ARKANSAS GAME & FISH COMMISSION

CRAPPIE MANAGEMENT PLAN

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MISSION STATEMENT: ***The goal of crappie management is to provide quality crappie fishing. Management efforts towards improving recreational crappie fishing will be optimized within the context of a multi-species fishery by accurately characterizing crappie population density and structure and enhancing crappie populations through harvest regulations, stocking, and habitat improvement.***

OBJECTIVES:

1. **Develop standardized sampling methodology for evaluating crappie populations.**
2. **Develop a set of biological criteria for identifying what a model crappie population in Arkansas should resemble based on standardized sampling procedures to manage both black and white crappie populations collectively.**
3. **Develop a Crappie Stock Assessment to provide a standardized means for fisheries managers to make objective evaluations of population structure and population trends over time.**
4. **Develop a set of biological criteria that would determine when or if harvest regulations would be appropriate for improving crappie population structure.**
5. **Develop guidelines and evaluate effectiveness of crappie supplemental stockings.**
6. **Evaluate need for stocking forage species such as threadfin shad when crappie growth is limited.**
7. **Evaluate need for stocking predator species such as saugeye when crappie overpopulation and stunting occurs.**
8. **Assess crappie habitat needs in Commission-owned and Federal water project lakes and implement appropriate habitat improvement projects.**
9. **Exploit opportunities to influence water management policy and operational features on Federal water project lakes to improve crappie habitat.**

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EXECUTIVE SUMMARY

Crappie collectively are the most sought after sport fish among senior resident anglers (44%), and second to bass (largemouth and spotted) among resident (34%) and non-resident (25%) anglers in Arkansas (Duda et al. 2000). Combined, resident and non-resident anglers spend an estimated $92.6 million annually fishing for crappie in Arkansas. Because of high angler interest and the significant contribution to the State's economy, the Arkansas Game and Fish Commission has intensified its efforts towards developing a species plan to optimize management efforts and enhance the quality of recreational crappie fishing by characterizing and improving crappie population structure.

A standardized sampling methodology for sampling and evaluating crappie populations was developed using trap nets. Trap netting will be conducted a minimum of 30 net-nights per month from September through November in an effort to collect sufficient numbers of crappie to allow population size and age structure analysis.

A set of biological criteria was developed to define a model crappie population in Arkansas based on standardized sampling results. Objectives for the five population parameters of density, growth, age structure, size structure, and recruitment were established by examining trap net data from fifteen Arkansas lakes. Lakes varied from oxbows to large Corps of Engineer impoundments and from relatively clear and infertile waters to very productive lakes with dense algae or plant growth.

A good crappie population has a high density of desirable-size fish available for angler harvest. Further, it will have adequate and consistent recruitment accompanied with sufficient growth to compensate for harvest.

An optimal crappie population in Arkansas will exhibit a growth rate of 201-mm to 275-mm (8-11 inches) at Age-2+, have a size structure (percent > 250-mm) above 30%, and show consistent recruitment. These metrics are minimally sufficient to describe a good crappie population. Age structure, growth, and mortality estimates are needed to determine the suitability for enacting minimum length limits and/or other harvest regulations.

A crappie stock assessment was developed based on estimates of density, growth, age structure, size structure, and recruitment. Values for the five parameters were established by examining trap net data from Arkansas lakes, and highest values were assigned to optimum measurements of each parameter. Values assigned to each population parameter were summed to give an overall rating for the crappie population condition. The Crappie Population Assessment should provide a standardized means for fisheries managers to make objective evaluations of population structure and population trends over time.

A set of biological criteria was developed to determine when or if harvest restrictions would be appropriate for improving crappie population structure. Management strategies based on growth and mortality rates, and age and size structure include adjusting crappie creel and length limits, management of predators, lake fertilization, stocking, and control of aquatic vegetation and turbidity.

Angler preference is an important consideration when minimum length limits are being examined as management strategies. The use of population modeling programs will be used to predict long-term effects on crappie harvest prior to implementation of minimum length limits. Due to the various growth and natural mortality rates of crappie populations across the state, statewide length limits may be detrimental and result in substantial reductions in yield to some fisheries. Therefore, statewide length limits are not a recommended management strategy for Arkansas crappie populations.

Guidelines for crappie supplemental stocking were developed, in which stocking rates are determined by lake size. New lakes have the highest priority for crappie stockings. Supplemental stockings in other lakes will be based on technical analysis of cove rotenone population samples and/or trap netting and social needs relevant to the fishery. Lakes over 4,050 ha, including Corp of Engineer impoundments, should be stocked through the nursery pond system. Crappie should not be stocked in lakes during years of high recruitment, since supplemental stocking is not likely to make a significant contribution to the naturally produced, strong year-class. Also, crappie should not be stocked in lakes where Age-0 to Age-1 mortality is high, because it is likely that supplemental stocking will have a similar high mortality rate due to poor conditions such as lack

of adequate forage, habitat, or high predation. Environmental manipulation techniques such as lake fertilization, water level manipulation, and habitat improvement will be used in tandem with regulations and stockings to improve crappie populations where these techniques are appropriate. Habitat assessments are to be performed on Commission-owned and Federal water project lakes to determine crappie habitat needs. Feasibility plans are to be drafted and implemented to address these needs as budget and resources allow in an effort to improve crappie habitat statewide.

No management plan is complete without proper evaluation, and management strategies suggested in this plan should be appropriately evaluated after exploitation studies have been initiated, population modeling has been conducted, harvest restrictions have been imposed, or creel surveys have been completed. Evaluation of additional trap netting data using the Crappie Stock Assessment will yield further information regarding the effectiveness of the management plan.

Natural mortality rates of Age-0 to Age-1 crappie should be derived by fishery managers to assess where supplemental stockings will be most beneficial. Fishery managers should also re-evaluate current crappie minimum length limits on Arkansas lakes using population modeling programs. Other sampling techniques such as using larger 8' x 8' or 6' x 6' trap nets and spring/fall electrofishing should be explored where standard trap net gear has been ineffective at sampling the crappie population.

Handling and hauling mortality of crappie must be estimated and reduced by hatcheries to minimize post-stocking mortality. Acceptable marking techniques for identification of stocked crappie also need to be investigated. Once a desirable marking technique is accepted, future contributions of stocked fish to year-classes can be evaluated.

A Crappie Recruitment Model is needed to determine what variables are having the greatest impact on crappie recruitment in Arkansas waters. The model would potentially help fishery managers identify those problems in reservoirs where corrective management could be applied, and would also help in predicting missing year-classes and thus, supplemental stocking guidelines on an annual basis.

Finally, the purchase and replacement of boats, motors, trap nets, funding for exploitation/tag reward studies, and continued workshops and application of fish population modeling is needed for successful implementation of this plan.

