Effects of Repeated Hoopnetting and Handling on Bonytail Chub

Craig P. Paukert[a]
U.S. Geological Survey, Kansas Cooperative Fish and Wildlife Research Unit
Division of Biology, 205 Leasure Hall, Kansas State University
Manhattan, Kansas 66506 USA

David L. Ward
Arizona Game and Fish Department, Research Branch
2221 West Greenway Road, Phoenix, Arizona 85023 USA

Pamela J. Sponholtz
U.S. Fish and Wildlife Service, Arizona Fisheries Resource Office
323 North Leroux, Flagstaff, Arizona 86001 USA

and

Kara D. Hilwig
SWCA Environmental Consultants
114 N. San Francisco Street, Suite 100, Flagstaff, Arizona 86001 USA

ABSTRACT

We evaluated the effects of repeated hoopnet sampling and subsequent handling on the endangered bonytail chub (*Gila elegans)* to determine if these sampling techniques cause increased mortality or reduce fish growth. A total of 327 bonytail chub was tagged with passive integrated transponder (PIT) tags and placed in a 0.04 ha pond on July 2003. These fish were sampled with hoop nets during four, three-day sampling events, two in fall (September-October 2003) and two in spring (June 2004). Fish were measured and weighed with the time required to complete all steps for processing an individual fish being recorded. Individual fish were handled from one to eight times during the study, with >95% recaptured five or fewer times. Fish that were recaptured multiple times grew less in length ($P<0.001$) and weight ($P<0.001$) than fish that were not recaptured. Fish recaptured up to five times grew only 12.8% of their initial weight compared to fish not recaptured which grew 29.7% of their initial weight.

INTRODUCTION

Sampling and handling fish are critical in determining characteristics of fish populations, but sampling practices should try to minimize impacts on fish communities. This is particularly true for rare and endangered species (Rahel et al. 1999). Researchers generally assume that handled fish survive and behave normally after release (Kelsch and Shields 1996), but recently non-lethal capture methods such as electrofishing have been shown to cause injuries and even death (e.g., Sharber and Carothers 1988, Holliman et al. 2003). Hoop netting is also considered a non-lethal sampling technique (Hubert 1996) and little attention has been given to the effects of this gear type on fish.

Repeated handling (e.g., weighing, measuring, tagging) is necessary for many fish studies, particularly when mark-recapture experiments are used to estimate population size, fish growth, and movement (e.g., Douglas and Marsh 1996, Gorman and Stone 1999). Many studies have examined the stress response in fish (reviewed by Wedemeyer et al. 1990), and all aspects of sampling including capture, handling, confinement, and time out of water can cause reduced growth (Aboul Hosn et al. 2000), stress, and possibly mortality (Kelsch and Shields 1996, Stickney and Kohler 1990). However, physiological responses of fish to handling from sampling can vary with the type of gear and techniques used to capture fish (Kelsch and Shields 1996). The effects of stress can be cumulative (Wedemeyer et al. 1990), and even standard handling procedures such as

[a] Corresponding author: cpaukert@ksu.edu

measuring and weighing fish may reduce growth and condition (Paukert et al. 2001). Traumatized fish can exhibit abnormal physiological, behavioral, and ecological responses that defeat study purposes (Nickum 1988), and delayed mortality as a result of handling can occur hours or days later (Kelsch and Shields 1996).

The objective of this study was to determine the effects of repeated hoop netting and handling on hatchery-reared bonytail chub (*Gila elegans*). We also wanted to determine the time required to process individual fish in the field to determine if there are time consuming processes (e.g., weighing, measuring, tagging) that could be minimized that may increase fish stress and reduce fish growth.

