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Movement patterns of endangered Roanoke logperch (*Percina rex*)

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Abstract – Using mark–recapture methods, we studied movements of endangered Roanoke logperch (*Percina rex* Jordan & Evermann), a benthic darter, at 12 riffle–run sites over a 9-year-long period in the Roanoke River, Virginia, USA. Our primary objective was to characterise movements among transects within sites, but we opportunistically recorded two between-site movements as well. Our recapture rate was low (22 of 485 marked fish), but most recaptured fish exhibited movements between tagging and recapture, relocating either to another transect within a site (12 fish) or to another site altogether (two fish). Within sites, Roanoke logperch exhibited fidelity over time to the areas in which they were initially marked. These restricted areas were lengthier than transects (>15 m) but shorter than entire riffle–runs (<150 m). The two between-site movements were extensive (3.2 and 2.5 km), observed over a long mark–recapture interval (2 and 5 years, respectively), and may have represented migratory or dispersal movements. Their detection required an unusually extensive study design. Both small- and large-scale movements fulfil important ecological functions for Roanoke logperch, and greater study of such movements in this and other darter species is needed to inform conservation choices.

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Key words: endangered species; movement–distance distribution; darter; dispersal; mark–recapture; migration

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Introduction

Movement is a key ecological process for fishes living in dynamic stream environments (Schlosser 1995). Frequent, localised movements enable fishes to track rapid changes in environmental conditions (Power 1984; Gowan & Fausch 2002; Albanese et al. 2004; Petty & Grossman 2004; Gowan 2007; Roberts & Angermeier 2007). Longer, migratory movements provide access to patchily distributed feeding, breeding and refuge resources needed over life history (Winn 1958; Welcomme 1979; Matheney & Rabeni 1995). Infrequent, long-distance dispersal movements enable the exchange of genes, colonists and surplus individuals between fish populations (Schlosser 1995; Schlosser & Angermeier 1995).

Our understanding of the frequency and extent of stream-fish movement is limited, especially for non-salmonid taxa. Existing studies have focused, often unintentionally, on small-scale, habitat-tracking movements. Our understanding of large-scale, migration and dispersal movements is therefore particularly poor. Our progress has been hampered by the logistical difficulty of executing movement studies spatiotemporally extensive enough to observe large-scale movements (Gowan et al. 1994; Albanese et al. 2003), the limited options available for tagging small fishes (Roberts & Angermeier 2004), and the legacy of

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the paradigm that 'local-site' factors control the population dynamics of stream fishes (Gerking 1953; Grossman et al. 1982).

Movement studies indicate that some nonsalmonid stream fishes exhibit generally high fidelity to meso-habitat patches within life-stages (Gerking 1953; Funk 1955; Stott 1967; Hill & Grossman 1987; Smithson & Johnston 1999), whereas others are nomadic (Stott 1967; Hoyt & Kruskamp 1982; Linfield 1985). Movement studies also show that stream fishes sometimes make extensive (e.g., stream- to watershed-scale) movements (Gorman 1986; Todd & Rabeni 1989; Matheny & Rabeni 1995; Albanese 2001), though most mark–recapture studies are not designed to detect such movements. There is also strong indirect evidence that stream fishes move extensively: fish can quickly re-colonise depopulated streams (Peterson & Bayley 1993; Ensign et al. 1997; Albanese 2001) and may spread rapidly through non-native streams when introduced there (Denoncourt et al. 1975; Buchanan & Stevenson 2003; Neely & George 2006).

Movements of darters (Percidae: Etheostomatini) appear to follow these same general patterns (Winn 1958; Reed 1968; Freeman 1995; Schaefer et al. 2003; Roberts & Angermeier 2007), but movement studies of darters are sparse. More knowledge of darter movement would enhance our basic understanding of population structure and persistence, as well as inform conservation strategies for this highly imperiled group. This paper describes our study of movements of the endangered Roanoke logperch (*Percina rex*), a benthic darter, in the Roanoke River, Virginia, USA. We use these data to draw inferences about the small- and large-scale movements of the species.

