to 0.422 mm³ and varied significantly among females ($P < 0.0001$). Hatch rates ranged from 49% to 96%, but there was no relationship between hatch rate and egg volume. Total lipids varied from 4.03% to 6.17%, and n-3 HUFAs comprised more than 3% of lipids in eggs from all females. There was no relationship between egg volume and lipid levels. Yolk-sac fry were also photographed within 3 h of hatching. Standard lengths of yolk-sac fry were less variable than egg volumes ($CV = 6.3\%$) and ranged from 2.35 to 3.62 mm. Average standard length ranged from 2.89 to 3.08 mm and also varied among females ($P < 0.0001$). Specific female and time to hatch explained 60% of the variability in yolk-sac fry SL. Some females had egg and fry characteristics more suitable to increasing survival and fingerling production. Selection for these characteristics in brood stock white bass females could lead to improved production of sunshine bass fingerlings.



MATERNAL AND TEMPERATURE INFLUENCES ON PERCENT HATCH AND TOTAL LENGTH AT HATCH OF SUNSHINE BASS

Steve E. Lochmann, Kelly J. Goodwin, and Christopher L. Racey

We examined the relation between temperature and egg stage duration, and tested the hypothesis that a longer egg stage would produce a larger larvae. We examined the relation between temperature and percent hatch. Finally, we tested the hypothesis that maternal genetic influences were greater than temperature effects on size at hatch and percent hatch. Eggs from female white bass *Morone chrysops* were fertilized by a single, but different male striped bass *M. saxatilis* each week for four weeks. Approximately 4000 eggs from each female were hatched at 14, 16, 18, and 20°C. Yolk-sac larvae were removed from the jars, photographed individually, and enumerated. Eggs incubated at a cooler temperature took longer to hatch, but larvae were significantly larger at hatch. Temperature did not influence percent hatch. The maternal influence



on length at hatch appeared to be greater than the temperature influence on length at hatch. There was an interaction between maternal influence and temperature. Larvae from some females exhibited a monotonically decreasing length at hatch as temperature increased. Larvae from other females exhibited a non-linear response to temperature, with larvae significantly larger at hatch at the lowest and highest temperatures and smaller at intermediate temperatures.



SUNSHINE BASS FINGERLING TANK CULTURE: EFFECTS OF TANK STOCKING DENSITIES ON GROWTH AND SURVIVAL

Gerald M. Ludwig and Steve E. Lochmann

Determining the optimum parameters for tank culture of sunshine bass fingerlings will facilitate a year-round supply of seed for the production cycle of this increasingly popular food fish. This experiment determined the relationship between the stocking density of sunshine bass larvae into tanks and their survival rate and size at the time they had become trained to accept commercial feeds. Four-day post-hatch (dph) larvae were stocked at 10 densities from 30 to 120 larvae/L at 10 larvae/L

increments. The larvae were initially fed rotifers cultured with *Nannochloropsis* sp. algae paste and commercial rotifer feed until 10 dph. Conversion to *Artemia* began at 7 dph and training to dry starter feed began at 20 dph. Photographs of live samples of larvae taken at 4 dph and harvest were used to determine length and depth of the fish. Regression analysis determined no significant relationship between survival and stocking density. Length and weight of the fish had a linear, negative relationship with stocking density, while total tank yield had a curvilinear relationship with stocking density. The stocking density that provided maximum yield was 85.6 larvae/L. Based on prices of larvae and fingerlings, maximum value was realized when larvae were stocked at 115 larvae/L.



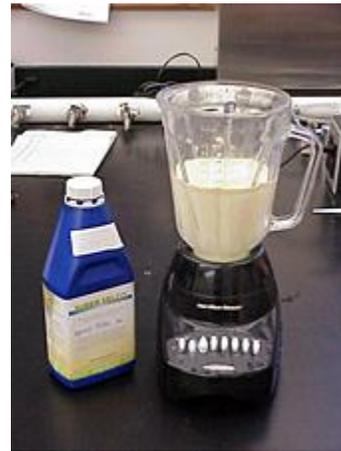


CHANGES IN LIPID AND FATTY ACID COMPOSITION OF WILDFRESHWATER ZOOPLANKTON DURING ENRICHMENT AND SUBSEQUENT STARVATION

Steve E. Lochmann, Kelly J. Goodwin, and Christopher L. Racey

ABSTRACT: Concentrated wild zooplankton, harvested from freshwater ponds, has been used to feed hybrid striped bass larvae in tanks. However, growth and survival were superior