METHODS AND MATERIALS

Three hundred twenty seven hatchery-raised bonytail chubs (101-173 mm total length) were tagged in the abdominal cavity with 400 KHz passive integrated transponder (PIT) tags, measured for total length (TL) and fork length (FL), weighed, and placed into a small (0.04 ha) pond located at the U.S. Forest Service Rocky Mountain Research Station in Flagstaff, Arizona on July 28, 2003. During the next two weeks, daily inspections of the pond were conducted to determine mortalities. Subsequent field sampling consisted of fish being handled during four, three-day sampling events, one each in September and October 2003 and two in June 2004. Six unbaited hoop nets (0.9 m diameter x 1.54 m long x 9.5 mm mesh) were placed in the pond and set overnight (16-22 h). Nets were lifted and all fish were placed into a 19-L bucket with water and transported to the handling station near the pond bank. Fish were then measured (TL and FL), weighed, scanned for the presence a PIT tag, and released back into the pond. All captured fish were inserted with a second PIT tag of a different frequency (134.2 KHz). In subsequent recaptures, fish tagged with a 134.2 KHz PIT tag did not receive and additional tag, but they were scanned for both the 400 and 134.2 KHz tags.

Personnel with at least one year of experience in handling and PIT-tagging conducted all fish processing. In addition to length, weight, PIT-tagging number, and general external characteristics for all recaptured fish, for 123 fish from 26 net sets, total processing and handling time as well as the times for each individual measurement were recorded. Nets were reset and fish processed each day for a total of three consecutive days. The pond was drained in July 2004 and all fish were measured, weighed, and scanned for PIT tags. Those fish that were never recaptured were considered as controls. All other fish were categorized by the number of times they were recaptured during the experiment (i.e., one, two, three, etc. recaptures). Growth in length was measured by subtracting FL at the initial stocking from FL at the harvest. Growth in weight was calculated similarly.

An analysis of covariance (ANCOVA) was used to determine if mean growth in FL and weight of fish recaptured multiple times differed from the FL and weight of the control fish. Since not all fish were collected during every sampling event, a repeated-measures analysis of variance was not appropriate. Regression analysis was used to determine if mean percentage of growth (i.e., growth in length or weight/initial length or weight x 100) was related to the number of times fish were recaptured and handled.

RESULTS AND DISCUSSION

There were 26 fish that died after introduction into the pond. Of those fish that died, 12 fish were handled at least once and then subsequently died and 14 fish died without ever being recaptured. Of the 12 fish that were handled and then later died, seven were handled only once, four were handled twice over one three-day period, and one was handled three times over a two-day period. This suggests that mortality was

independent of handling. The mean number of bonytail chubs collected per overnight net set was 7.9 (SE=1.1) in 79 net sets.

Individual fish were handled from one to eight times during the study. However, only five or fewer fish were handled six, seven, or eight times; these fish were thus excluded from further analyses. Fish recaptured multiple times grew significantly less than unhandled fish (ANCOVA, F=4.83, DF=5,282, P<0.001). Fish handled five times grew an average of 5.7 mm FL (SE=0.52) compared to fish which were not recaptured which grew an average of 10.9 mm FL (SE=0.69) over the 11-month period. Fish not recaptured grew on average 9.5% of their initial body length, whereas fish recaptured five times grew 4.8 % of their initial body length (r^2=0.94, P<0.002; Fig. 1). Weight gain also decreased with increased handling. Fish not recaptured grew significantly more (mean=4.75 g SE=0.46) than fish handled five times (mean =2.1 g; SE=0.62; ANCOVA F=5.33, DF=5,273, P<0.001) over an 11 month period. Fish not recaptured gained in weight an average of 29.7% (SE=3.1), whereas fish recaptured five times gained on average only 12.8% (SE=5.84)(r^2=0.86, P=0.008; Fig. 1).

The continued decline in growth we observed with successive recapture events indicates that declines in growth were likely the effects of repeated capture and handling and not by PIT tagging. Since all fish were PIT-tagged, the difference in fish treatments was the number of times the fish were recaptured. These results are consistent with other studies on PIT tagged fish which found minimal impact of PIT tags on various species of fish (Prentice et al. 1990, Jenkins and Smith 1990). Recent work on bonytail chubs also indicates minimal effects of PIT tags unless fish were fed prior to tagging (Childs 2002). Ward (2003) evaluated swimming performance of bonytail chubs in the laboratory and suggested that normal handling procedures (weighing, measuring and insertion of PIT tags) did not affect swimming ability. Proper tagging techniques and the choice of an appropriate marking program can minimize handling and tagging risks (Guy et al. 1996). However, the cumulative effects of tagging and successive handling unquestionably affected fish growth. It is not known if this level of reduced growth of individual fish

