Population Characteristics of Channel Catfish from the Kansas River, Kansas

Michael C. Quist and Christopher S. Guy
Kansas Cooperative Fish and Wildlife Research Unit[a]
Division of Biology
Kansas State University
Manhattan, Kansas 66506 USA

ABSTRACT

Channel catfish (*Ictalurus punctatus*) were sampled from the Kansas River during October 1996 and August 1997 from Fort Riley Military Reservation and during August 1997 near Lawrence, Kansas. Fish varied in length from 100 to 506 mm at Fort Riley and from 120 to 637 mm at Lawrence. Catch per unit effort (number per net-night) was greater at Lawrence than at Fort Riley. Proportional stock density values were 23 and 48 for the Fort Riley and Lawrence samples, respectively. Individuals from both populations were in poor condition and typically had relative weight values less than 90. Age structure was similar between locations; however, approximately 44% of the channel catfish from Fort Riley were from the 1993 year class. Mean back-calculated lengths at age were significantly higher at Lawrence than Fort Riley for fish of ages 1 through 4 ($P \leq 0.05$). Incremental growth analysis on channel catfish from Fort Riley indicated that growth was fastest during 1993. Channel catfish collected near Lawrence did not exhibit the same trends in recruitment and growth. These data illustrate spatial variation in population characteristics of channel catfish in a prairie river and suggest the importance of over-bank discharge on recruitment and growth.

INTRODUCTION

The channel catfish (*Ictalurus punctatus*) is widely distributed throughout the United States and occurs in nearly all aquatic habitats in Kansas (Cross and Collins 1995). Despite its popularity with anglers (Burlingame 1997), few studies have described population characteristics of the channel catfish from lotic ecosystems in Kansas. Therefore, the objective of our study was to describe the relative abundance, size structure, condition, age structure, and growth of channel catfish from the Kansas River. In addition, we were interested in describing longitudinal differences in growth rates and the influence of discharge on growth.

METHODS AND MATERIALS

The Kansas River is formed by the confluence of the Smoky Hill River and Republican River near Junction City, Kansas. The entire

---

[a]The Unit is jointly supported by Kansas State University, Kansas Department of Wildlife and Parks, U. S. Geological Survey--Biological Resources Division, and the Wildlife Management Institute.

drainage area covers portions of Colorado, Nebraska, and Kansas (Metcalf 1966) and constitutes approximately 12% of the Missouri River watershed. The Kansas River rarely exceeds bank-full width. See Sanders et al. (1993) for a detailed review of the dominant land uses, habitat alterations, physiography, and historic changes in the fish communities within the Kansas River basin.

Channel catfish were sampled from the Kansas River on Fort Riley Military Reservation near Ogden, Kansas (river kilometers {rkms} 263 to 274 ; October 1996 and August 1997) and below Bowersock Dam near Lawrence, Kansas (rkms 75 to 63 ; August 1997). Mean annual discharge (1964 to 1996) was approximately 82 cubic meters per second (cms) at Fort Riley and 209 cms (1937 to 1996) near Lawrence (Putnam et al. 1996).

Eight hoop nets (1.1-m diameter mouth; 13-mm bar mesh; throats on the second and forth of seven hoops) were baited with cheese to increase catch rate (Pierce et al. 1981, Gerhardt and Hubert 1989). Nets were checked daily and rebaited if necessary. Fish were measured to the nearest millimeter (total length) and weighed to the nearest 0.1 g (Acculab V-1200). Pectoral spines were removed from all channel catfish according to the techniques described by Sneed (1951) for age and growth analysis. Transverse sections were cut 0.2 to 0.5 mm thick with a low speed diamond saw (Buehler Isomet) distal to the basal groove (Sneed 1951, Marzolf 1955). A dissecting microscope coupled with a computer image analysis system was used to mark annular growth rings.

Catch per unit effort (CPUE) was calculated as the number of channel catfish per net-night. Nets that collapsed and did not fish effectively were omitted from analyses. Size structure was assessed using proportional stock density (PSD) and incremental relative stock density (RSD; Gabelhouse 1984), where PSD is the proportion of stock-length fish that are quality-length and RSD is the proportion of stock-length channel catfish that are within a specified length category. Condition of channel catfish was assessed by calculating mean population relative weight (*Wr*) and incremental *Wr* values (Wege and Anderson 1978, Brown et al. 1995). Because we failed to collect channel catfish from Fort Riley in 1997, comparisons of catch rate, size structure, and condition were not conducted between the Fort Riley (October 1996) and Lawrence (August 1997) samples.