when cultured rotifers and brine shrimp nauplii were offered as first feeds. We hypothesized that wild freshwater zooplankton could be enriched with HUFA in a manner similar to cultured zooplankton, which would enhance the nutritional value of the wild zooplankton. Wild zooplankton was enriched with Super Selco for 24 h. The lipid and fatty acid composition of wild zooplankton were monitored during the enrichment period and during the subsequent 72 h. Wild zooplankton had an initial total lipid level of 38 mg/g dry weight (DW), but lipid level rose to 72 mg/g DW after enrichment. Wild zooplankton was initially deficient in highly unsaturated fatty acids (HUFA), but after enrichment, wild zooplankton had a HUFA level of 10.41 mg/g DW. This was above a level recommended for good growth and survival of hybrid striped bass larvae. Nutritional state of wild zooplankton had returned to a pre-enrichment level 24 h after termination of enrichment. Therefore, harvesting and concentrating wild zooplankton from culture ponds, followed by 24 h of enrichment, offers producers another option for providing nutrition to early life history stages of hybrid striped bass larvae.



GOLDEN SHINER EGG SIZE, LIPID, FATTY ACID, AND AMINO ACID COMPOSITION DURING A SPAWNING SEASON

Steve E. Lochmann, Kelly J. Goodwin, Rebecca T. Lochmann, Nathan M. Stone, and Troy Clemment

The Arkansas baitfish industry leads the nation in production of golden shiner *Notemigonus crysoleucas*. We examined egg volume and the lipid, fatty acid, and amino acid composition of golden shiner eggs, produced by a group of captive brood stock, over a season, as a means of suggesting nutritional requirements for brood stock diets. Average egg volume was 0.67 (+ 0.117) mm³ and egg volume declined during the spawning season. Golden shiner egg total lipid averaged 15.67 (+2.99) µg per egg, and triacylglyceride (TAG) concentration was 6.82 (+1.81) µg per egg. Based on the stability of egg total lipid, the percent neutral lipid, the consistent contribution of TAG to neutral lipid,



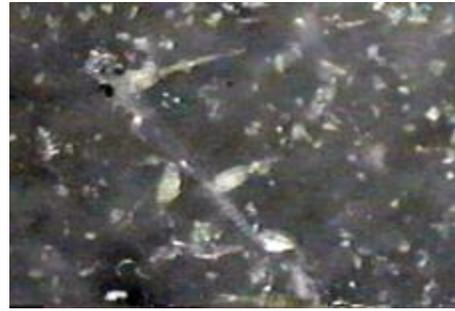
the consistent TAG concentration, and the stable fatty acid and amino acid profiles, we conclude that lipid and amino acids in eggs from the experimental group were stable. The eggs should be equally sufficient for embryological development throughout the spawning season, but specific indices of egg and fry quality must be measured to confirm the links among egg size, biochemical composition, and egg and fry quality.



MORTALITY OF FISH LARVAE EXPOSED TO VARYING CONCENTRATIONS OF CYCLOPOID COPEPODS

Emmanuel A. Frimpong and Steve E. Lochmann

Cyclopoid copepods can prey on freshwater fish larvae. The magnitude of predation is related to cyclopoid copepod size, cyclopoid copepod concentration, and larval size, and is also likely to be specific to certain species. We studied 5-d-old larvae of sunshine bass *Morone chrysops* x *M. saxatilis* (female white bass x male striped bass), golden shiner *Notemigonus crysoleucas*, fathead minnow *Pimephales promelas*, and goldfish *Carassius auratus* in four separate experiments. Larvae were stocked at 20/L into 2 L of water containing varying concentrations of the cyclopoid copepods *Cyclops vernalis* and *Mesocyclops vericans* to ascertain the effect of predation on mortality. We also compared predation rates observed in this study to rates predicted by an empirical model of crustacean predation on fish larvae from the literature. Sunshine bass alone were susceptible to predation mortality at the cyclopoid copepod concentrations used in this study. Mortality at 400 cyclopoids/L was significantly



higher than mortality at 0-100 cyclopoids/L. Mortality at 500 cyclopoids/L was significantly higher than mortality at any other treatment concentration. Observed predation rates were much lower than predation rates predicted by the model. Stocking 4.11 mm TL or larger sunshine bass larvae into ponds with fewer than 300 cyclopoids/L probably represents a low risk of predation. Golden shiner, fathead minnow, and goldfish larger than 5 mm TL, stocked in ponds with less than 500 cyclopoids/L would likely experience little cyclopoid copepod predation.