INTRODUCTION

Both black crappie *Pomoxis nigromaculatus* and white crappie *P. annularis* are found throughout Arkansas (Robison and Buchanan 1988). Both species prefer quiet waters, and are almost always found near cover such as brush piles, tree tops, standing timber, and aquatic vegetation. Black crappie prefer cooler, deeper waters and seem to dominate in clear, vegetated, acidic waters, while white crappie tend to dominate in eutrophic (richer), more turbid, alkaline waters.

Crappie collectively are the most sought after sport fish among senior resident anglers[*] (44%), and second to bass (largemouth and spotted) among resident (34%) and non-resident (25%) anglers in Arkansas (Duda et al. 2000). Questionnaire results also indicated that a large percentage of anglers (62% of senior residents, 48% of residents, and 43% of non-residents) choose to consume the different species of fish they catch (Duda et al. 2000).

In 1996, resident anglers spent $191.3 million and non-resident anglers spent $110.4 million fishing in Arkansas waters (Maharaj and Carpenter 1997). Combined, resident and non-resident anglers spend an estimated $92.6 million annually fishing for crappie in Arkansas. Because of high angler interest and the significant contribution to the State's economy, the Arkansas Game and Fish Commission has intensified its efforts towards developing a species plan to optimize sampling and management strategies towards improving the quality of recreational crappie fishing.

For years, biologists believed lakes with large numbers of undersized crappie were the result of overpopulation and stunting (Goodson 1966; Ming 1971). As biologists began to look more closely at crappie age-and-growth, they often found over-harvest instead of over-population (Webb and Ott 1991). Colvin (1991) reported over-harvest of crappie in a large Missouri reservoir. However, this is not always the case as Reed and Davies (1991) recommended against size restrictions to protect the crappie fishery from over-harvest, because high natural mortality would have nullified the benefits of a delayed harvest.

Past crappie management in Arkansas was seldom based on well-defined objectives developed from the three rate functions of recruitment, growth, and mortality, which reflect crappie abundance and size structure. Often, crappie received little or no direct management. A standardized approach to characterizing the state's crappie populations was needed to provide reliable information.   A research team was formed in 1994 to develop criteria to best characterize crappie population structure and optimize management efforts. Fifteen lakes were sampled with trap nets between 1989 and 1993 to gather data to develop this plan (Table 1). Lakes varied from oxbows to large Corps of Engineer impoundments and from relatively clear and infertile waters to very productive lakes with dense algae or plant growth.

Successfully managing crappie populations requires understanding and manipulating processes controlling recruitment. Recruitment is the number of crappie surviving their first year of life, and is influenced by spawning success, environmental conditions (temperature, food availability, water level fluctuation, turbidity, etc.) and predation on young-of-the-year (YOY) crappie. Arkansas' lakes undergo fluctuations in water levels, temperature, turbidity and organic inputs. These factors greatly affect the success of crappie spawns and produce natural variations in fry production. Under proper circumstances these variations are evident later in recruitment and eventually in age structure.

Cyclic and highly variable recruitment is a principal management problem in crappie fisheries, which generally produce strong year-classes every 3-5 years (Swingle and Swingle 1967). Results from Allen and Miranda's (1997) crappie age-structure population model suggested that a specific combination of stock abundance and environmental conditions produced cyclic recruitment in crappie populations. These factors may act in combination resulting in high recruitment when stock abundance is low and environmental conditions are favorable, and low recruitment when stock abundance is high and environmental conditions are unfavorable. In addition, modeling suggested that even with favorable environmental conditions, production of a strong year class might lead to reduced or only average recruitment in subsequent (1-5) years.

The predator population also affects fry/juvenile mortality and subsequent recruitment. We speculate that a high-density bass population results in low crappie recruitment due to intense predation (high natural mortality), in which surviving crappie are fast growing and reach large size. Many fishermen would prefer this situation to catching numerous smaller crappies (AMRA 1988). An example is Bear Creek Lake, which holds a dense population of 250mm-325mm (10-13") largemouth bass, and shows low crappie recruitment and rapid growth with average size of 320-mm (12.5") at age 2+. In contrast, Lake Greenlee has low bass density and shows crappie to be

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[*] anglers who have purchased an Arkansas Senior Citizen (65+) fishing license

overpopulated, slow growing, and seldom reaching more than 150-mm (6”) in length as adults.

Dense predator populations have been shown to be inefficient in controlling YOY crappie when turbidity levels are high or thick vegetation is present. Channel scar lakes or shallow lowland lakes are perhaps Arkansas’ most fertile lake type and often have dense vegetation and/or turbid water used as cover by many YOY fishes. These lakes show good to high recruitment values and low mortality of YOY crappie, which results in low growth rates. Recruitment must be controlled to properly manage these lakes. Added fishing pressure and relaxed limits may not be sufficient to control overpopulation. Control of vegetation and turbidity may provide an answer.

In lakes containing moderate densities of largemouth bass and low crappie density, natural fluctuations in crappie production show up as inconsistent recruitment and missing year classes. Lakes Beaver, Bob Kidd, Nimrod, and Horseshoe show large variations in age structure due to inconsistent recruitment. The most appropriate management strategy in these situations may be to manage the habitat (water level, cover, fertilization) to enhance spawning success and recruitment.

Harvest regulation is one possible way to influence crappie populations when exploitation (angler harvest) is high. However, only under conditions of rapid crappie growth and low natural mortality will minimum length limits improve yield (average weight of fish harvested) in crappie populations. Prior to the implementation of minimum length limits, population-modeling programs should be used to predict long-term effects on the crappie population. Modeling results can be evaluated by subsequent field data collections. Knowledge of angler preference when minimum length limits are being investigated should also be an important consideration for fishery managers in the decision-making process.

CRAPPIE POPULATION EVALUATION

STANDARDIZED SAMPLING PROCEDURES

Trap net samples are described as the most efficient and precise means of sampling crappie. Boxrucker and Ploskey (1988) found trap nets to have a higher catch per unit effort (CPUE) and lower within season variability than either electrofishing or gill netting, and were the only types to adequately sample YOY crappie. Fall trap netting best represented population structure. McInerny (1988) found age and size structure of black crappie from fall trap netting similar to that harvested by fishermen during the same season. Miranda et al. (1990a) found a significant correlation between white crappie abundance from spring trap netting and springtime angler harvest per hour.

The primary objective of trap netting is to collect sufficient numbers of crappie to allow population size and age structure analysis in lakes with significant crappie fisheries.   Trap netting may also be used to collect fish for mark-recapture population and exploitation estimates.

Temporal variations in size and age structure of crappie are evident within our fall trap net samples in Arkansas. A higher percentage of YOY are caught in early fall, while larger, older fish are caught in late fall. Better estimates of population parameters can be obtained by sampling throughout the fall. All fish will be aged by examining otoliths. This method results in less error and variability than the scale method (Boxrucker 1986).

