

HABITAT USE BY THE FISHING SPIDER *DOLOMEDES TRITON* IN A  
NORTHERN EVERGLADES WETLAND

Frank Jordan  
*Department of Zoology*

Howard L. Jelks  
*Department of Wildlife and Range Sciences*

Wiley M. Kitchens  
*U.S. Fish & Wildlife Service*  
*Department of Wildlife and Range Sciences*  
*Florida Cooperative Fish & Wildlife Research Unit*  
*117 Newins-Ziegler Hall, University of Florida*  
*Gainesville, Florida 32611*

HABITAT USE BY THE FISHING SPIDER *DOLOMEDES TRITON* IN A  
NORTHERN EVERGLADES WETLAND

Frank Jordan, Howard L. Jelks, and Wiley M. Kitchens

**Abstract:** We investigated patterns of habitat use by adult fishing spiders *Dolomedes triton* in a seasonally dynamic freshwater wetland of the northern Everglades. Spiders were collected monthly (July 1990-January 1992) in adjacent wet prairie, alligator hole, and sawgrass habitats. Overall density of adult fishing spiders during the study period was 0.1 spiders per m<sup>2</sup>. However, there was extensive seasonal variation in abundance of these semiaquatic arthropod predators. Spider densities were significantly higher in sawgrass stands than in wet prairies or alligator holes, which did not differ from one another. Habitat-specific attributes were correlated with the observed distribution of fishing spiders. Sawgrass sites were characterized by shallower water depths, well developed canopy structure, extensive litter deposits, and fewer potential avian and piscine predators. Structural complexity and habitat heterogeneity influence the demographics of the fishing spider in freshwater marshes of the Everglades.

**Key Words:** *Dolomedes triton*, habitat use, structure, fishing spider, Everglades, Florida, predation

**Running Head:** Jordan *et al.*, SPIDER HABITAT USE

## INTRODUCTION

Spiders of the genus *Dolomedes* (Araneae: Pisauridae) are common in freshwater habitats of North America (Carico 1973). For example, the fishing spider (*Dolomedes triton*) is a conspicuous member of wetland communities in the Florida Everglades (Serrao 1980). These semi-aquatic, hunting arachnids are voracious predators of terrestrial arthropods, fishes, and anurans (Barbour 1921; Gudger 1922, 1925, 1931; Meehan 1934; Williams 1979; Bleckmann and Lotz 1987). Therefore, it is plausible that fishing spiders are keystone predators. However, there is little agreement concerning the general role that spiders play in structuring either aquatic or terrestrial prey communities (Turnbull 1973, Foelix 1982, Nyffelder and Benz 1987, Orazé and Grigarick 1989). Quantitative abundance and distribution data are needed to increase our understanding of spiders as predators.

In this paper, we provide basic habitat use information about the fishing spider in the Arthur R. Marshall Loxahatchee National Wildlife Refuge, a northern Everglades wetland system. Specifically, patterns of differential habitat use and seasonal variation in abundance were examined during an 18-month period. Also, variation in spider abundance was examined through correlative analyses of structural characteristics of the habitats (e.g., water depth, canopy height, plant biomass).

## Methods and Materials

Research was carried out in the northern Everglades (Palm Beach County, Florida) at the Arthur R. Marshall Loxahatchee National Wildlife Refuge (hereafter the Refuge). The Refuge is a 57,234-hectare impounded marsh system historically comprising emergent wet prairies, sawgrass stands, alligator holes, and elongate tree islands (Loveless 1959). More detailed habitat descriptions are provided by Richardson et al. (1990).

The Refuge is the northern remnant of the historical Everglades, which stretched from the southern shores of Lake Okeechobee to the mangrove forests of northern Florida Bay. Currently, it is part of the vast south Florida water routing system, and is operated as Water Conservation Area 1 by the South Florida Water Management District. The entire marsh is encircled by a deep-water canal and dike system that drains an approximately equal area of the Everglades Agricultural Area. The altered hydrological regime, coupled with agriculturally derived nutrient effluents, has led to extensive habitat conversion in the Refuge (Richardson et al. 1990). For example, approximately 6,000 acres of sawgrass-dominated habitat has been replaced by a virtual monoculture of cattail (*Typha domingensis*). Concern over the impact of habitat degradation on wildlife resources provided the primary impetus for this research.