RESPONSES OF BROOK AND BROWN TROUT TO STREAM REHABILITATION IN A MICHIGAN FOREST STREAM

Veronica Bullock, A.J. Cline, and Steve E. Lochmann

The White River is located in west central Michigan, partially within the Huron-Manistee National Forests. The White River is one of the “Blue Ribbon” trout streams in the Lake Michigan drainage. It is wadeable, and the bottom consists of a combination of cobble, gravel, and sand.

Developments, road construction, and crossings generally increase the amount of sand in the river and can negatively effect trout reproduction. Fisheries biologists with the Huron-Manistee National Forest undertook a stream rehabilitation project to minimize sand accumulation. Instream features were added to provide habitat, capture sand, increase pool depth and frequency, and minimize sand accumulation in the stream channel. Chapman’s mark/recapture estimates of population abundance were calculated in 2001 for brown *Salmo trutta* and brook *Salvelinus fontinalis* trout, prior to construction of instream structures, in two reaches of the river. Trout were collected with a barge electroshocker, identified, measured for total length, fin-clipped to mark the fish, and released downstream of the area being sampled. Subsequently, instream features (lunkers, deflectors, brush bundles, and platform structures) were put in place in the White River. In 2005, the two reaches were again sampled with the barge electro-fisher. Species were identified, measured, and fin-clipped as



before. Chapman’s mark/recapture estimates of abundance were calculated for both trout species. We compared the size distributions prior to, and following the instream work using chi-square tests ($\alpha=0.05$). We also compared the abundance of both trout species prior to and following the rehabilitation work. Abundance of brown trout increased 1.5 to 2.5 times following instream work. Abundance of brook trout remained the same in one reach and increase 1.4 times in the second reach. Brown trout size distributions significantly increased in both stream reaches. Brook trout size distribution increased in the reach that did not exhibit a significant increase in abundance, but did not change in the reach that exhibited a significant increase in abundance. Trout populations exhibited improvements in either abundance or size structure, or both, following the instream work. This stream habitat management strategy may be a model for improvement of habitat in other Michigan trout streams.



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THE FISH COMMUNITY OF MADDOX BAY RUNOUT

Steven Mondragon, Richard Hines, and Steve E. Lochmann

Maddox Bay Runout connects Maddox Bay and Indian Bayou to the main channel of the White River. Concerns about stream crossings of Maddox Bay Runout for logging activities led to a survey of ichthyofauna. We sampled five

randomly selected 0.1-mile segments of the 1.5-mile long stream. Ichthyofauna was sampled with one

10-minute backpack electrofishing sample per stream segment. We conducted two seine hauls per segment with a 30 x 6-ft knotless nylon seine with 3/16-inch mesh. We also set one minifyke net overnight in each of the stream segments. We collected 1763 specimens representing 48 species and 13 families. The two most prominent families were cyprinids and percids. Cypress minnow, blacktail shiner, weed shiner and ribbon shiner made up 80% of the individual fish collected during the study. The darter

community in Maddox Bay Runout appears intermediate between Indian Bayou and the main channel of the White River.



EVALUATION OF SHORELINE SEINING AND MINI-FYKE NETS IN FLOODPLAIN LAKES

S.J. Clark, John R. Jackson, and Steve E. Lochmann

Mini-fyke nets (MFN) were compared with shoreline seining (SS) to assess their relative abilities to describe littoral fish assemblages in 14 White River, AR floodplain lakes. Lakes ranged in size from 1 ha to 48 ha. Lakes greater than 2.4 ha were sampled using three MFN, while those smaller than 2.4 ha were sampled using two MFN. MFN were set



for a 24-hour period. SS effort depended on the amount of open shoreline with a minimum of one seine haul and a maximum of 30 seine hauls conducted per lake. MFN were deployable in all of the 14 sample lakes; whereas SS could only be used in 10 lakes due to woody vegetation. MFN collected more fish (3148) than SS (777). Overall, MFN species richness was 42 with 18 unique species. SS species richness was 25 with one unique species. In lakes sampled using both gears, Cyprinidae (42%), Centrarchidae (31%), and Clupeidae (9%) were most commonly caught in MFN whereas Poeciliidae (43%), Centrarchidae (30%), Cyprinidae (12%) were most commonly caught in SS. MFN were more efficient at sampling littoral fish assemblages than SS, required less manpower, and were fishable in all lakes