Materials and methods

Study species and area

The Roanoke logperch is a benthic darter endemic to the Roanoke and Chowan river drainages of Virginia, where it occupies several medium to large streams in the Ridge and Valley, Piedmont and upper Coastal Plain physiographic regions (Jenkins & Burkhead 1994). Roanoke logperch utilise a variety of habitat configurations over their life history, but at all stages are intolerant of heavy silt deposition (Jenkins & Burkhead 1994; Rosenberger & Angermeier 2003). After emergence, Age-0 individuals occupy pool margins (Roberts & Angermeier 2006) and backwaters (Rosenberger & Angermeier 2003). Maturation occurs at Age 1 or 2, and spawning takes place in spring in swift run mesohabitats (Jenkins & Burkhead 1994). Fish one or more years of age forage and over-winter in riffles, runs and flowing pools (Rosenberger & Angermeier 2002). Roanoke logperch can live up to 6 years and reach a total length (TL) of around 160 mm (Jenkins & Burkhead 1994). The species has presumably suffered dramatic range reductions, because of anthropogenic reductions of silt-free habitats, and was therefore listed as endangered under the U.S. Endangered Species Act in 1989 (U.S. Federal Register 54:34468-34472).

The upper Roanoke River (upstream of Smith Mountain Reservoir) is an unregulated, sixth-order stream containing series of riffle, run and pool meso-habitats (Fig. 1). Roanoke logperch occupy the mainstem Roanoke River and downstream portions of two large tributaries (North Fork and South Fork Roanoke River; Jenkins & Burkhead 1994). Therein, large juvenile and adult fish are mostly restricted to riffle–run sequences, where they reach their highest range-wide population densities (Rosenberger 2007).

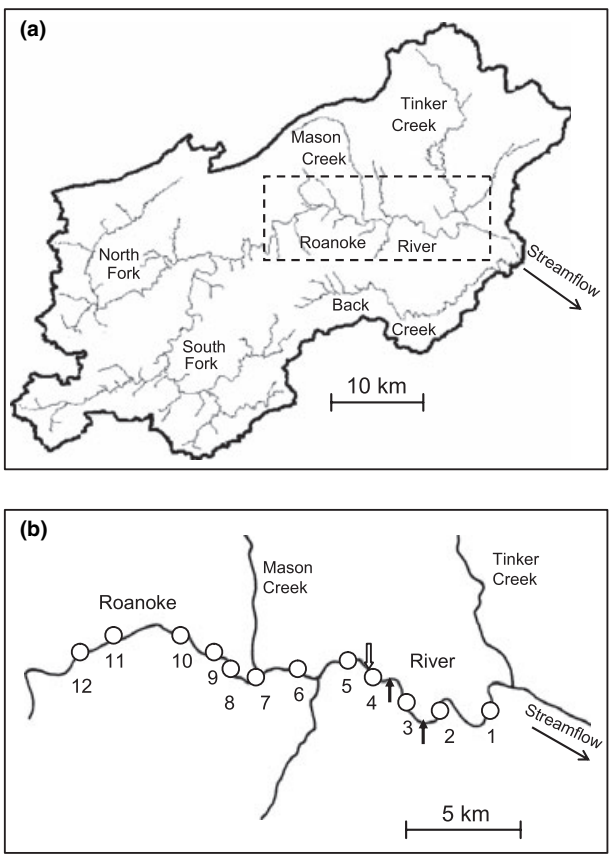

Fig. 1. (a) The upper Roanoke River watershed in Virginia, USA. Roanoke logperch occur throughout the depicted segment of the Roanoke River, as well as the downstream portions of the North and South forks. Roanoke logperch also historically occurred in Mason and Tinker creeks, but are believed to be extirpated therein. The dashed rectangle indicates the area shown in the inset below. (b) The mark–recapture study segment of the Roanoke River. Site locations are indicated by numbered arrows. The locations of a 1-m-high dam and of two bridge culverts are indicated by one white and two black arrows, respectively.

Lower-velocity pools in this system typically lack silt-free microhabitats suitable for Roanoke logperch (Rosenberger & Angermeier 2002) and can separate suitable riffle–runs by 1 km or more. Within riffle–runs, fish typically select deeper, swifter microhabitats with larger, less-silted substrate (Ensign & Angermeier 1994; Rosenberger & Angermeier 2003). We have observed that the spatial locations of such microhabitats within Roanoke River riffle–runs change little over time (Roberts & Angermeier 2006). This observation suggests that Roanoke logperch might exhibit fidelity to small areas within riffle–runs.