This study was carried out as part of a larger ecological characterization of the Refuge and its aquatic macrofaunal assemblages. To collect aquatic macrofauna, an aluminum throw-trap (100 x 100 x 75 cm) was thrown into the desired habitat and pressed firmly into the substrate. Aboveground vegetation was identified and counted (relative coverage by species), uprooted, and shaken to dislodge any macrofauna. A bar seine with 3.0 mm stretch mesh was then passed through the trap until three consecutive empty sweeps were obtained. Traps were visually inspected for spiders following the clearing procedure. Fishing spiders were identified, counted, and returned to the surrounding habitat. The mesh size used to clear the throw trap could have allowed smaller spiders to escape, therefore abundance estimates may be conservative. The throw-trap technique used in this study was designed initially for sampling fishes and aquatic macroinvertebrates, but also proved effective at collecting adult fishing spiders.

Several habitat variables were measured in addition to vegetation composition. Water depth and canopy height were measured to the nearest centimeter inside each trap prior to removal of plants. Percentage of dead sawgrass (= amount dead/total amount present)

within each trap was visually estimated at the sawgrass sites. Combined (live and dead) aboveground vegetation was dried and weighed to the nearest gram to obtain plant biomass estimates. Water temperature was measured with a YSI dissolved oxygen meter.

The study involved a stratified random design with blocking. Areas (blocks) were random coordinates located throughout the Refuge. Within an area, one site each of sawgrass, wet prairie, and alligator hole habitat were visited. These sites were sampled as encountered, and in as close proximity to one another as possible. Within each of these habitats, three traps (subsamples) were randomly collected. Therefore, sampling was carried out at three ecologically relevant scales: among similar habitat types, among different habitat types, and across the marsh landscape.

Sampling was carried out monthly (except December 1991) from August 1990 through January 1992. Each month, six areas were randomly selected for sampling using a grid map of the Refuge and a random number table. Areas were rejected if they were deemed inaccessible by airboat (i.e., woody vegetation or too dry). Therefore, 54 trap samples (6 areas x 3 habitats x 3 subsamples) were collected during each of the 17 months (total n=918). This design was used to minimize airboat damage to vegetation associated with repetitive sampling of fixed positions.

Analysis of variance (ANOVA) was used to test for differential habitat occupation by fishing spiders. The response variable in this analysis was the average number of spiders in the three subsamples for each site. The independent variables were habitat type (sawgrass, wet prairie, alligator hole), area (a statistical block effect), month, and the interaction between habitat type and month. Water depth was used as a covariate. The response variable was  $\log_{10}$  transformed to reduce observed heteroscedasticity. Visual inspection of residual plots indicated that this problem was corrected. Scheffe's test was used for multiple comparisons of means. Multiple regression was used to model the correlative relationship between average spider density in sawgrass and the six associated habitat parameters (relative abundance of sawgrass, percentage of dead sawgrass, plant biomass, water depth, canopy height, and temperature). Sawgrass sites with no spiders present were omitted from this analysis. Significance was set at  $p < 0.05$  for all statistical tests.

## Results

Sawgrass, wet prairie, and alligator hole sites were physically distinct from one another (Table 1). Sawgrass sites were virtually monotypic, with *Cladium jamaicense* comprising 94% of the plant cover at these sites. The wet prairie sites were dominated by the emergents *Eleocharis* spp. and *Rhynchospora* spp. Alligator holes were comprised primarily of *Utricularia* spp. and *Nymphaea odorata*. Wet prairies and alligator holes were generally deeper and more open, whereas sawgrass sites were relatively shallow (average depth = 22 cm) and had well-developed canopies (average height = 145 cm) that provided significant shading and cover. Aboveground plant biomass (dry weight) ranged from a low of 125 g/m<sup>2</sup> in alligator holes to a high of 757 g/m<sup>2</sup> in sawgrass, with wet prairie sites being intermediate at 284 g/m<sup>2</sup>. Dead plant material on average comprised 44% of the total *C. jamaicense* coverage in sawgrass sites. The other two habitats did not have well-developed litter deposits.

Fishing spiders were distributed non randomly with respect to habitat type ( $F_{2,169} = 5.1$ ,  $p < 0.05$ ; see Figure 1). Fishing spiders were significantly more abundant in sawgrass than in either wet prairies or alligator holes, which did not differ from each other (Scheffe's multiple comparison procedure). The blocking effect accounted for 20% of the variation observed in spider abundance, but was not significant ( $F_{85,169} = 0.9$ ,  $p > 0.05$ ). Therefore, the observed patterns of differential habitat use were consistent across the wetland landscape.