INFLUENTIAL ENVIRONMENTAL/HYDROLOGICAL GRADIENTS AND SPATIOTEMPORAL PATTERNS IN FISH ASSEMBLAGES IN THE LOWER WHITE RIVER, ARKANSAS

S.J. Clark, John R. Jackson, and Steve E. Lochmann

Five floodplain lakes within the White River National Wildlife Refuge were sampled in 2002, 2004, and 2005 to assess temporal variation of fish assemblages and lake environmental/hydrological variables. Lakes were sampled

using boat electrofishing, experimental gill nets, and mini-fyke nets. Hydrologic variables were calculated by obtaining river stage that each lake connected to the river. Lakes sampled were highly diverse and provided a gradient of habitats allowing for shifts in fish assemblages but not drastic changes. A shift from cyprinid dominated lakes to cyprinid/centrarchid-dominated lake occurred. Relative abundance of cyprinids was highest during 2002. In 2004, a decrease in cyprinids abundance and increase in centrarchids abundance was observed and by 2005 relative abundance of cyprinids and centrarchids were nearly equal. Over the 3-year period, the decrease in the mean days lakes were connected to the river decreased. Catches in 2002 were dominated by emerald shiners, which are documented as preferring water with current. As the number of days connected decreased, the abundance of emerald shiners decreased while the relative abundance of more lentic species such as bluegill increased. Even though shifts in fish assemblages occurred within lakes, overall changes in the system were not evident.



EFFECTS OF DOUBLE-CRESTED CORMORANTS ON LARGEMOUTH BASS AND CRAPPIE IN LAKE CHICOT, ARKANSAS

Christopher L. Racey, Amy Fenech, and Steve E. Lochmann

The mortality of crappie *Pomoxis* spp. and largemouth bass *Micropterus salmoides* populations due to depredation by double-crested cormorants (DCCOs) was quantified and the diet overlap of DCCOs and largemouth bass was evaluated for fall, winter, spring, and all seasons combined in Lake Chicot. The DCCOs consumed between 85 and 863 crappie and between 91 and 1032 largemouth bass per year. The DCCOs consumed an estimate of between 0.002% and 0.02% of the crappie population per year when using rotenone data to estimate population abundance or between 0.01% and 0.32% of the population when using creel survey data to estimate population abundance. The DCCOs consumed between 0.26% and 3.00% of the largemouth bass population using rotenone data to estimate population abundance and between 0.03% and 1.53% using creel survey data to estimate population abundance. Diet overlap was biologically significant (greater than or equal to 60%) in the fall using percentage of total number and weight of prey, and relative importance index values for prey items. However, diet overlap was insignificant for diet measures used in all other seasons and for all seasons combined.



Over-wintering DCCOs had little or no negative effects on largemouth bass and crappie populations in Lake Chicot.

TOXICITY OF ISOPROPYL METHYLPHOSPHONIC ACID TO EGGS OF GOLDEN SHINER AND CHANNEL CATFISH

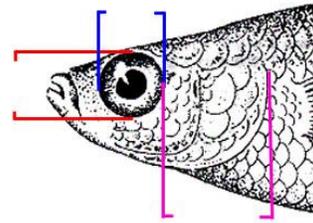
Chris C. Green and Steve E. Lochmann

ABSTRACT: The Pine Bluff Arsenal has been ordered to incinerate a number of the chemical weapons currently stored at the facility in accordance with the Chemical Weapons Convention Treaty of 1997. Sarin is a nerve agent that acts as an acetylcholinesterase inhibitor. In the event of an accident during incineration, Sarin has the potential to be expelled into the environment. Isopropyl methylphosphonic acid (IMPA) is the main hydrolysis product of Sarin. Golden shiner *Notemigonus crysoleucas* and channel catfish *Ictalurus punctatus* eggs were exposed to IMPA. Fifteen fertilized eggs were placed in 250-mL test tubes containing 200 mL of water with five different concentrations of IMPA ranging from 35 to 75 mg/L for golden shiner and 115 to 175 mg/L for channel catfish. There were four replicates per treatment and a control. Each test tube was aerated with air stones and maintained at a temperature of 25 °C. The LC50 for eggs was determined by estimating the concentration of IMPA in which half of the individuals failed to hatch. The LC50 for golden shiner egg hatchability was 60 mg/L (upper 95% C.I. 68 mg/L, lower 95% C.I. 53 mg/L). The LC50 for channel catfish was 157 mg/L (upper 95% C.I. 179 mg/L, lower 95% C.I. 144 mg/L). These results are critical in understanding the toxicological properties of this potential environmental contaminant. They are also important in conducting risk assessments relative to activities at the PBA.