GEAR SPECIFICATIONS

Trap nets are constructed with two (2) 3' x 6', 5/16" diameter, steel frames with center braces and four (4) 2.5' diameter hoops of 3/8" steel. The 3' x 6' frames are 30" apart, and the first hoop is 32" from the second frame. The hoops are 24" apart. The second 3' x 6' frame has a slit throat and the first hoop has a 6" throat.   The net material is 1/2" square NO.105 L knotless nylon, netset treated. The cod end of the net has a string closure with a 5' No. 5 braided nylon string.

The leads are 1/2" square No. 105L knotless nylon hung 14 meshes per foot on No. 60 nylon twine, netset treated with 2" x 1.5" cork floats spaced at 3' intervals and 1.5 oz. weights spaced at 2' intervals. The leads are 50' in length and 3.5' deep with the exception that shorter leads can be used near steep drop-offs. Leads are permanently attached to the second 3' x 6' frame center brace.

Alternatively, Miranda et al. (1996) reported that floating trap nets with larger frames, and longer and deeper leads than the standard 3' x 6' frame with 50' lead may be necessary in larger, deeper reservoirs where catch rates are low. These large 8' x 8' frame floating trap nets with 200' leads resulted in larger sample sizes with moderate sampling effort when fished in habitats that previously were not sampled effectively by standard trap net gear.

Although the larger 8' x 8' frame net caught more crappies than the standard net, fishing the net can sometimes be problematic. The net is bulky, and because of its size and weight can be difficult to handle when wet. Wind and wave action can cause the nets to be disabled, especially in open-water sets. The large nets are also at risk floating in open waters where they are likely to be encountered by boaters.

Isaaks and Miranda (1997) developed a smaller 6' x 6' frame floating trap net with a 150' lead that is easier to handle than the larger 8' x 8' nets. The 6' x 6' net resulted in catch rates that were lower than the 8' x 8' net, but significantly greater than standard nets. Therefore, the 6' x 6' floating nets may be a compromise between the standard 3' x 6' nets and the more cumbersome 8' x 8' floating nets.

SAMPLING EFFORT

Trap netting will be conducted during the months of September, October and November when water temperatures are between 16 - 26 degrees C (61 – 79 °F). Minimum effort is 30 net nights per month, or 150 crappie greater than Age-0 for lakes less than 810 hectares (2000 acres), or 250 crappie greater than Age-0 for lakes 810 hectares or larger.

SITE SELECTION

Nets should be set perpendicular to crappie movement. Suggested areas include gradually sloping lake bottoms at the mouths of coves, off points, or areas adjacent to old river channels. Net sets in or near standing timber or where the leads break over a sharp drop-off should be avoided. To reduce variability over time, the same locations should be netted from year to year. Global Positioning Systems (GPS) can also be used to record net site locations that are consistently more productive.

NET SET PROCEDURES

Nets should be set at least one hour prior to sunset. If nets are left in the same location, then they should be checked at the same time each day if possible. Also, trap nets should not be fished at the same set more than two nights in succession.

All crappie collected are differentiated by species, and total length and weight for each fish recorded. When large numbers (>200) of fish <80mm are collected, subsamples of 25% by number are permitted.

Otoliths will be removed for age determination from a minimum of 10 fish per 25-mm (1-inch) length group for each species. Otoliths will be read using a dissecting microscope or microfiche. A micrometer is optional, but is required for back calculations. All trap net sampling data including information obtained from otolith readings will be recorded and processed using the Fisheries Division trap net software, currently being developed.

LIMITATIONS

There are several problems inherent to this sampling scheme. These problems should not influence recommendations; however, fish managers should be aware of these limitations and make changes in sampling schemes when necessary.

Crappies are growing during the sampling period from September through November. Differences in lengths during this period may obscure length-frequency histograms and length-at-age determinations. Sample variance of length-at-age will increase with the width of the sampling window. Growth during the sample period is especially critical for younger age groups. This may cause problems when comparing population statistics from year to year and make it more difficult to identify changes.

Young of the year crappie are typically caught in higher proportions earlier in the fall, and larger, older crappie are generally caught later in the fall. This makes it necessary to sample over the entire 3-month period to obtain a representative sample. Should the minimum number of crappie be caught early in the sampling season, the older component may not be represented in proportion to their abundance in the population.

Additionally, the percentage of crappie of a given age within a size group can only be estimated within 10%, if 10 fish per size class are aged. When more accuracy is required, more or all fish should be aged. Sampling from September through November, calculating length at a standard age (back calculations), and aging all fish can reduce these problems.

CRAPPIE POPULATION ASSESSMENT

Developing appropriate objectives for population parameters combined with standardized sampling procedures are vital to achieving effective fisheries management (Anderson, 1975). In the last few years, considerable attention has been given to the use of structural indices to describe and classify population structure.

Colvin and Vasey (1986) developed a method of assessing white crappie populations in Missouri based on fall trap netting. Their system is based on standard point values assigned to estimates of density, growth (length-at-age), age structure, size structure, and recruitment calculated from fall trap net samples. A 0-10 rating is assigned to each of the five population parameters. The five scores are then summed to give an overall index of population condition. This assessment is currently used to evaluate crappie population structures in Missouri (M. Colvin, Missouri Department of Conservation, personnel communication).

A primary objective of the Crappie Management Plan was to develop a stock assessment index to evaluate crappie populations in Arkansas (Table 2). Missouri's Stock Assessment Index was selected as a model from which to begin. The Missouri index, however, was developed for large reservoirs and white crappie populations only. Arkansas has both species of crappie existing in large impoundments as well as small lakes. Therefore, the Missouri Stock Assessment Index was adjusted to accommodate for these differences. Trap net data collected between 1989-1993 from fifteen Arkansas lakes, which varied from oxbows to large Corps of Engineer impoundments, were used to generate the model.

Arkansas' lakes contain mixed populations of white and black crappie that must be managed as a group for regulatory simplification and so are combined for stock assessment. Values (1-10) are assigned for ranges of five population parameters (density, growth, age structure, size structure and recruitment) calculated from fall trap net samples. Highest point values are assigned to optimum measurements of each parameter. Because crappie density values varied greatly among the fifteen lakes sampled, and recruitment values are sometimes a poor indicator of actual Age-0 abundance, these two parameters have been weighted disproportionally in the assessment. Point values assigned to each population parameter are summed to give an overall rating for the crappie population condition. However, the values of the individual parameters are more useful for management purposes than the final assessment value.

The Crappie Population Assessment (Table 2) should provide a standardized means for fisheries managers to make objective evaluations of population structure and population trends over time in specific lakes. The assessment can also be used to compare indices between similar lake types such as Bull Shoals and Norfork.

CHARACTERISTICS OF A GOOD CRAPPIE POPULATION

A good crappie population has a high density of desirable-size fish available for angler harvest. Further, it will have adequate and consistent recruitment accompanied with sufficient growth to compensate for harvest.

DENSITY

Density is a function of recruitment and mortality. Catch per trap net-night of Age-1 and older fish in fall samples is used as an index of density. Age-0 crappies are excluded because trap nets do not sample Age-0 in proportion to their abundance and the presence of a large year-class could bias the sample.