Study design

For a concurrent monitoring study of Roanoke logperch, 12 sampling sites were established along a 23-km-long segment of the Roanoke River (Fig. 1; Roberts & Angermeier 2006). Mason Creek, which historically contained Roanoke logperch, enters the Roanoke River within the study segment; however, we presume that the tributary functioned as neither a source nor destination of Roanoke logperch because recent surveys have failed to capture the species there (Rosenberger 2007). Each sampling site comprised a discrete riffle–run complex and averaged 23 m in width (range 14–34 m) and 120 m in length (range 55–160 m). The average distance between neighbouring sites was 2.1 km (range 0.6–3.7 km). Unsampled, intervening reaches contained various habitat types, including riffle–runs and pools. No obvious physical barriers separated sites, except for bridge culverts between Sites 2 and 3 and Sites 3 and 4 and a 1-m-tall dam between Sites 4 and 5 (Fig. 1). We divided each site into a series of permanent, 15-m-long sampling transects (4–11 per site). Transect width ran the width of the stream. During each fish-sampling occasion, transects were sampled by backpack electrofishing a 4-m-wide by 10-m-long area (i.e., quadrat) immediately upstream of a stationary 5-mm-mesh bag seine. We sampled as many nonoverlapping quadrats as would fit across a transect's width. This is an effective method for collecting adult and large juvenile Roanoke logperch in the Roanoke River (Ensign & Angermeier 1994; Roberts & Angermeier 2006). With a few exceptions, all 12 sites were sampled twice annually between 1998 and 2006, after the spawning season: once in summer (29 June–31 August) and once in autumn (1 September–31 October) (Table 1). Omissions resulted from high-streamflow periods that prevented sampling of all sites in a given sampling season, and were haphazard with respect to site identity.

Within this study design, we used mark–recapture methods to determine spatiotemporal movement patterns of Roanoke logperch. Although the long, unsampled reaches separating sites and long temporal intervals between sampling occasions were not ideal for characterising the full distribution of fish movements, we reasoned that the spatiotemporal extensiveness of the study would provide us a unique opportunity to observe movement over larger scales

Table 1. Overall marking and recapture totals for Roanoke logperch.

Sampling year	Sampling season	Number of sites sampled	Mark type	Number of fish marked	Number of fish recaptured from (recapture rate)	Number of fish recaptured in
1998	Summer	12	VIE	29	4 (0.14)	0
1999	Summer	12	IPD	52	0 (0.00)	1
2000	Summer	12	IPD	45	2 (0.04)	1
2001	Summer	12	VIE	51	4 (0.08)	0
2002	Summer	12	VIE	64	5 (0.08)	0
2003	Summer	5	VIE	12	0 (0.00)	1
2004	Summer	6	–	0	–	2
2005	Summer	12	–	0	–	0
2006	Summer	12	–	0	–	0
1998	Autumn	12	VIE	73	4 (0.05)	2
1999	Autumn	7	IPD	38	0 (0.00)	3
2000	Autumn	12	IPD	21	0 (0.00)	2
2001	Autumn	12	VIE	31	1 (0.03)	3
2002	Autumn	12	VIE	49	1 (0.02)	5
2003	Autumn	12	VIE	20	1 (0.05)	2
2005	Autumn	12	–	0	–	0
2006	Autumn	12	–	0	–	0
Total				485	22 (0.05)	22

The summer and autumn sampling periods comprised 29 June–31 August and 1 September–31 October, respectively. Fish were marked either with visible implant elastomer (VIE) or injectable photonic dye (IPD). After autumn 2003, no fish were marked, but all captured fish were checked for marks. No sites were sampled in autumn 2004. Recapture rate indicates the proportion of fish marked in a particular sampling interval that were subsequently recaptured.