A total of 918 1-m<sup>2</sup> throw-trap samples were collected during the study, yielding 85 *Dolomedes triton*. Individual traps contained between 0 and 5 spiders. Overall density was 0.1 fishing spiders per m<sup>2</sup>. However, there was considerable temporal variation in abundance estimates. Monthly densities ranged from 0.3 spiders per m<sup>2</sup> in May 1991, to no spiders during the months of February, March, and April of 1991. Monthly variation in mean abundance of fishing spiders was significant ( $F_{16,169} = 3.2$ ,  $p < 0.05$ ). Although significant, the month effect only accounted for 12% of the variation observed in spider abundance. There were no clear seasonal trends in spider abundance and interannual variation was great. The interaction between month and habitat type was not significant ( $F_{32, 169} = 1.5$ ,  $p > 0.05$ ). Monthly spider densities and water depth did not covary (Spearman correlation = 0.14,  $p > 0.05$ ). The covariate water depth was not significant ( $F_{1, 169} = 0.0$ ,  $p > 0.05$ ) and failed to account for any of the observed variation in densities of fishing spiders.

Within-habitat analyses were limited to sawgrass sites because we found relatively high numbers of fishing spiders therein. Of the 102 independent sawgrass sites visited during this study, 34 yielded adult fishing spiders. For these 34 sites, multiple regression analysis revealed that the six measured habitat parameters (relative cover of sawgrass, percentage dead sawgrass, plant biomass, water depth, canopy height, and temperature) accounted for 54% (adjusted  $R^2$ ,  $p < 0.05$ ) of the observed variation in adult fishing spider abundance in sawgrass sites. Relative cover of sawgrass and percentage of dead sawgrass were the only significant independent variables in the multiple regression model. Mean spider abundance was positively, but weakly, correlated with these two parameters. However, removal of any of the other independent variables significantly reduced the predictive power of the regression model.

## Discussion

The overall abundance of the fishing spider *Dolomedes triton* in this freshwater marsh system appeared to be low. Density estimates may be low because of loss of smaller spiders through the 3-mm mesh seine. Unfortunately, comparable quantitative abundance data are not available for this species, or for freshwater wetland spiders in general. Bleckmann and Rovner (1984) found an average of 0.3 *Dolomedes triton* per meter of shoreline for a lake in Ohio. Previous studies in different aquatic systems have revealed significantly higher densities of smaller-sized spiders. For example, LaSalle and de la Cruz (1985) found higher densities of *Lycosa watsoni* (9.5 spiders per m<sup>2</sup>) and *Pirata mayaca* (17.8 spiders/m<sup>2</sup>) in the vegetation of a Mississippi salt marsh. However, salt marsh ecosystems are highly productive compared with the historically nutrient-poor Everglades (Richardson et al. 1990, Gunderson and Loftus 1992)

The finding of higher densities of fishing spiders in sawgrass is concordant with previous work by Bleckmann and Rovner (1984). They found that the number of *Dolomedes triton* was highest in cattail habitat and decreased as a function of decreasing plant cover and complexity. Relative to emergent vegetation of lesser stature, cattail and sawgrass provide similar habitat structure for fishing spiders: tall plant canopies with elevated levels of shading, enhanced protection from avian and piscine predators and reduced wind stimuli. Fishing spiders are not web builders, but rather rely on mechanoreception to detect prey that have become trapped on the water's surface or that are swimming just beneath it (Williams 1979, Bleckmann and Barth 1984, Bleckmann 1985, Bleckmann and Lotz 1987). The reduced amount of wind stimuli (i.e., sensory noise) characteristic of denser and taller vegetation increases the ability of fishing spiders to detect vibratory signals generated by potential prey (Bleckmann and Rovner 1984).

Sawgrass stands of the Florida Everglades are relatively dense and spatially complex. For this reason, sawgrass is not commonly used as a foraging habitat by either avian or piscine predators (Gunderson and Loftus 1992). Fishing spiders would easily fall prey to either of these two predatory groups. For example, the gut of an immature little blue heron collected in Florida contained 32 *Dolomedes triton* (Carico 1973). The remains of semiaquatic spiders have also been found in fish stomachs (F. Jordan, unpublished data). Therefore, it appears that lowered predation risk could help explain the observed patterns of habitat use by fishing spiders.



In addition to providing a "quieter" and "safer" environment for fishing spiders, sawgrass may also provide enhanced foraging opportunities. The abundant sawgrass litter provides excellent ambush sites for these sit-and-wait predators. Sawgrass habitat in this portion of the Everglades supports a diverse assemblage of potential prey (F. Jordan, unpublished data). Fish densities average about 15/m<sup>2</sup>, with the surface-dwelling golden topminnow (*Fundulus chrysotus*) and mosquitofish (*Gambusia holbrooki*) being common in this habitat. Interestingly, the pygmy sunfishes (Elassomatidae), which are documented prey of semi-aquatic spiders (Gudger 1931), are most abundant in sawgrass habitats (i.e., *Elassoma evergladei*). Various aquatic invertebrates (odonate larvae, coleoptera, hemiptera) and anuran larvae (*Rana grylio*, *Acris gryllus*) are also common in this habitat.