We used the direct proportion method to determine back-calculated length at age to facilitate comparison with previous studies. Mean back-calculated length at age was weighted by sample size within each age group to decrease the influence of older or rarer individuals in the analysis. Analysis of variance (ANOVA) was used to determine differences between mean back-calculated length at age from the two locations (Sokal and Rohlf 1981).

Fisheries scientists are often interested in the influence of management practices, sex, or environmental conditions on growth (defined as growth in length for this study). However, growth is a function of both age and environmental effects--which are difficult to disseminate. Weisberg and Frie (1987) and Weisberg (1993) presented a method to remove the effect of age on growth-- allowing direct interpretation of environmental effects. The Linear Growth Model Program (Weisberg 1993) was used to evaluate the effects of discharge on growth for channel catfish collected from Fort Riley (October 1996). The analysis was based on the most current growth year. For example, fish collected in 1996 did not have a full year's growth; therefore, growth increments were modeled relative to 1995. An alpha level of 0.05 was used to determine statistical significance in all statistical tests.

RESULTS AND DISCUSSION

Length and weight data were collected from 69 channel catfish in October 1996 from Fort Riley and from 72 fish in August 1997 at Lawrence. We did not collect channel catfish from Fort Riley in August 1997, despite 40 net-nights of effort. Catch per unit effort of channel catfish was 1.5 at Fort Riley and 2.6 at Lawrence. These catch rates are higher than those reported from the Platte River, NE (0.04 in August; Holland and Peters 1992) and the Powder River, WY (0.9 during July-August; Gerhardt and Hubert 1991), but lower than the Des Moines River, IA (10.2 during June-September; Mayhew 1973). Our results are most similar to those reported by Hesse et al. (1979) who reported a CPUE of 1.5 from the Niobrara River, NE during September. From our data, it appears that channel catfish are more abundant near Lawrence compared to Fort Riley (0 in 1997, 1.5 in 1996). However, comparisons between the samples from Fort Riley in 1996 and Lawrence in 1997 are not directly comparable due to possible sampling bias caused by temporal variation.

Size structure of sampled channel catfish also varied between locations. Channel catfish varied from 100 to 506 mm at Fort Riley and from 120 to 637 mm at Lawrence. Of the channel catfish sampled, only 35% from Fort Riley and 38% from Lawrence were stock length (i.e., ≥ 280 mm). However, channel catfish sampled from Fort Riley were typically shorter than from Lawrence (Table 1). No fish greater than preferred length (i.e., 610 mm) were collected from Fort Riley; whereas, 7% of the stock-length channel catfish were greater than 610 mm from Lawrence. Mean *Wr* of both populations was 86, while incremental *Wr* values were generally below 80--indicating poor condition (Table 1). Similar to CPUE, comparisons between locations must be made with caution due to possible temporal variation in size structure and condition.

Age structure was similar between populations, except the Lawrence sample contained four fish older than age 5 (Table 1). Forty-four percent of the channel catfish sampled at Fort Riley were from the 1993 year class (Figure 1). The Kansas River exceeded bank-full width in 1993, which likely increased recruitment to the fishery. However, the same trend was not observed at Lawrence where only 25% of the channel catfish were from the 1993 year class. The floodplain of the Kansas River at Fort Riley is densely vegetated; whereas, below Bowersock Dam, much of the floodplain is developed (i.e., urbanization). Welcomme (1979) suggests that when floodplain quality is high (e.g., abundance of spawning habitat and prey), fish reproduction and recruitment often increase in response to flooding.

Risotto and Turner (1985) reported that catch rates of commercial species (e.g., catfish *Ictalurus* spp., common carp *Cyprinus carpio*, suckers *Catostomus* spp.) in the Mississippi River were greatest in areas with adjacent bottomland hardwood forest prone to inundation. These studies, including the current study, indicate the importance of flooding and floodplain quality to recruitment of riverine species.