than most study designs allow. During each sampling event from summer 1998 to autumn 2003, all captured Roanoke logperch that had no existing tag were anaesthetised with MS-222, given a unique tag using two injectable fluorescent marks of varying colour and body location, and, following recovery from anaesthesia, were released into a low-velocity area within the transect of capture. We recorded the capture location (transect and site), configuration of marks, age group (0 vs. 1+), and, beginning in 2000, sex of marked and recaptured individuals. In 1998 and 2001–2003, we marked fish using visible implant elastomer (VIE; Northwest Marine Technology, Inc., Shaw Island, Washington, USA), which exhibited >95% retention and no mortality in 21 individuals of closelyrelated northern logperch (*Percina caprodes*) in a 428-day-long laboratory trial (Rosenberger & Angermeier 2002). In 1999 and 2000, we used injectable photonic dye (IPD; New West Technology, Inc., Arcata, California, USA) in the field study, but because of its apparent poor retention (see *Results*), returned to using VIE in 2001. Marking was discontinued after 2003, but in sampling events between summer 2004 and autumn 2006, we continued to anaesthetise all captured Roanoke logperch, check them for marks and record information as above.

Data analysis

Using recapture data, we characterised general patterns of within- and between-site movement and specifically asked whether Roanoke logperch exhibited fidelity to their initial marking locations within sites. For analysis, we assumed that the net displacement distance of a fish between its initial marking and subsequent recapture locations represented the total distance the fish had moved over that time interval. We measured this distance as the distance between the midpoints of marking and recapture transects; thus, individuals captured twice in the same transect exhibited a movement distance of 0 m (i.e., nonmovement), individuals recaptured one transect away from the one in which they were marked exhibited a movement distance of 15 m, and so forth. The same distance-assignment scheme was applied to between-site movements. This approach provided only a minimum estimate of the potential distance moved, as it did not account for complex, exploratory movements (e.g., Matheney & Rabeni 1995).

A more serious limitation of our study design was the reduced ability to detect movements relative to nonmovements. Mobile marked fish could escape recapture by moving into unsampled areas within sites or unsampled reaches outside of sites. As a result, our estimates both of movement rate (i.e., the proportion of recaptured individuals that exhibited movement) and of average distance moved were likely biased downward. Such sampling bias is pervasive in mark–recapture studies, and is an oft-cited explanation for the longstanding 'restricted movement paradigm' of stream fish movement (Gowan et al. 1994). We therefore interpreted observed movement patterns in light of this potential bias.

We also explicitly accounted for our sampling bias when analysing within-site movement. Our rationale was as follows: if fish exhibit no fidelity to particular areas (i.e., are nomadic) within sites, then all within-site movement distances should have an equal likelihood of being observed. On the other hand, if fish exhibit fidelity to particular spatial locations within sites, then, within these sites, short movement distances should be more likely to be observed than long movement distances. These contrasting expectations provide a means to test for fidelity using movement data. However, in our study design, not all within-site movement distances were equally detectable. For example, 15-m-long movements could be detected from all transects, whereas 150-m-long movements could be detected only from transects located at the endpoints of our longest sites (Fig. 2; see also Albanese et al. 2003; Roberts & Angermeier 2007). We therefore generated an empirical distribution of the movement distances that were detectable in our study, in 15-m-long increments. We compared the mean (D) of this distribution to the mean (M) of the distribution of movement distances actually observed during the study. Under the null hypothesis, supported by a test

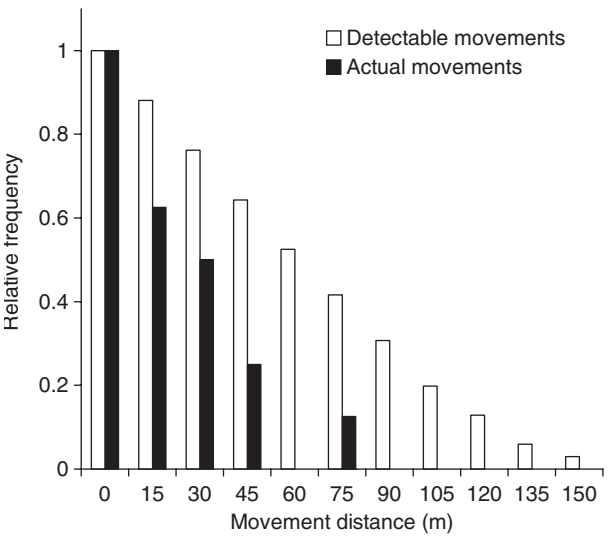

Fig. 2. Relative frequencies of within-site detectable movement distances and within-site actual distances moved by Roanoke logperch, pooled across sites and sampling periods. The means of distance distributions differed significantly ($P = 0.004$, t=2.892; see text), indicating that fish moved shorter distances than would be predicted if fish had moved to all parts of sites with equal likelihood.