Catch rates of 10 to 39 Age-1 and older crappie per net-night are considered optimal for our purposes. However, when sufficient forage is available and growth is good (mean length @ Age-2+ >250mm) higher densities are acceptable. Lower scores are assigned to the same catch per net night if growth is poor (mean length at Age-2+ <200mm).

Density, fish movement, weather conditions, and other factors influence trap net catch rates. Lake morphometry, water levels, presence of cover, etc influence capture efficiency. Catch rates may not always represent actual density. For this reason, several years of data are desired when analyzing crappie populations.

Population density influences the ratings of 2 other parameters. When densities of crappie are good (>20 Age-1+ and older per net-night), broader ranges of growth rates and size structure are accepted as desirable.

GROWTH RATE

Growth rate (mean length @ Age-2+) should be a good indicator of the availability of forage relative to crappie abundance. Growth influences the size and age structure of a population and affects sizes of fish available for harvest by anglers. In a desirable population, fish should reach a minimum harvestable size in a reasonable period of time.

A good crappie population should have a growth rate between 201-mm (8") and 275-mm (11") at Age-2+. Current data shows Arkansas lakes are capable of growth rates within this range. Crappies above 225mm begin to add weight at a faster rate and are valued more highly by fishermen.

High growth rates (> 275-mm @ Age 2+) are associated with lower than optimal densities and age structure. However, higher growth rates are acceptable when density is high since an adequate forage base must be present to produce good growth. Poor growth (≤200-mm @ Age 2+) may be attributed to other trophic levels other than forage fishes, since crappie less than 150-mm (6”) forage primarily on plankton and aquatic invertebrates.

Growth influences the value assigned to the density rating. Density is rated higher when accompanied by good growth because density is not likely to be the limiting factor. Growth indirectly influences age structure by determining at what age crappie become vulnerable to angler harvest. Faster growing crappie become vulnerable to angling mortality sooner. Growth rate also influences the value of recruitment. Recruitment is rated higher when accompanied by good growth since density is not likely to be a limiting factor.

AGE STRUCTURE

The age structure of a population is the result of recruitment and mortality (fishing and natural). Age structure is most useful as an indicator of mortality and may be our best indicator of recruitment, although it takes 1 to 2 years for a year class to show an effect. **The management objective for age structure is at least 10% of the population comprised of Age-3 and older crappie.** Colvin and Vasey (1986) used percentage of Age-4 and older as an indicator of age structure for Missouri’s crappie populations. Boxrucker (1989) found the highest mortality of Oklahoma crappie to occur before Age-3. Current data indicates Arkansas’ annual mortality is similar, therefore, the percentage of Age-3 and older crappie (excluding Age-0 fish) is used to assess age structure.

Higher assessment values are assigned to age structure when growth is good. An adequate forage base as indicated by good growth will allow for a higher density of older, larger fish. High age structure (>25% of adult fish 3+ or older) indicates strong recruitment, relatively low angler harvest, and a higher proportion of larger fish when growth is good. Low age structure (<10% of adult fish 3+ or older) combined with good growth indicates relatively high angler harvest, high natural mortality, and/or missing year-classes. Inconsistent recruitment and single year-classes moving through the population most likely cause variability in age structure within a lake.

SIZE STRUCTURE

Size structure, the percent of fish greater than 250-mm (10”) excluding YOY, indicates the percentage of desirable fish available to the angler. Size structure is dependent upon recruitment, growth rate, and mortality. It is related to age structure since older fish are larger whenever there is sufficient forage.

Size structure is considered optimal if 30-59% of crappie are greater than 250mm (10"). Fewer points are awarded to higher values of size structure because a high percentage of large crappie also indicates lowered numbers of younger fish and possible missing year-classes. Missing year-classes can cause negative effects to the size structure for several years.

High scores for size structure are assigned to a wider range of percentages when density is high. In a dense population, high percentages of large fish are less likely to indicate missing year-classes.

Size structure assessment is useful in predicting the effectiveness of a length limit. For example, a 10" minimum length limit would be less effective when the size structure is either very low or very high relative to the age structure. A truncated size structure dominated by numerous small fish, relative to age structure, indicates a lack of forage and possible stunting. A size structure dominated with a few, large crappies may indicate a missing year class.

RECRUITMENT

Recruitment, the number of (YOY) crappie per net-night, is variable between lakes and may not accurately describe abundance. Within the same lake, however, recruitment should be consistent from year to year.

Catch rates of 4 to 29 crappie YOY per net-night is considered optimal. Recruitment values provide insight into year-class strength. When growth is good, high values are given to a wider range of percentages because density is less likely to be the limiting factor. Low recruitment (very near 0) probably indicates low densities of YOY and potential missing year-classes, while high values are often associated with lakes that display higher crappie densities and slower growth. Boxrucker (1989) suggested that excessive recruitment may adversely affect growth, but is sometimes unclear and usually restricted to the first and second year of growth. Low recruitment or missing year-classes also reduces the numbers of fish available to fishermen and the numbers of spawning adults.

Recruitment directly affects density, size structure and age structure. Because trap nets may not sample Age-0 in proportion to their true abundance, the contribution of this metric to the assessment value is reduced. Age structure may be a more accurate indicator of recruitment, although, it takes 1 to 2 years for a year class to show an effect.

In summary, an optimal crappie population in Arkansas will exhibit a growth rate of 201-mm to 275-mm at Age-2+, have a size structure (percent > 250-mm) above 30%, and show consistent recruitment. These metrics are minimally sufficient to describe a good crappie population. Age structure, growth, and mortality estimates are needed to determine the suitability for enacting minimum length limits and/or other harvest regulations.

Of the 12 lakes that we have more than 1 year's data, 4 lakes (Overcup, Harris Brake, DeGray, Lake Charles) exhibited metrics described for a good population. Bear Creek Lake has a high size structure assessment value, but a high growth rate may indicate less than optimal density. Horseshoe and Felsenthal both display low growth rates and possible stunting. Lakes Beaver, Bob Kidd, Nimrod, and Horseshoe all show large variations in age structure probably due to inconsistent recruitment and missing year classes.

MANAGEMENT ACTIONS

HARVEST REGULATION GUIDELINES

Harvest regulations and management strategies are recommended to shift crappie populations toward what is considered a good population, as previously described (Figure 1). This chart outlines a consistent and objective way of assessing crappie populations, which will help fish managers identify problem areas and direct them towards needed research and management activities. Harvest regulations assume angling exploitation is significantly impacting the size and age structure of a crappie population. Crappie 10-inches and larger provide considerably more benefit to anglers than do smaller crappie. Ten inches was considered to be the minimum size that should be harvested by anglers based on length-weight relationships showing that white and black crappie begin adding proportionally more weight per unit length when they are 8 or 9-inches long. According to Mark Zurbrick, (Missouri Department of Conservation pers. comm.), fifteen 10-inch crappie will weigh more than twenty 9-inch crappie. Durocher (1990) found that 8-inch crappie would double in weight if allowed to reach 10-inches.