It has been suggested that fishing spiders may play an important role in Everglades marsh food webs (Gunderson and Loftus 1992). However, no research has examined the predatory role played by these spiders in natural wetlands. Much research has focused on the distributional and trophic ecology of spiders found in cultivated rice fields (e.g., Heiss and Meisch 1985, Orazé et al. 1988, Orazé and Grigarick 1989; see review in Nyffelder and Benz 1987). However, no studies have integrated the two approaches (i.e., habitat and feeding) into a unified model of spider predation and community dynamics. Future research should address this issue in both managed and natural wetland ecosystems.

Spatial complexity is one of the most important factors affecting spider ecology (Uetz 1991). Horizontal and vertical variation in habitat structure affects both population and assemblage level dynamics of spiders (Turnbull 1973, Riechert and Gillespie 1986, Uetz 1991). In this study, we found that the complex wetland mosaic comprising the northern Everglades affected the distribution of the fishing spider *Dolomedes triton*.

## Acknowledgments

This research was carried out as part of a doctoral research project by the senior author. Sean Coyne, Jane Jimeian, and other volunteers helped to collect spiders and other swamp creatures. Kim Babbitt, Peg Johnson, John Ramsey, and Mark Stowe kindly reviewed the manuscript. The staff of the Arthur R. Marshall Loxahatchee Refuge provided logistical support and access to the Refuge. This study was made possible by funding from the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service.

## Literature Cited

- Abraham, B. J. 1983. Spatial and temporal patterns in a sagebrush steppe community (Arachnida: Aranae). *Journal of Arachnology* 11:31-50.
- Barbour, T. 1921. Spiders feeding on small cyprinodonts. *Psyche* 28:131-132.
- Bleckmann, H. 1985. Perception of water surface waves: how surface waves are used for prey identification, prey localization, and intraspecific communication. *Advances in Sensory Physiology* 5:147-166.
- Bleckmann, H. and F. G. Barth. 1984. Sensory ecology of a semi-aquatic spider (*Dolomedes triton*). II. The release of predatory behavior by water surface waves. *Behavioral Ecology and Sociobiology* 14:303-312.
- Bleckmann, H. and T. Lotz. 1987. The vertebrate-catching behaviour of the fishing spider *Dolomedes triton* (Aranae, Pisauridae). *Animal Behavior* 35:641-651.
- Bleckmann, H. and J. S. Rovner. 1984. Sensory ecology of a semi-aquatic spider (*Dolomedes triton*). I. Roles of vegetation and wind-generated waves in site selection. *Behavioral Ecology and Sociobiology* 14:297-301.
- Carico, J. E. 1973. The nearctic species of the genus *Dolomedes* (Araneae: Pisauridae). *Bulletin of the Harvard Museum of Comparative Zoology* 144:435-488.
- Foelix, R. F. 1982. *Biology of Spiders*. Harvard University Press, Cambridge, MA, USA.
- Gudger, W. E. 1922. Spiders as fishermen. *Journal of the American Museum of Natural History* 22:565-568.
- Gudger, W. E. 1925. Spiders as fishermen and hunters. *Journal of the American Museum of Natural History* 25:261-275.
- Gudger, W. E. 1931. Some more spider fishermen. *Natural History* 31:58-61.