result of $M \geq D$, we would fail to reject that fish exhibited no fidelity to particular areas within sites. Under the alternative hypothesis, supported by a test result of $M < D$, we would reject the null in favour of the conclusion that fish exhibited fidelity to initial marking locations within sites. We conducted statistical comparisons of M to D using Monte Carlo-based nonparametric t-tests in the program Resampling Procedures (Howell 2000; 100,000 randomisations), assessing significance at the 0.05 level. To account for potential bias in movement direction, we conducted tests using: (i) only upstream within-site movements plus nonmovements, (ii) only downstream within-site movements plus nonmovements and (iii) all within-site movements plus nonmovements, but because conclusions were the same across all tests, we report results only for the latter.

We used Monte Carlo t-tests to assess variability in movement distance between directions (within-site movements only) and between sexes (all within-site recaptures). We used linear regression to assess relationships between an individual's size-at-marking TL and the distance it moved, and between the time-lapse between marking and recapture of an individual (days) and the distance it moved. In both cases, regression models were built separately using: (i) within-site and within-year recaptures only, (ii) within-site recaptures over all years and (iii) all recapture data. In all of the above procedures, significance was assessed at the 0.05 level.

Results

Over the duration of the study, we marked 485 Roanoke logperch, 22 of which (5%) we recaptured (Table 1). Recapture rates were generally higher for fish marked in summer than in autumn (6% vs. 3%), and were higher for fish marked with VIE than with IPD (6% vs. 1%). Only two of 156 fish marked with IPD were ever recaptured. Recaptures were evenly distributed across sites, occurring in all but Site 6. Two marked individuals were captured during the summer 2004 recapture-only sampling period, but no additional marked fish were captured in 2005 or 2006 (Table 1).

Of the 22 recaptured individuals, eight (36%) exhibited no net movement from their marking transect, 12 (55%) exhibited between-transect, within-site movement and two (9%) exhibited between-site movement (Table 2). Within sites, downstream movements were more common than upstream ones (8 vs. 4), but mean (±SD) within-site movement distance did not differ significantly between directions (28 ± 13 m downstream vs. 34 ± 28 m upstream; $t = 0.490$, $P = 0.836$). Mean within-site movement distance was greater for males (23 ± 26 m) than for females (11 ± 14 m), but not significantly so ($t = 0.812$, $P = 0.498$). Pooling directions and sexes, the mean movement distance (M) of within-site recaptures, including non-movers, was 18 ± 20 m (Fig. 2). The mean detectable movement distance within sites (D) was 41 ± 36 m, and was significantly greater than M

Table 2. Individual recapture records for Roanoke logperch, ordered by date of marking.

Date marked	Date recaptured	Capture interval (d)	Marking site	Recapture site	Mark type	Distance moved (m)	Fish sex
10 July 1998	23 September 1999	440	2	2	VIE	30	?
22 July 1998	2 October 1998	72	7	7	VIE	15	?
24 July 1998	14 September 1998	52	10	10	VIE	30	?
28 July 1998	18 July 2000	720	12	12	VIE	30	Male
7 September 1998	6 October 999	394	3	3	VIE	0	?
24 September 1998	29 June 1999	278	9	9	VIE	0	?
30 September 1998	23 September 1999	358	2	2	VIE	15	?
30 September 1998	12 September 2003	1807	2	3	VIE	2500	Male
11 July 2000	18 October 2000	99	4	4	IPD	45	Male
12 July 2000	30 October 2000	110	8	8	IPD	45	Male
6 August 2001	19 September 2001	44	12	12	VIE	0	Male
7 August 2001	17 October 2001	41	2	2	VIE	0	Male
7 August 2001	19 September 2002	408	2	2	VIE	75	Male
15 August 2001	8 October 2001	24	11	11	VIE	30	Female
16 October 2001	23 September 2002	342	7	7	VIE	0	Female
11 July 2002	12 September 2002	63	9	9	VIE	15	Female
16 July 2002	24 September 2002	70	1	1	VIE	0	Male
16 July 2002	24 September 2002	70	3	3	VIE	0	Male
16 July 2002	28 August 2003	439	1	1	VIE	0	Female
16 July 2002	24 August 2004	800	1	2	VIE	3200	Male*
13 September 2002	3 October 2003	385	5	5	VIE	15	Male
7 October 2003	24 August 2004	351	1	1	VIE	15	Male