Restrictive size limits can perform an important role in managing crappie populations. The success of restrictive size limits meeting certain management objectives for crappie populations has varied among water bodies (Colvin 1991; Larson et al. 1991; Webb and Ott 1991; Mitzner 1995; Boxrucker 1999). Length limits are probably the most effective tool for controlling crappie harvest, because creel limits which are likely to be acceptable to anglers (≥15 fish/day) do not significantly affect crappie population characteristics (Allen and Miranda 1997). Length limits can also increase average weight of fish harvested by anglers without a considerable decrease in yield. Allen and Miranda (1995) evaluated published data from crappie populations across the southeastern and Midwestern U.S., and indicated that only under conditions of rapid growth and low natural mortality would minimum length limits improve yield in crappie populations. In addition, crappie populations with slow growth or high natural mortality are probably best managed without a length limit.

Crappie populations are dynamic and greatly influenced by annual recruitment. Evaluation of a crappie length limit may be misinterpreted when population or creel survey data is used, since they are influenced by highly variable recruitment. Colvin (1991) reported that poor recruitment prevented an accurate assessment of a crappie length limit in a Missouri reservoir. Webb and Ott (1991) discovered that a 10-inch minimum length limit improved crappie fisheries in three reservoirs, however, post-evaluation after the limit was established indicated that it was short-lived (3-4 years). The use of population modeling programs such as MOCPOP or FAST can assume constant or variable recruitment and predict long-term effects on harvest prior to the implementation of minimum length limits. The results of modeling can then be evaluated by subsequent collections of field data. Maceina et al. (1998) effectively used a Beverton-Holt equilibrium yield model to predict the effects of four different crappie length limits in Weiss Lake, Alabama. They found that a 10-inch minimum length limit would increase yield of crappie, only if conditional natural mortality rates were less than 35%. However, anglers would also have to accept a decrease in their creel limit in exchange for the increased average weight of crappie.

Recruitment from fry into the adult population and subsequent growth appears partially dependent on predators, primarily largemouth bass. High predator densities may reduce crappie recruitment due to intense predation, in which surviving crappie are fast growing and reach large size.

In lakes with dense, slow growing crappie, relaxed creel limits could be beneficial. If aquatic vegetation or turbidity is causing inefficient predation, these conditions should also be controlled.

Finally, anglers on a particular water body may desire higher numbers of smaller fish, and knowledge of angler preference when minimum length limits are being investigated should be an important consideration for the fishery manager in the decision-making process. Due to the various growth and natural mortality rates of crappie populations across the state, statewide length limits may be detrimental and result in substantial reductions in yield to some fisheries. Therefore, statewide length limits are not a recommended management strategy for Arkansas crappie populations.

Predator/Prey Manipulation

The need to improve crappie growth rates in reservoirs has been the focus of many management efforts. The strategies used typically involve manipulation of the predator/prey balance. This is especially challenging when dealing with species such as crappie which are both planktivorous and piscivorous (after reaching approximately six inches in length) for significant portions of their lives. A management strategy that favorably affects the planktivorous life stage may have no effect or possibly a negative effect on the piscivorous life stage.

The introduction of threadfin shad as supplemental forage for a crappie population has been met with mixed results. Supplemental stocking of threadfin shad may adversely impact young crappie in a population. Competition for plankton between threadfin shad and young crappie can occur if shad densities are too high. Kansas Game and Fish Commission cut their stocking rate of threadfin shad from 25 per hectare to 12.5 per hectare because of possible problems with competition for zooplankton on Osage Lake (Mosher 1984).

Overwinter survival and availability of threadfin shad broodstock are viable concerns for the fisheries manager. Sustained winter water temperatures below 41 degrees Fahrenheit are lethal to threadfin shad and will occur in Arkansas lakes during some winters.

Threadfin shad have also been shown to be valuable prey for crappie (McConnel and Gerdes 1964; Bartholomew 1966; May et al. 1975; Hepworth and Pettengill 1979). Some studies have documented growth of larger piscivorous crappie following supplemental stocking of threadfin shad. These growth gains were most notable in systems where forage was deficient before threadfin shad introductions. Because many Arkansas lakes and reservoirs already contain adequate shad forage, shad introductions may not be beneficial.

Boxrucker (1987) reported the population of crappie in Thunderbird Reservoir, Oklahoma improved after the introduction of saugeye. It appeared the improvement of crappie population structure was the result of a density dependent growth response resulting from predation on crappie by adult saugeye. Horton and Gilliland (1990) found that saugeye in Thunderbird Reservoir began feeding on crappie after reaching 350-mm (14 inches) and that crappie comprised more than 60% of the diet of saugeye greater than 525-mm (21 inches). Saugeye became significant predators of crappie after reaching 457-mm (18 inches). This information, along with concerns regarding overharvest of “needed predators” led to the implementation of an 18-inch minimum limit for Thunderbird Reservoir saugeye.

Fisheries managers should consider interactions of adult saugeye and existing predator populations. In systems with high shad densities, crappie may not be readily utilized as forage by the saugeye. If data from Arkansas lakes indicates bass populations are not effective predators due to high turbidity or thick vegetation, saugeye might also be poor at controlling crappie density.

CRAPPIE STOCKING GUIDELINES

Supplemental crappie stocking has long been used as a management strategy when overexploitation, increased fishing pressure, or poor recruitment has led to a decline in the crappie population. Currently, the Arkansas Game and Fish Commission stocks approximately 0.5 million black and white crappie combined in many of its lakes and reservoirs annually to improve crappie fisheries. However, Murphy and Kelso (1986) suggest that several factors, including post-stocking survival, determine the success of any stocking program.

Post-stocking survival of hatchery-reared fish is related to many variables including fish size and condition, pre- and post-stocking environments, genetics, and handling and transportation processes (Mazeaud et al. 1977; Parker 1986; Williamson and Carmichael 1986; Wallin and Van Den Avyle 1995). Estimates of initial post-stocking mortality rates of crappie reported from only a few studies in the literature ranged from 0-100%.

Sammons et al. (2000) assessed initial post-stocking mortality, year-class contribution, and predation upon recently stocked crappies in seven Tennessee impoundments. Their initial post-stocking mortality rates for crappie ranged from 0-95%, averaged 16%, and were most heavily influenced by extreme hauling densities (144g/L). Exposure to stresses such as poor water quality and overcrowding during removal from hatchery ponds likely influence initial crappie survival and should be considered to improve the stocking process.