- Gunderson, L. H. and W. F. Loftus. 1992. The Everglades. p. 123-134. *In* W. H. Martin, S. G. Boyce, and A. C. Esternacht (eds.) *Biotic Communities of the Southeastern United States*. John Wiley & Sons, New York, NY, USA.
- Heiss, J. S. and M. V. Meisch. 1985. Spiders (Araneae) associated with rice in Arkansas with notes on species compositions of populations. *Southwestern Naturalist* 30:119-227.
- LaSalle, M. W. and A. A. De La Cruz. 1985. Seasonal abundance and diversity of spiders in two intertidal marsh plant communities. *Estuaries* 8:381-393.
- Loveless, C. M. 1959. A study of the vegetation of the Florida Everglades. *Ecology* 40:1-9.
- Meehan, O. L. 1934. Spiders that fish. *Natural History* 34:538-540.
- Nyffelder, M. and G. Benz. 1987. Spiders in natural pest control: a review. *Journal of Applied Entomology* 103:321-339.
- Oraze, M. J. and A. A. Grigarick. 1989. Biological control of aster leafhopper (Homoptera: Cicadella) and midges (Diptera: Chironomidae) by *Pardosa ramulosa* (Araneae: Lycosidae) in California rice fields. *Journal of Economic Entomology* 82:745-749.
- Oraze, M. J., A. A. Grigarick, J. H. Lynch, and K. A. Smith. 1988. Spider fauna of flooded rice fields in northern California. *Journal of Arachnology* 16:331-337.
- Oraze, M. J., A. A. Grigarick, and K. A. Smith. 1989. Population ecology of *Pardosa ramulosa* (Araneae, Lycosidae) in flooded rice fields of northern California. *Journal of Arachnology* 17:163-170.
- Richardson, J. R., W. L. Bryant, W. M. Kitchens, J. E. Mattson, and K. R. Pope. 1990. An evaluation of Refuge habitats and relationships to water quality, quantity, and hydroperiod: a synthesis report. Arthur R. Marshall Loxahatchee National Wildlife Refuge, U.S. Fish and Wildlife Service, Boynton Beach, FL, USA.

- Riechert, S. E. and R. G. Gillespie. 1986. Habitat choice and utilization in web-building spiders. p. 23-48. *In Spiders: Webs, Behavior, and Evolution*. Stanford University Press, Stanford, CA, USA.
- Scheidler, M. 1990. Influence of habitat structure and vegetation architecture on spiders. *Zoologica Anzio* 5:333-340.
- Serrao, J. 1980. Giant spiders of the Everglades. *National Parks* 54:12-13.
- Turnbull, A. L. 1973. Ecology of the true spiders (Araneomorphae). *Annual Review of Entomology* 18:305-348.
- Uetz, G. W. 1991. Habitat structure and spider foraging. p. 325-348. *In* S. S. Bell, E. D. McCoy, and H. R. Mushinsky (eds.) *Habitat Structure: the Physical Arrangement of Objects in Space*. Chapman and Hall, New York, NY, USA.
- Williams, D. S. 1979. The feeding behaviour of New Zealand *Dolomedes* species (Aranae: Pisauridae). *New Zealand Journal of Zoology* 6:95-105.

Table 1. Characteristics of sawgrass, wet prairie, and alligator hole habitats sampled on the Arthur R. Marshall Loxahatchee National Wildlife Refuge, Florida during August 1990-January 1992. Values given are means for 918 1-m<sup>2</sup> throw-trap samples. Canopy composition values are relative cover (%) of plant species. Values with different letters (across rows) are significantly different at the  $p < 0.05$  level (ANOVA followed by Scheffe's multiple comparison test).

Habitat Variables	Sawgrass	Wet Prairie	Alligator Hole
Biomass (g/m <sup>2</sup> )	757 <sup>a</sup>	284 <sup>b</sup>	125 <sup>c</sup>
Water depth (cm)	22 <sup>a</sup>	31 <sup>b</sup>	41 <sup>c</sup>
Canopy height (cm)	145 <sup>a</sup>	74 <sup>b</sup>	28 <sup>c</sup>
<b>Canopy composition</b>			
<i>Cladium jamaicense</i>	94 <sup>a</sup>	0 <sup>b</sup>	1 <sup>b</sup>
<i>Eleocharis</i> spp.	0 <sup>a</sup>	25 <sup>b</sup>	4 <sup>a</sup>
<i>Eriocaulon</i> spp.	0 <sup>a</sup>	1 <sup>a</sup>	0 <sup>a</sup>
<i>Nymphaea odorata</i>	0 <sup>a</sup>	6 <sup>a</sup>	65 <sup>b</sup>
<i>Pontederia</i> spp.	1 <sup>a</sup>	0 <sup>a</sup>	0 <sup>a</sup>
<i>Rhynchospora</i> spp.	1 <sup>a</sup>	54 <sup>b</sup>	4 <sup>a</sup>
<i>Utricularia</i> spp.	1 <sup>a</sup>	8 <sup>a</sup>	22 <sup>b</sup>
<i>Xyris</i> sp.	1 <sup>a</sup>	3 <sup>a</sup>	0 <sup>a</sup>
Other	2 <sup>a</sup>	3 <sup>a</sup>	4 <sup>a</sup>

Figure 1. Habitat use by the fishing spider (*Dolomedes triton*) in the Arthur R. Marshall Loxahatchee National Wildlife Refuge, Florida. Each bar is the mean number of spiders per m<sup>2</sup> ± 1 SE of 306 throw trap samples. Means with different letters are significantly different at the p < 0.05 level (ANOVA followed by Scheffe's multiple comparison test).