The 12 sites are numbered from downstream to upstream. Fish were marked either with visible implant elastomer (VIE) or injectable photonic dye (IPD). All individuals were at least 1 year old at marking, except for the individual indicated with an asterisk, which was marked at Age 0. Fish sex was not recorded in 1998 or 1999.

(t = 2.892, P = 0.004; Fig. 2). We therefore reject the null hypothesis that fish moved all sampled distances with equal likelihood, in favour of the alternative hypothesis that Roanoke logperch exhibited fidelity to the locations of their initial marking within sites.

The time interval between marking and recapture of an individual ranged from 24 to 1807 days (Table 2). The two longest intervals corresponded to the two between-site movements. One male fish moved 2.5 km upstream from Site 2 to Site 3, crossing a bridge culvert in transit, between autumn 1998 and autumn 2003. Based on its length, the fish was at least 1 year old at marking (J. Roberts, unpublished data), and was therefore at least 6 years old at recapture. Another male fish moved 3.2 km upstream from Site 1 to Site 2 between summer 2002 and summer 2004. This fish was the only marked Age-0 individual that was ever recaptured.

Neither fish-size nor the mark–recapture time interval significantly influenced within-site movement distance, but both significantly influenced movement when the two between-site movements were included. Distance moved was not significantly related to individual length-at-marking within sites within years (F = 0.115, P = 0.743, d.f. = 9) or within sites across all years (F = 0.410, P = 0.530, d.f. = 19), but was significantly negatively related to length when all data were considered (F = 11.979, P = 0.002, d.f. = 21). Similarly, distance moved was not significantly related to the mark–recapture time interval within sites within years (F = 2.449, P = 0.156, d.f. = 9) or within sites across all years (F = 0.304, P = 0.588, d.f. = 19), but was significantly positively related to the time interval when all data were considered (F = 23.423, P < 0.0001, d.f. = 21).

Discussion

We recorded frequent Roanoke logperch movement over the 9-year period of study. Most (64%) recaptured fish had moved between marking and recapture, relocating either to a different part of the marking site (15–75 m away) or to another site altogether (2.5–3.2 km away). In our view, these within- and between-site movements represented different movement processes, corresponding to the centre and tails, respectively, of a leptokurtic movement distribution (Stott 1967; Skalski & Gilliam 2000; Fausch et al. 2002), so we analysed and considered them separately.

We viewed within-site movements as opportunities for Roanoke logperch to track dynamic changes in the spatial configurations of microhabitat conditions within riffle–run mesohabitats (Power 1984; Petty & Grossman 2004; Gowan 2007). Although Roanoke logperch moved frequently among transects within sites, these movements tended to be to transects adjacent to the transect of initial fish marking; mean movement distance was significantly shorter than would be predicted if fish had moved to all parts of sites with equal likelihood. Our results thus indicate that adult and large-juvenile Roanoke logperch exhibited fidelity to restricted areas that were relatively stable in location, lengthier than a 15-m-long transect, yet shorter than a 150-m-long riffle–run. This fidelity was persistent over time, given that within-site movement distance did not increase with the length of the mark–recapture interval. Fidelity was also unrelated to the size of the individual, in contrast to studies of other stream fishes, which have shown higher transience in smaller, sub-dominant individuals (Gowan & Fausch 2002; Petty & Grossman 2004).