Year class contribution is commonly used to evaluate the effectiveness of a stocking program (Boxrucker 1986; Heidinger and Brooks 1998; Sammons et al. 2000). Year class contribution and survival of stocked fish has been shown to vary from lake to lake and from year to year within the same waters (Fielder 1992; Elrod et al. 1993; Heidinger and Brooks 1998; Sammons et al. 2000). Crappie year class contribution from supplemental stocking ranged from 0-93% in seven Tennessee impoundments, and indicates that supplemental crappie stocking is not successful in all Tennessee reservoirs (Sammons et al. 2000). Angler creel data also indicated that in one Tennessee reservoir only 1% of stocked crappies since 1995 had contributed to the fishery through 1998, while in another reservoir stocked crappies contributed significantly to angler's creel during the same time. Predation by resident piscivores on stocked crappie was a primary factor suspected of limiting stocking success in some Tennessee impoundments.

Predation on stocked fishes by resident predator fishes has been commonly theorized (Fielder 1992; Elrod et al. 1993). The occurrence of stocked crappies in predator stomachs containing food ranged from 14 - 41% in five Tennessee reservoirs (Sammons et al. 2000). Size of stocked crappie may have increased predation risk, because stocked black crappie were on average 30% and 40% smaller than black and white crappies found in the wild at the time of stocking. Sammons et al. (2000) suggested that high predator densities in some Tennessee impoundments are a significant factor limiting supplemental crappie stocking success.

Success of stocking contributions have been shown to vary with fluctuations in natural year-class strength, in which highest contributions from stocked fish developed in years when natural recruitment was low (Heidinger and Brooks 1998). In Normandy Reservoir, Tennessee where supplemental crappie stocking was shown to be successful, natural recruitment was considered below average (Sammons et al. 2000). Hence, when strong year-classes are present in the fishery, stocking contributions are less likely to be effective.

The effectiveness of stocking crappie to supplement missing year classes or poor recruitment is currently being evaluated in Arkansas (S. Lochmann, University of Arkansas at Pine Bluff, unpublished data). Early results suggest that there should be some clear guidelines for stocking crappie in Arkansas' waters.

1. Crappie should be stocked according to the most successful or dominant crappie species in the lake. If the lake is dominated by a particular species, then the

environmental conditions of the lake are apparently more favorable or conducive for that species recruitment and survival.

2. Crappie handling and hauling mortality needs to be minimized to 10-20%. Handling/hauling mortality estimates in the Lake Chicot Crappie Study ranged from 1-40%, while the Tennessee study ranged from 0-95% with an average of 16%. Unless handling/hauling mortality is minimized, time, money, and manpower are being misappropriated by supplemental stocking crappie in Arkansas waters.
3. Crappie should not be stocked in lakes where Age-0 to Age-1 mortality is high. If the annual mortality rate of Age-0 crappie in the natural population is high, then it is likely that stocked crappie will have a similar high mortality rate due to poor conditions such as lack of adequate forage, habitat, or high predation. Fishery managers can determine mortality rates of Age-0 to Age-1 from cove rotenone samples conducted over time.
4. Crappie should not be stocked in lakes during years of high natural recruitment, because supplemental stocking is not likely to make a significant contribution to the year class. For example, if a lake has a natural reproduction of 500 fish/ha, then stocking 50 fish/ha (10%) would not make a reasonable contribution to the year class. This practice would allow for crappie supplemental stockings to be reallocated to lakes where natural reproduction was unsuccessful.

STOCKING RATE

There is good evidence that supplemental stocking of crappie during years of unsuccessful reproduction and suitable conditions, such as low initial post-stocking mortality and decreased predator densities, can make up a reasonable high proportion of missing year-classes (Sammons et al. 2000). Currently, the Arkansas Game and Fish Commission stocks approximately 0.5 million black and white crappie combined in many of its lakes and reservoirs annually to improve crappie fisheries. The decision to supplementally stock a lake will be based on a combination of technical analysis of sampling data and social considerations. Lakes with high natural mortality or high occurrence of Age 0 crappie will be considered poor candidates for supplemental stocking. New lakes and lakes exhibiting poor natural spawns are considered the best candidates for stocking. Crappie should be stocked in the fall/winter during the year in which natural recruitment was poor in an effort to make a significant contribution to the missing year class.

Prioritization of lakes is warranted due to requests for crappie being greater than the number produced by the hatchery system. Therefore, new and renovated lakes have the highest priority for crappie stockings and should be stocked at a rate at or near 250/ha (100/acre). Supplemental stocking justification varies on technical and social needs as well as hatchery capabilities. Stocking rates are provided as guidance only to be considered in the matrix of population needs, social needs, and hatchery capabilities. Lakes under 1,215 ha (3,000 acres) will be given next priority and will be stocked at a rate of up to 125/ha (50/acre). Finally, lakes ranging in size from 1,215 to 4,050 ha (10,000 acres) will be stocked at a rate of up to 62/ha (25/acre). Lakes over 4,050 ha, including Corp of Engineer impoundments, should only be stocked through the nursery pond system to optimize hatchery production space.

NURSERY PONDS

Nursery ponds will be utilized for supplemental crappie stocking when located on reservoirs, including Corps of Engineer impoundments, where stocking is requested. This will free up hatchery pond space for other species due to the length of crappie production (March-October) and also decrease handling/hauling mortality. However, crappie may not be needed every year if lakes are capable of producing adequate natural spawns, therefore, District Fisheries personnel may choose to reallocate pond space to other species, which could benefit from the nursery pond. District Fisheries personnel are strongly encouraged to use other means such as lake fertilization, water level manipulation (controlled winter drawdowns), and habitat improvement to enhance crappie recruitment. Crappie brood stock collection for the nursery ponds will also be the responsibility of District Fisheries personnel.

LAKE FERTILIZATION

Lake fertilization is a widely accepted technique used to improve fish populations. The fertility or richness of the water determines the productivity of the lake, and a more productive lake will support more fish. Fertilizer increases lake productivity by stimulating the growth of microscopic plants known as phytoplankton. Phytoplankton is the basis of the food chain and is a primary food source for many larval fishes. Increases in phytoplankton will increase the production of zooplankton, which ultimately increases fish production. This is especially important to crappie, which are primarily planktivorous feeders until they reach a length of 150-mm (6-inches) and then switch to a more piscivorous diet. Upper and Lower White Oak Lake has been fertilized since

1978 and 1988 respectively, and has resulted in a 4-5 fold increase in the number of crappie YOY/hectare produced since the fertilization program began (D. Turman, AGFC, unpublished data).

DRAWDOWNS

Controlled winter drawdowns administered every four to five years is an effective, low cost management tool that provides several positive benefits to a crappie population. Nutrients tied up in exposed substrate are oxidized and released back into the system when the lake is refilled, resulting in a natural lake fertilization. Reduced lake area concentrates fish and allows for heavy crappie predation on forage species and increases in angler success and harvest. Winter drawdowns are also useful in controlling, by freezing, undesirable or expanding aquatic vegetation. For greatest effectiveness, drawdowns should be conducted from August through January and expose from 40-50% of the lakebed, which can usually be achieved with a 4-6 foot drawdown.