Growth of channel catfish varied between locations. Channel catfish at Lawrence had significantly higher mean back-calculated length for ages 1 through 4 ($P \leq 0.05$; Table 1). Although mean back-calculated length at age 5 and 6 were higher for channel catfish collected at Lawrence, these differences were not significant ($P > 0.05$). Channel catfish exceed stock length by age 5 at both locations (Table 1).

Table 1. Size structure [proportional stock density (PSD) and relative stock density of stock- to quality- (RSD S-Q; 280-409 mm) and quality- to preferred-length (RSD Q-P; 410-609 mm) channel catfish], condition [mean population relative weight (*Wr*) and *Wr* of stock- to quality- (*Wr* S-Q) and quality- to preferred-length (*Wr* Q-P) channel catfish] and mean back-calculated length at age of channel catfish collected from the Kansas River. Values in parenthesis represent 80% confidence intervals for size structure and ± one standard error (SE) for condition and mean back-calculated length at age.

	Fort Riley	Lawrence	*P*-value[c]
Size structure			
PSD	23 (13)	48 (16)	
RSD S-Q	77 (16)	52 (22)	
RSD Q-P	23 ([a])	41 ([a])	
Condition			
overall	86 (1.64)	86 (1.62)	
Wr S-Q	80 (1.67)	77 (1.84)	
Wr Q-P	79 (5.43)	78 (2.51)	
Age			
1	59 (2.78)	95 (3.26)	0.0001
2	148 (3.96)	181 (6.72)	0.0001
3	220 (8.99)	254 (9.67)	0.0001
4	295 (22.37)	332 (6.01)	0.02
5	398 (3.15)	407 (7.98)	0.6
6	444 ([b])	478 (9.97)	0.4
7	-	528 (5.82)	-
8	-	587 ([b])	-

[a] Sample size not sufficient to calculate 80% confidence intervals.

[b] Only one channel catfish collected.

[c] No statistical comparisons were made between locations for size structure and condition because of temporal variation in sampling.

In general, growth of channel catfish from Fort Riley was similar to growth of channel catfish throughout the Midwest. However, channel catfish at Lawrence were generally 10 to 20 mm longer at a given age than other populations. Compared to other Kansas water bodies, growth was similar to the Big Blue River (Minckley 1959), but faster than in Tuttle Creek Reservoir (Klaassen and Townsend 1973) and the Smoky Hill River (Klaassen and Eisler 1971). In addition, Klaassen and Townsend (1973) and Klaassen and Eisler (1971) used the regression technique which likely overestimated back-calculated lengths at age (Carlander 1981, Francis 1990).