FLUCTUATING ASYMMETRY AND RELATIVE CONDITION IN GOLDEN SHINER (*NOTEMIGONUS CRYSOLEUCAS*) AND CHANNEL CATFISH (*ICTALURUS PUNCTATUS*) REARED IN SUBLETHAL CONCENTRATIONS OF ISOPROPYL METHYLPHOSPHONIC ACID

Chris C. Green and Steve E. Lochmann



Stress during embryological development can result in small random differences between left and right sides of a bilateral trait.

This fluctuating asymmetry (FA) has been proposed as a measure of the level of stress a group of organisms experienced during embryological development. Toxicants have been shown to increase FA among groups with increasing exposure during development. Studies have shown a relationship between asymmetry and indices of condition. The Pine Bluff Arsenal (PBA) has been ordered to incinerate a number of the chemical weapons currently stored at the facility in accordance with the Chemical Weapons Convention Treaty of 1997. In the event of an accident during incineration, sarin or its decomposition products have the potential to be expelled into the environment. Isopropyl



methylphosphonic acid (IMPA) is the main hydrolysis product of Sarin. This study examines the use of FA as an indicator of developmental stress due to sublethal exposures to a toxicant. We compared FA in fourteen morphological characters among groups of golden shiner (*Notemigonus crysoleucas*) and channel catfish (*Ictalurus punctatus*) exposed to sublethal concentrations of IMPA during embryological development. The relationship between relative condition and asymmetry are also examined.

EVALUATION OF POPULATION DYNAMICS AND STOCKING CONTRIBUTION OF LARGEMOUTH BASS IN TWO POOLS OF THE ARKANSAS RIVER

Elizabeth Heitman, Chris Racey, and Steve E. Lochmann



Largemouth bass stock characteristics and population dynamics in two pools of the McClellan-Kerr Arkansas River Navigation System were assessed. We evaluated the initial results of a fingerling stocking effort initiated by the Arkansas Game and Fish Commission. Approximately 500,000 fingerling largemouth bass (app. 50 mm) were stocked into 10 pools of the Arkansas River. Largemouth bass were collected with a

SmithRoot 7.5 GPP electrofisher, set at 60 cycles per second and voltage was adjusted between 4 and 5 amps of electricity. For pool 5, proportional stock density (PSD) was 47% and relative stock density preferred (RSD-P) was 16%. For pool 9, PSD was 31% and RSD-P was 11%. Total annual mortality was 57% and 81 % for pools 5 and 9, respectively. Contribution of stocked largemouth bass fingerlings was evaluated by examining oxytetracycline marks.



POSSIBLE EFFECTS OF DOUBLE-CRESTED CORMORANTS AND LARGEMOUTH BASS PREDATION ON CRAPPIE IN AN ARKANSAS OXBOW LAKE

Amy S. Fenech, Steve E. Lochmann, Andrew Radomski, David Wooten, and Mike Hoy



Mortality rates of age-0 to age-1 crappie (*Pomoxis* sp.) in Lake Chicot, an oxbow lake of the Mississippi River have been estimated to be approximately 90% in recent years. Increasing numbers of Double-crested cormorants (*Phalacrocorax auritus*) feeding on Lake Chicot are suspected by many anglers to be the cause of high mortality rates in sportfish populations. However, Arkansas Game and Fish Commission report an increase in the density of largemouth bass (*Micropterus salmoides*) which may be having an affect on crappie survival. Collections of largemouth bass and cormorants will be taken seasonally with an additional collection of largemouth bass taken in the summer months. The diet and potential impact of largemouth bass and wintering cormorants will be investigated over a one-year period. We will attempt to use bioenergetic models to determine which of these factors is having a greater impact on the mortality of young sportfish in Lake Chicot.