HABITAT MANAGEMENT

Fishery biologists have long suspected that reservoir hydrology influences crappie reproductive success and contributes to the cyclic nature of these fisheries. Successful reproduction and recruitment of fishes has been linked to years when high water levels provided more spawning sites and protective cover for larval fish (Bennett 1954, 1970; Bross 1969). Side channels and backwater areas have been shown to provide prime habitat for a variety of fish species (Bade 1980; Pitlo 1992).

Drawdowns or dewatering of backwater areas during spawning can result in marked reductions in habitat size and quality, including temporary loss of the littoral zone and its associated vegetation. The temporary elimination of the littoral zone can also result in the loss of juvenile fish, because they use littoral zone aquatic vegetation as shelter from adult piscivores (Werner et al. 1983). Dewatering can also reduce availability of spawning substrate, and expose nests with eggs and larval fish to drying conditions. Ploskey (1986) found that spawning success for most littoral species was positively related to water level increases during the spawning period because additional spawning habitat was produced for adults, and increased food and habitat resources were available for larval fish.

It is widely recognized that management strategies designed to improve crappie populations and harvest is dependent primarily upon water-level management. Therefore, the Arkansas Game and Fish Commission will actively pursue opportunities to positively influence water control policy and operations on Federal water project lakes to benefit crappie fisheries.

HABITAT IMPROVEMENT

Lake managers have long recognized the advantages of structure to attract and hold fish. The primary purpose of fish shelters or attractors is to congregate fish to improve fishing success for anglers. Fish can also be encouraged to spawn when provided with good spawning substrate.

Suitable shelters can be constructed from a variety of materials. Brush, tires, stake beds, rock piles, standing timber, and shoreline vegetation all make good fish attractors. Establishing native aquatic vegetation in the littoral zone is particularly useful for impoundments that lack fish cover, and is currently being studied on Greeson and Bull Shoals lakes in Arkansas (C. Horton, AGFC, personal communication).

The placing of fish attractors in large impoundments has been shown to improve catch rates and harvest of fish. The Bull Shoals/Norfork Fish Cover Project installed 600 fish attractors containing over 70,000 trees (M. Oliver, AGFC, personal communication). The attractors covered 65ha (160ac) of lake bottom and extended 53 km (33mi) of shoreline. Scuba inspection and angler reports indicated that the attractors were successful in congregating fish and improved fishing and spearfishing over control areas. Short-term evaluation of fish attractors in seven Florida lakes indicated that areas with attractors produced significantly higher angler catches than control areas. Both number and weight of fish increased after the addition of artificial structures in Wewoka Lake, Oklahoma (Wright 1979).

Brush shelters have been shown to be more effective than most other materials used to construct attractors. Reef construction from tires, brush, and cement blocks in Lake Tohoekaliga, Florida revealed that more fish were observed and caught around brush than other materials, but all types of attractors congregated more fish than open water control areas.

More recently several artificial shelter designs have come on the market that are made from plastic or synthetic materials. Fish attractors made from PVC tubing were experimented with in Lake Chicot in 1985, and more recently heavy duty snow fencing was used to attract and hold fish. Both materials were successful in congregating fish and resulted in increased angler success (J. Smith, AGFC, unpublished data).

Habitat assessments are to be performed on Commission-owned and Federal water project lakes to determine crappie habitat needs. Habitat assessment protocols are to be developed and feasibility plans are to be drafted and implemented to address the needs as budget and resources allow. Fisheries Division will actively pursue opportunities to implement appropriate crappie habitat improvement projects with the general goal of improving habitat statewide.

RESEARCH / RESOURCE NEEDS

RESEARCH NEEDS

1. No management plan is complete without proper evaluation. Management strategies suggested in this plan should be appropriately evaluated after exploitation studies have been initiated, population modeling has been conducted, harvest restrictions have been imposed, or creel surveys have been completed. Evaluation of additional trap netting data using the Crappie Stock Assessment will yield further information regarding the effectiveness of the management plan.
2. Natural mortality rates of Age-0 to Age-1 crappie should be derived by fishery managers to assess where supplemental stockings will be most beneficial.
3. Handling and hauling mortality of crappie should be estimated and reduced by hatcheries to minimize post-stocking mortality to 10-20%.
4. Crappie marking techniques, such as six-hour oxytetracycline baths, should be investigated for supplemental stock identification purposes. Once a desirable marking technique is accepted, future contributions of stocked fish to year-classes can be evaluated.
5. Fishery managers should re-evaluate current crappie minimum length limits using population modeling programs.
6. A Crappie Recruitment Model is needed to determine what variables are having the greatest impact on crappie recruitment in Arkansas waters. The model would potentially help fishery managers identify those problems in reservoirs where corrective management could be applied, and would also help in predicting missing year-classes and thus, supplemental stocking guidelines on an annual basis.
7. Fishery managers should explore the use of other sampling techniques such as the larger 8' x 8' or 6' x 6' floating trap nets and spring/fall electrofishing in lakes where standard trap net gear has been ineffective at sampling the crappie population.

RESOURCE NEEDS

1. Trap net boats and motors ($6,000) replaced as needed
2. Trap nets ($475/net) replaced as needed
3. Dissecting Microscopes
4. Ocular micrometers
5. Data reduction and analysis software for trap nets (currently being developed).
6. Exploitation/Tag Reward studies ($2,500/each)
7. Continuing Education workshops on population modeling
8. Develop standardized protocol for assessing habitat needs in Arkansas lakes.

Table 1. TRAP NET SAMPLE RESULTS FROM 15 ARKANSAS LAKES

Lake Year	Density	Growth Rate	Age Structure	Size Structure	Recruitment	Assessment
Beaver						
1991	0.41	254	30.8	38.5	0	61.25
1992	0.36	248	3.3	13.3	0.6	37.5
1993	0.31	279	0	12.0	0.01	35.0
Bob Kidd						
1991	3.43	236	6.3	31	3.6	65
1992	1.86	201	38	23	0	48.65
1993	3.1	279	5.65	19.4	0.83	38.75
Nimrod						
1991	8.5	224	16	28.25	1.5	68.75
1992	7	233	1	24	2.4	53.75
Horseshoe						
1990	40.4	194	6	2.5	4.2	46.25
1991	13.55	178	16	3.3	13.05	60
Chicot						
1991	7.2	292	4.5	25.4	1.75	41.25
1992	7	276	11.4	38.8	1.11	68.75
1993	1.18	293	8.5	56	2.18	56.25
Overcup						
1991	32.5	244	0.31	16	3.5	52.5
1992	10.4	237	0	20.2	0.83	47.75
Harris Brake						
1991	8.5	257	3.6	43.6	4.6	66.25
1992	7.1	265	0.7	37.3	6.4	61.25
DeGray						
1993	1.5	241	10.3	16.1	1.83	58.75
1994	0.97	238	9.2	16.0	0.21	45
Felsenthal						
1989	2.06	197	22.3	15	15.7	51.25
1990	3.98	222	22.9	22.9	4.99	67.5
1991	2.38	204	15.5	13.9	4.62	66.25
1993	1.55	178	30.62	14.83	0.13	35
Blue Mountain						
1991	7.3	226	1.98	19.18	2.8	48.75
1993	8.2	215	27.19	13.4	8.74	61.25