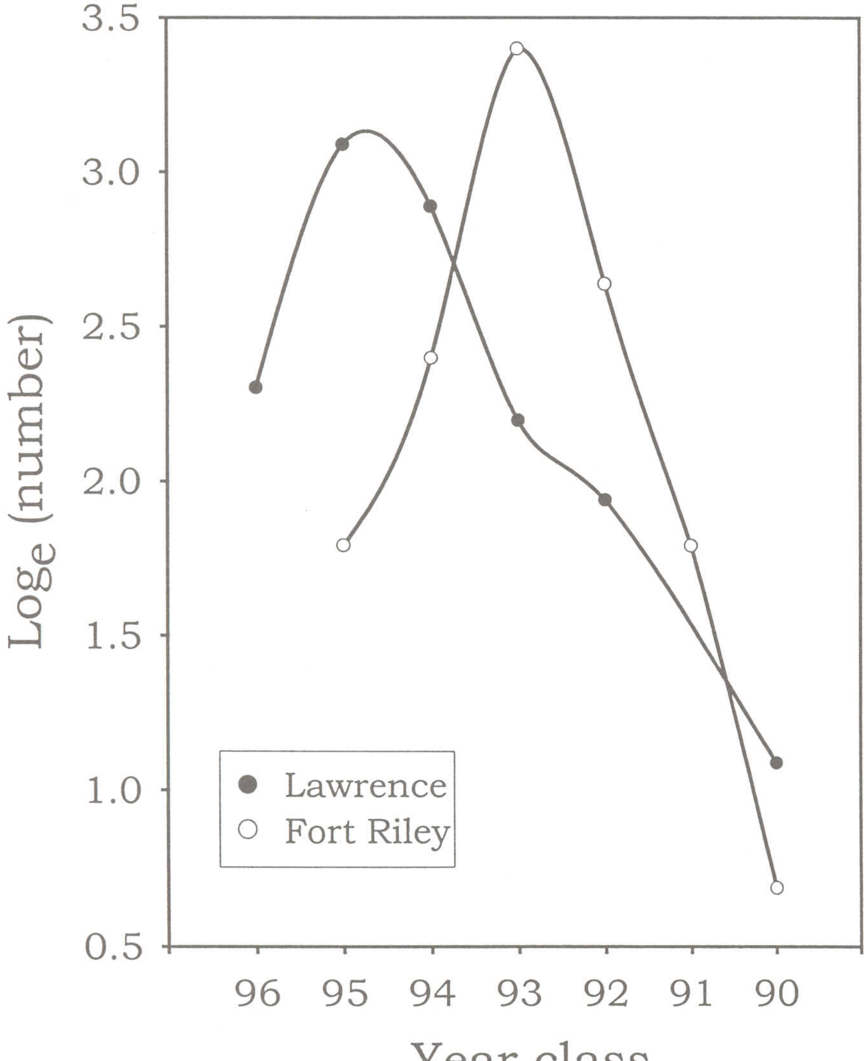

Figure 1. Natural logarithm of abundance at each year classes for channel catfish collected from the Kansas River at Fort Riley Military Reservation (October 1996) and Lawrence (August 1997).

The observed longitudinal differences in growth of channel catfish from the Kansas River are likely due to prey availability. The Kansas River at Lawrence contains a high proportion of silt and detrital substrates. Conversely, the Kansas River at Fort Riley is dominated by sand substrate. Typically, sand substrate has lower invertebrate productivity than soft-bottom or rocky substrate (Ward 1992). An abundance of aquatic invertebrates may influence growth, especially during early life history (Bailey and Harrison 1948). Klaassen and Eisler (1971) found that growth of channel catfish in the Smoky Hill River was extremely slow compared to other populations and attributed the difference to low productivity resulting from the shifting-sand substrate.

It is unlikely that prey availability is the sole mechanism regulating growth in length. Differences in turbidity (Finnel and Jenkins 1954, Marzolf 1957), cover, macrohabitat availability (e.g., riffles; Bailey and Harrison 1948), water quality, or temperature (Shrable et al. 1969) also influence growth. It is difficult to determine the mechanisms affecting growth, because environmental factors will influence individual fish differently depending on their life history stage. However, methods are available to account for age and allow generalized interpretations of environmental effects on growth rates.

We used the incremental growth model to determine the influence of discharge on growth (Figure 2). In 1993, the Kansas River exceed bank full width (2481 cms) at Fort Riley and increased growth is likely due to increased instream production resulting from inundation of the floodplain and the consequent influx of nutrients or increase in prey availability. We conducted the same analysis for channel catfish collected from Lawrence; however, we could not remove age effects due to the strong age × year interaction ($P \leq 0.001$). It is likely that benefits of flooding during 1993 were not realized due to the floodplain characteristics below Bowersock Dam. It is also possible that our methods were inadequate in detecting growth differences due to environmental conditions.

Similar to reproductive success and recruitment, increased growth can result from flooding. When the floodplain is inundated, shallow, prey-rich habitat is available to fishes (Welcomme 1979). An increase in prey availability coupled with refuge from high flows and predators often results in fast growth. For example, Bayley (1988) found that growth of omnivorous species in a South American River was approximately 60% greater during flooding. The author attributed the increase in growth to increased prey availability. Similarly, Gunderson (1968) found that brown trout (*Salmo trutta*) biomass was 44% greater in stream sections with a forested floodplain compared to areas with poor floodplain quality (i.e., sparse woody vegetation). Although we did not find an increase in year-class strength or growth below Bowersock Dam, our sample from Fort Riley suggests that overbank flooding may increase both recruitment and growth of channel catfish in the Kansas River. This is likely due to variability in floodplain characteristics between the locations.