AN EVALUATION OF STOCKING CRAPPIE IN LAKE CHICOT ARKANSAS

Christopher L. Racey and Steve E. Lochmann

Crappies (*Pomoxis* spp.) are the most sought after game fishes in Arkansas and their management is becoming more important. The Arkansas Game and Fish Commission (AGFC) received reports from local anglers in the early 1990s that crappie densities were declining in Lake Chicot, a 2024-ha natural oxbow lake of the Mississippi River. In response, the AGFC initiated a stocking effort beginning in 1998. White crappie (*P.*



annularis) fingerlings were marked by immersion in a 6-h bath of 500 mg/L of oxytetracycline-hydrochloride buffered with 2000 mg/L of dibasic sodium phosphate. Marking efficacy was 97%. Handling mortalities ranged from 20 to 72%. Initial contribution of stocked fish to the year classes was 9 and 15% for the 1998 and 1999 year classes, respectively. Trap nets were used subsequently to sample wild and stocked crappie. Stocked crappie contributed 0.8% to the 1998 year class at the time the fish entered the fishery. Stocked crappie did not contribute to the 1999 year class. Differential survival rates between wild and stocked fish may have accounted for the difference between initial and final contributions. We recommend that crappie be stocked only when the following conditions are met: 1) all fish should be marked prior to stocking; 2) 72-h handling mortality should be 20% or less; 3) stocked fish should make up at least 10% of the year class at recruitment; and 4) the cost-benefit ratio associated with stocking should be acceptable to the natural resource agency and the public.



USE OF RELATIVE ABUNDANCE AND CONDITION TO PREDICT SURVIVAL OF HYBRID STRIPED BASS (*Morone chrysops* x *M. saxatilis*) FINGERLINGS

Chao Mwatela, Steve E. Lochmann and Jerry Ludwig

Survival of palmetto bass during fingerling production averages about 35%, but survival of sunshine bass is usually lower and more variable. Reasons for variability include poor zooplankton management, handling mortality associated with stocking, or water quality problems. We hypothesized that survival could be predicted early in a fingerling production run by combining estimates of relative abundance with measures of nutritional condition. Twelve 0.1-acre ponds were filled with well water and fertilized five days before being stocked with five-day-old sunshine bass fry. To induce variability in condition and survival, the twelve ponds were divided into a control and three treatment levels according to fertilization rate. The three treatments were twice, three times, and four times the control fertilization rate. Fry were sampled from each pond once/week for three weeks. Fry that were concentrated in an area illuminated by a propane lantern were collected using a small plankton net (30 cm diameter mouth, 150 micron mesh). Fry were videotaped for morphometric analysis and preserved. After five weeks, ponds were seined twice and survival was determined. Morphometric measures, including body depth at the pectoral fin insertion (BDP) and body depth at the anus (BDA), were collected from the images. Preliminary results suggest that abundance during the first week explained 60% of the variability in survival at five weeks. Abundance and a morphometric measure of condition (BDP/BDA) explained about 70% of the variability in survival. We concluded that relative abundance and condition may be useful together as a management tools during production of sunshine bass.





AN EVALUATION OF TREATMENTS AFFECTING ZOOPLANKTON POPULATIONS FOR WATER RE-USE AND EFFLUENT REDUCTION

Emmanuel Frimpong and Steve E. Lochmann

Regulation of aquaculture effluents in the United States is imminent. High potential costs are associated with effluent treatment, monitoring, and reporting. To circumvent strict compliance monitoring, and as a water conservation technique in response to declining aquifer levels, re-use of pond water is becoming a trend in the Arkansas baitfish industry. The biggest challenge to this practice is predation on fry by cyclopoid copepods present in this old water. The aim of this study was to evaluate methods of restarting the zooplankton bloom in pond water held from previous production operations. The succession and abundance of zooplankton namely, rotifers, copepod nauplii, adult copepods and cladocerans in ponds containing old water, old water treated with 0.25 mg/L dimethyl(2,2,2-trichloro-1-hydroxyethyl)phosphate (Dylox), and mechanically filtered old water were compared to ponds filled with new well water. All ponds were fertilized twice a week with cottonseed meal and inorganic liquid fertilizer (N: P = 10:30) at the commercial rate. Zooplankton were sampled and water quality was monitored daily for 6 weeks. It took 8 days to reach the peak (~1000/liter) of the rotifer bloom in new water. Compared with new water, mechanically filtered and chemically treated water had comparable numbers of rotifers by day 8 (see figure). Chemical treatment had the highest rotifer and copepod blooms ($P < 0.05$). Filtration removed copepods and cladocerans, followed immediately by increased nauplii. Chemical treatment removed only cladocerans, resulting in rising and stabilizing copepod numbers. Mechanical filtration improved rotifer and nauplii abundance in early days, and greatly reduced and delayed copepod abundance. Mechanical filtration improved old water quality more than chemical treatment.