TRAP NET SAMPLE RESULTS FROM 15 ARKANSAS LAKES (CONTINUED)

Lake Year	Density	Growth Rate	Age Structure	Size Structure	Recruitment	Assessment
Bear Creek						
1991	0.51	320	2.17	34.78	3.26	46.25
1994	1.48	302	18.05	56.39	0.37	62.50
Conway						
1993	71.8	243	34.9	33.7	27.9	83.75
Upper White Oak						
1993	0.68	287	18.03	22.95	30.33	61.25
Lower White Oak						
1993	0.06	265	0	16.67	1.92	33.75
Lake Charles						
1993	3.2	264	13.75	25.6	0.68	58.75
1994	9.3	260	12.4	26.5	0.65	62.5

TABLE 2. ARKANSAS CRAPPIE POPULATION ASSESSMENT

Number per Trap Net-Night (excluding YOY)

	0-2	3-4	5-9	10-19	20-29	30-39	>40
Density	1	2	5	8	9	8	5
(good growth)	1	2	5	8	10	10	10
(poor growth)	1	2	3	4	4	3	2

Mean Length (mm) at Age 2+

	151-175	176-200	201-225	226-250	251-275	>275
Growth Rate	1	4	8	10	8	6
(w/ good density)	2	6	9	10	10	10

Percent Age 3 and Older (excluding YOY)

	<4.9	5-9.9	10-14.9	15-19.9	20-24.9	>25
Age Structure	1	4	8	10	8	6
good growth	2	5	9	10	10	8

Percent Over 250-mm (10") (excluding YOY)

	<10	10-19	20-29	30-39	40-49	50-59	>59
Size Structure	1	3	5	8	10	8	5
good density	1	3	7	10	10	10	8

Number of Age 0 per Trap Net-Night

	<1.0	1.0-1.9	2.0-3.9	4.0-9.9	10-18.9	19-29.9	>29.9
Recruitment	1	4	6	8	9	8	4
good growth	1	4	6	10	10	10	6

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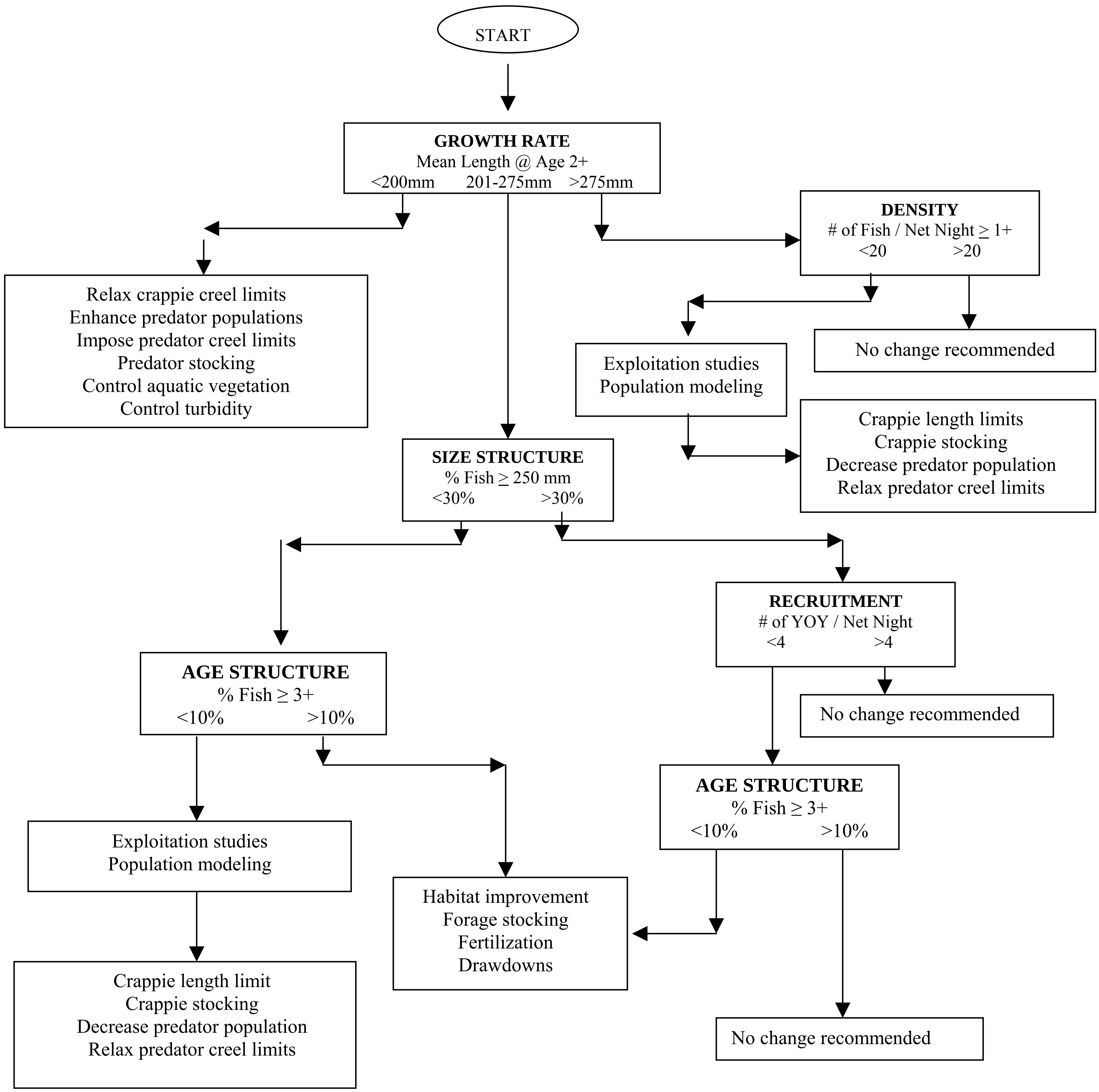
good growth	Mean Length At End of 3rd Growing Season (2+) >250mm.
poor growth	Mean Length At End of 3rd Growing Season (2+) <201mm.
good density	At Least 20 Age 1 and Older Per Trap Net-Night.

To Calculate Total Assessment Value (Maximum 100) sum:

Value for Number per Trap Net-Night	____ X 1.25 = ________
Value for Mean Length At Age (2+)	____ X 2.50 = ________
Value for Percent Age 3 and Older	____ X 2.50 = ________
Value for Percent Over 250 mm (10")	____ X 2.50 = ________
Value for Number of Age 0 per Trap Net-Night	____ X 1.25 = ________

Total Assessment Value = ________

FIGURE 1. Management strategies for crappie populations under various population structure conditions.



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