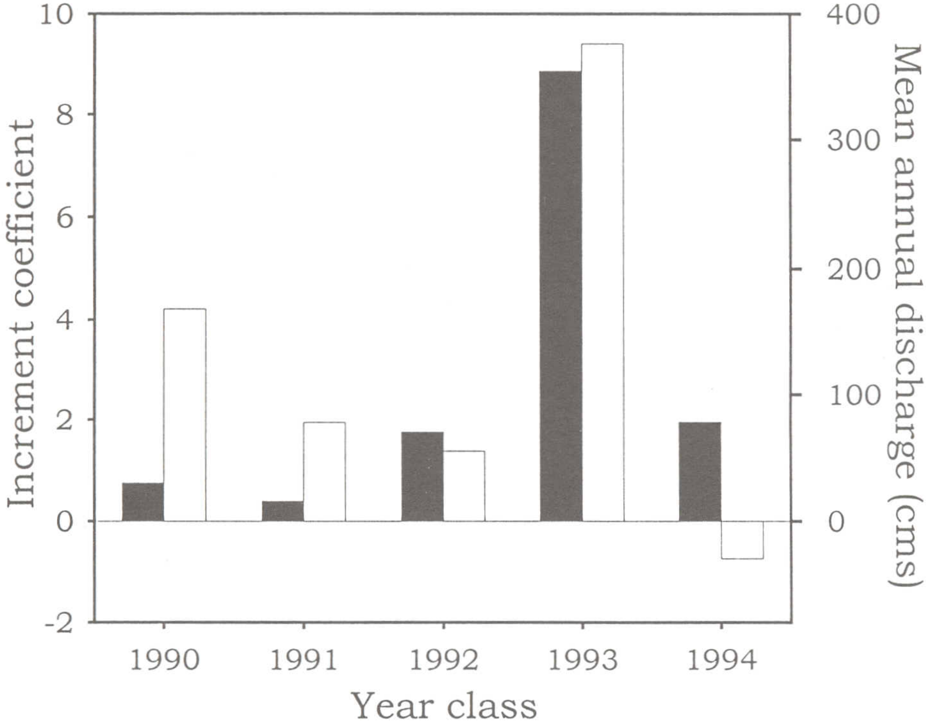

Figure 2. Increment growth coefficient (open bars) and mean annual discharge [cubic meters per second (cms); black bars] for channel catfish collected from the Kansas River at Fort Riley Military Reservation (October 1996). Increment growth coefficient is a parameter estimate relative to the most current growth year (i.e., 1995).

ACKNOWLEGMENTS

We thank Matt Burlingame, Dave Hoover, Matt McCoy, Greg Norris, Jeff Tillma, Jeff Tripe, and Jennifer Wiens for their assistance in the field. We also thank Travis Horton for reviewing the manuscript. Funding was provided by Kansas State University, Division of Biology, Seed Grant and the U. S. Army, Department of Defense.

LITERATURE CITED

Bailey, R. M., and H. M. Harrison, Jr. 1948. Food habits of the southern channel catfish (*Ictalurus lacustris punctatus*) in the Des Moines River, Iowa. Transactions of the American Fisheries Society 75:110-138.

Bayley, P. B. 1988. Factors affecting growth rates of young tropical floodplain fishes: seasonality and density-dependence. Environmental Biology of Fishes 21:127-142.

Brown, M. L., F. Jaramillo, Jr., D. M. Gatlin, III, and B. R. Murphy. 1995. A revised standard weight (W_s) equation for channel catfish. Journal of Freshwater Ecology 10:295-302.

Burlingame, M. N. 1997. Kansas licensed angler use an preference survey and attitudes towards angling by secondary education students. Master's thesis. Kansas State University, Manhattan.

Carlander, K. D. 1981. Caution on the use of the regression method of back-calculating lengths from scale measurements. Fisheries 6(1):2-4.

Cross, F. B., and J. T. Collins. 1995. Fishes in Kansas, 2nd edition. University of Kansas Museum of Natural History, Lawrence.

Finnell, J. C., and R. M. Jenkins. 1954. Growth of channel catfish in Oklahoma waters: 1954 revision. Oklahoma Fisheries Research Laboratory, Report 41.

Francis, R. I. C. C. 1990. Back-calculation of fish length: a critical review. Journal of Fish Biology 36:883-902.

Gabelhouse, D. W., Jr. 1984. A length categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.

Gerhardt, D. R., and W. A Hubert. 1989. Effect of cheese bait on seasonal catches of channel catfish in hoop nets. North American Journal of Fisheries Management 9:377-379.

Gerhardt, D. R., and W. A. Hubert. 1991. Population dynamics of a lightly exploited channel catfish stock in the Powder River system, Wyoming-Montana. North American Journal of Fisheries Management 11:200-205.