Fidelity of Roanoke logperch to restricted portions of sites could have been due to: (i) low species vagility in general, (ii) lack of temporal variation in the spatial locations of suitable microhabitats within sites or (iii) an inability of individuals to perceive, or unwillingness of individuals to move in response to, spatial variation in habitat quality. Our underwater observations of Roanoke logperch swimming actively within riffle–runs, as well as our observations of occasional, long-distance movements (see *Results*), leads us to reject the first explanation, at least at the mesohabitat scale. We lack the behavioural data necessary to examine the third explanation. However, we have observed that the amounts and locations of suitable Roanoke logperch microhabitats (*sensu* Ensign & Angermeier 1994; Rosenberger & Angermeier 2003) have remained relatively stable over the course of this study (Roberts & Angermeier 2006). Such stability could reduce the need for substantial habitat-tracking movement within sites, and thus supports the second explanation for home-range fidelity.

In contrast to small-scale, within-site movements, we categorise the two between-site movements as either migration or dispersal. These two upstream movements of 3.2 and 2.5 km, represent exceptional movement records for a darter, and indeed for nonsalmonid stream fishes in general (see also Hoyt & Kruskamp 1982; Matheny & Rabeni 1995; Albanese 2001). Both movements were based on observations made over a long time interval (2–5 years), though we do not know whether movement was rapid or gradual over the interval. Distant movements could serve any of various ecological functions for Roanoke logperch, including accessing new resources in new mesohabitats and stream-reaches (Schlosser 1995), counteracting larval drift (Hall 1972; Turner 2001; Slack et al. 2004), connecting sub-populations occupying patchily distributed riffle–runs (Slack et al. 2004; Roberts & Angermeier 2007), or colonising new populations (Denoncourt et al. 1975; Buchanan & Stevenson 2003; Neely & George 2006).

Various lines of evidence suggest that, when Roanoke logperch leave a local area within a riffle–run, they tend to move extensively. First, given that the survival rate of subcutaneously marked logperch is high (Rosenberger & Angermeier 2002), our low recapture rate of marked fish suggests that many marked fish emigrated from sites prior to re-sampling. Such emigration may have been artificially increased by our electrofishing; however, if present, this response was exhibited nonuniformly across individuals, given that we observed low transience among fish recaptured within sites. Second, although our odds of detecting movements >150 m in length were quite low, 9% of the fish that we recaptured had moved more than 2 km. Burkhead (1983) serendipitously observed a similarly long Roanoke logperch movement in the upper Roanoke River; the marked adult was caught by an angler 2.3 km downstream from the site where it was marked 10 months prior. Finally, Roanoke logperch have been captured in coves of Smith Mountain Reservoir (one adult in 1981) and Leesville Reservoir (two adults in 1989), at least 20 km downstream from the nearest known reproducing populations in Roanoke River and Pigg River, respectively (Jenkins & Burkhead 1994). These fish may have been attempting dispersal.

Mark–recapture studies are inherently biased towards over-sampling sedentary individuals and under-sampling mobile ones. This is particularly true for stream fishes, whose movements often exceed the boundaries of mark–recapture sites (Gowan et al. 1994; Skalski & Gilliam 2000). Even within an evenly-sampled mark–recapture site, subtler bias arises because not all movement distances are equally detectable (Albanese et al. 2003). Such bias was present in our study, but we confronted it directly using a *post hoc* method for generating the distribution and expected value of movement under the null hypothesis of spatially random movement, given knowledge of the distribution of sampling effort. This general approach may prove applicable to other hypothesis tests conducted on movement distributions that have been obtained using mark–recapture data.

Like many darters, Roanoke logperch face pervasive threats from agriculture, urbanisation and hydropower generation (Rosenberger 2007). More complete knowledge of Roanoke logperch movement would help managers delineate the areas needed to protect populations from further threats and ensure that these areas remain demographically interconnected. Future movement studies of Roanoke logperch should be tailored specifically to document: (i) the spatial and temporal variability of home ranges in different environments, (ii) the size and variance of the mobile fraction of the population, (iii) the spatial extents over which migration and dispersal processes operate, (iv) whether and how much movement has been affected by anthropogenic alterations of habitat and (v) how movement contributes to population viability and persistence. Such knowledge is critical to the effective management of Roanoke logperch, as well as other darters living in dynamic stream environments.

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