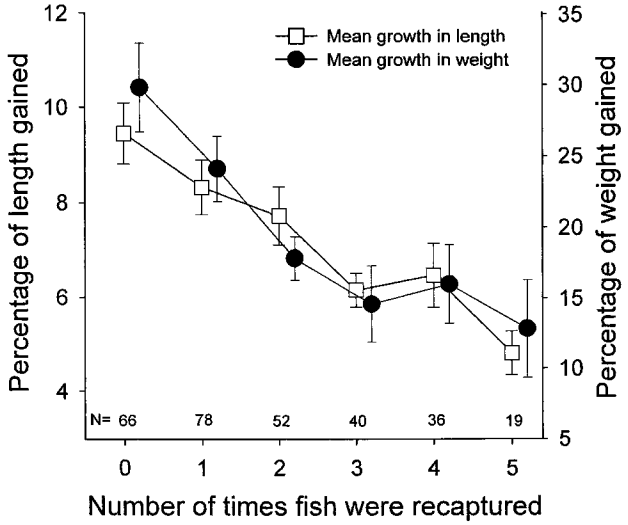

Figure 1. Mean percentage of length and weight gain (100 x [harvested size - initial size]/initial size) for bonytail chubs hoop-netted and recaptured up to five times, September 2003-July 2004. Bars represent one standard error. The number of fish in each group is shown above the x-axis.

may lead to biologically-significant population effects. We did not measure the effects of increased handling on other factors such as reproductive success or size-related differences in handling. However, tertiary effects of reduced growth have been shown in other species to lead to reduced resistance to disease and reproductive success (Wedemeyer et al. 1990).

Fish were handled for mean total time of 479 to 505 s, depending on if the fish needed to be PIT tagged (Table 1). Initial processing, which included the time required to lift the net from the water, place the fish in a bucket, transport the fish to the processing area, and hold each in the bucket until further processing, averaged 424-436 s, which was 86-89% of the total handling time. Only 55 to 69 s were needed to scan the fish for presence of a PIT tag, measure TL and FL, weigh the fish, and insert a new PIT tag. Of the 55 to 69 s, 48-58% of that time was spent scanning fish for the presence of a PIT tag. Even with efforts to streamline procedures so that the amount of time fish were out of their natural environment was minimized, our results indicate that repeated hoopnetting and handling may affect individual fish growth. Further study of the physiological and reproductive impacts caused by repeated handling using hoop nets and other non-lethal gears (e.g., trammel nets, Paukert 2004) is needed to better assess population-level impacts of repeated sampling on bonytail chub, since understanding the effects of sampling is essential in designing successful biological monitoring programs.

Table 1. Mean time (s) and standard error (SE) required to process bonytail chub from initial lifting of the net from water to final release of fish. Tagged fish already had two passive integrated transponder (PIT) tags and were therefore not PIT tagged again.

	Untagged fish N=88		Tagged fish N=35	
	Mean time (s)	SE	Mean time (s)	SE
Net lift and time in bucket	436	50	424	36
PIT-tag scanning	33	3	32	1
Measuring	12	1	13	1
Weighing	7	1	10	2
PIT tagging	17	3		
Total time from net lift to release	505	50	479	36

ACKNOWLEDGEMENTS

We thank the Grand Canyon Monitoring and Research Center who funded this study and John Rinne for use of the U.S. Forest Service Rocky Mountain Research Station facilities. Andrew Makinster, Josh David, and Scott Rogers provided valuable assistance with sampling fish. We thank Quent Bradwisch for providing research specimens. Joanna Whittier provided database and statistical assistance. The work was conducted under Federal Endangered Species permit number TE67811-0 by the US Fish and Wildlife Service.

LITERATURE CITED

Aboul Hoshn, W., P. Dutilleul, and D. Boisclair. 2000. Handling and stocking-density effects on growth rhythms of brook trout, *Salvelinus fontinalis*. Canadian Journal of Zoology 78:1026-1031.