Gunderson, D. R. 1968. Floodplain use related to stream morphology and fish populations. Journal of Wildlife Management 32:507-514.

Hesse, L. W., G. Zuerlein, R. Vancil, L. Koziol, B. Newcomb, and L. A. Retelsdorf. 1979. Niobrara-Missouri River fishery investigations. Nebraska Game and Parks Commission, Nebraska Technical Series No. 5, Project F-10-R, Lincoln.

Holland, R. S., and E. J. Peters. 1992. Differential catch by hoop nets of three mesh sizes in the lower Platte River. North American Journal of Fisheries Management 12:237-243.

Klaassen, H. E., and M. K. Eisler. 1971. Age and growth of channel catfish in the Smoky Hill River of western Kansas. Transactions of the Kansas Academy of Science 73:439-445.

Klaassen, H. E., and A. H. Townsend. 1973. Age and growth of channel catfish in Tuttle Creek Reservoir, Kansas. Transactions of the Kansas Academy of Science 76:248-253.

Marzolf, R. C. 1955. Use of pectoral spines and vertebrae for determining age and rate of growth of channel catfish. Journal of Wildlife Management 19:243-249.

Marzolf, R. C. 1957. The reproduction of channel catfish in Missouri ponds. Journal of Wildlife Management 21:22-28.

Mayhew, J. 1973. Variations in the catch success of channel catfish and carp in baited hoop nets. Proceedings of the Iowa Academy of Science 80:136-139.

Metcalf, A. L. 1966. Fishes of the Kansas River system in relation to zoogeography of the Great Plains. University of Kansas Publications, Museum of Natural History 17:23-189.
Minckley, W. L. 1959. Fishes of the Big Blue river basin, Kansas. University of Kansas Publications, Museum of Natural History, Lawrence.
Pierce, R. B., D. W. Coble, and S. Corley. 1981. Fish catches in baited and unbaited hoop nets in the upper Mississippi River. North American Journal of Fisheries Management 1:204-206.
Putnam, J. H., D. L. Lacock, D. R. Schneider, M. D. Carlson, and B. J. Dague. 1996. Water resources data Kansas water year 1996. U. S. Geological Survey Water-Data Report KS-96-1, Lawrence.
Risotto, S. P., and R. E. Turner. 1985. Annual fluctuation in abundance of the commercial fisheries of the Mississippi River and tributaries. North American Journal of Fisheries Management 5:557-574.
Sanders, R. M., Fr., D. G. Huggins, and F. B. Cross. 1993. The Kansas River system and its biota. Pages 295-326 *in* L. W. Hesse, C. B. Stalnaker, N. G. Benson, and J. R. Zuboy, editors. Proceedings of the symposium on restoration planning for the rivers of the Mississippi and Missouri river ecosystem. U. S. National Biological Survey, Biological Report 19.
Shrable, J. B., O. W. Tiemeier, and C. W. Deyoe. 1969. Effects of temperature on rate of digestion by channel catfish. Progressive Fish Culturist 31:131-138.
Sneed, K. E. 1951. A method for calculating growth of channel catfish, *Ictalurus punctatus*. Transactions of the American Fisheries Society 80:174-183.
Sokal, R. R., and F. J. Rohlf. 1981. Biometry, 2nd edition. Freeman, San Francisco.
Ward, J. V. 1992. Aquatic insect ecology: 1. biology and habitat. John Wiley & Sons, Inc., New York.
Wege, G. J., and R. O. Anderson. 1978. Relative weight (W_r): a new index of condition for largemouth bass. Pages 79-91 *in* G. D. Novinger and J. G. Dillard, editors. New approaches to the management of small impoundments. American Fisheries Society, North Central Division, Special Publication 5, Bethesda, Maryland.
Weisberg, S. 1993. Using hard-part increment data to estimate age and environmental effects. Canadian Journal of Fisheries and Aquatic Sciences 50:1229-1237.
Weisberg, S., and R. V. Frie. 1987. Linear models for the growth of fish. Pages 127-143 *in* R. C. Summerfelt and G. E. Hall, editors. The age and growth of fish. Iowa State University Press, Ames.
Welcomme, R. L. 1979. Fisheries ecology of floodplain rivers. Longman, New York, New York.

Received: 4 May 1998 Accepted: 2 August 1998