Childs, M. 2002. Evaluation of tagging mortality and retention in juvenile humpback chub: bonytail as a surrogate. Report to Grand Canyon Monitoring and Research Center, Flagstaff, Arizona.

Douglas, M. E. and P. C. Marsh. 1996. Population estimates/population movements of *Gila cypha*, an endangered cyprinid fish in the Grand Canyon regions, Arizona. Copeia 1996:15-28.

Gorman, O. T. and D. M. Stone. 1999. Ecology of the spawning humpback chub *Gila cypha* in the Little Colorado River near Grand Canyon, Arizona. Environmental Biology of Fishes 55:115-133.

Guy, C. S., H. L. Blankenship, and L. A. Nielsen. 1996. Tagging and marking. Pages 353-384 in B. R. Murphy and D. W. Willis, editors. Fisheries techniques, second edition. American Fisheries Society, Bethesda, Maryland.

Holliman, F. M., J. B. Reynolds, and T. J. Kwak. 2003. A predictive risk model for electroshock-induced mortality of the endangered Cape Fear shiner. North American Journal of Fisheries Management 23:905–912.

Hubert, W. A. 1996. Passive capture techniques. Pages 157-192 in B. R. Murphy and D. W. Willis, editors. Fisheries techniques, second edition. American Fisheries Society, Bethesda, Maryland.

Jenkins, W. E. and T. I. J. Smith. 1990. Use of PIT tags to individually identify striped bass and red drum stocks. Pages 341-345 in N. E. Parker, A. E. Giorgi, R. C. Heidinger, D. B. Jester, Jr., E. D. Prince, and G. A. Winans, editors. Fish marking techniques. American Fisheries Society Symposium 7, American Fisheries Society, Bethesda, Maryland.

Kelsch, S. W. and B. Shields. 1996. Care and handling of sampled organisms. Pages 121-156 in B. R. Murphy and D. W. Willis, editors. Fisheries techniques, second edition. American Fisheries Society, Bethesda, Maryland.

Nickum J. G. 1988. Guidelines for use of fishes in field research. Fisheries13(2):16-23.

Paukert, C. P., P. J. Chvala, B. L. Heikes, and M. L. Brown. 2001. Effects of implanted transmitter size and surgery on survival, growth, and wound healing of bluegill. Transactions of the American Fisheries Society 130:975-980.

Paukert, C. P. 2004. Comparison of electrofishing and trammel netting variability for sampling native fishes. Journal of Fish Biology 65:1643-1652.

Prentice, E. F., T. A. Flagg, and C. C. McCutcheon. 1990. Feasibility of using implantable passive integrated transponder tags (PIT) tags in salmonids. Pages 317-322 in N. E. Parker, A. E. Giorgi, R. C. Heidinger, D. B. Jester, Jr., E. D. Prince, and G. A. Winans, editors. Fish marking techniques. American Fisheries Society Symposium 7, American Fisheries Society, Bethesda, Maryland.

Rahel, F. J., R. T. Muth, and C. A. Carlson. 1999. Endangered species management. Pages 431-454 in C. C. Kohler and W. A. Hubert, editors. Inland fisheries management in North America, second edition. American Fisheries Society, Bethesda, Maryland.

Sharber, N. G. and S. W. Carothers. 1988. Influence of electrofishing pulse shape on spinal injuries in adult rainbow trout. North American Journal of Fisheries Management 8:117-122.

Stickney, R. R. and C. C. Kohler. 1990. Maintaining fishes for research and teaching. Pages 633-663 in C. B. Schreck and P. B. Moyle, editors. Methods for fish biology. American Fisheries Society, Bethesda, Maryland.

Ward, D. L. 2003. Effects of marking techniques and handling on swimming ability of bonytail chub. Journal of the Arizona-Nevada Academy of Science 36:34-36.

Wedemeyer G. A., B. A. Barton, and D. J. McLeay. 1990. Stress and Acclimation. Pages 451-489 in C. B. Schreck and P. B. Moyle, editors. Methods for fish biology. American Fisheries Society, Bethesda, Maryland.

Received: 23 February 2005 Accepted: 21 May 2005