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EARTHWORM SPECIES AVAILABLE TO AMERICAN WOODCOCK (*SCOLOPAX MINOR*) ON THE WINTERING GROUNDS IN EASTERN NORTH CAROLINA, USA.

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ABSTRACT

American woodcock *(Scolopax minor)* are migratory shorebirds that have experienced annual population losses of 1.1 % since 1968. The primary food source of American woodcock on their wintering grounds is earthworms, but few studies have identified the earthworm species available. Previous wintering woodcock research in eastern North Carolina reported that woodcock foraged for earthworms in conventionally-tilled soybean fields and that 99% of earthworms consumed by woodcock were *Aporrectodea* or *Diplocardia* spp. Today, most farmers have switched to no-till agriculture, which may have affected the diversity of earthworms available to woodcock. During February 2009 and February-March 2010, we collected 2102 earthworms and identified 13 species, 8l.3% of which were *Aporrectodea* or *Diplocardia* spp. The species richness of earthworms in our samples compared to prior research suggests the conversion from conventional-tillage to no-till agricultural practices has increased earthworm species richness on American woodcock foraging grounds or that woodcock selectively feed on some earthworm species.

Keywords: American woodcock, earthworms, North Carolina, *Scolopax minor*, wintering grounds.

RÉSUMÉ

La Bécasse d'Amérique (*Scolopax minor*) est un oiseau limicole migrateur dont les effectifs ont subit une diminution annuelle de 1.1 % depuis 1968. Sa principale nourriture en zone d'hivernage est constituée de vers de terre, mais peu d'études ont identifié les espèces disponibles. Des recherches antérieures, dans une zone d'hivernage de l'est de la Caroline du Nord, ont montré que la bécasse se nourrissait dans les terres de culture du soja labourées de façon conventionnelle, et que 99 % des vers de terre consommés par la bécasse étaient des espèces d'*Aporrectodea* ou de *Diplocardia*. Aujourd'hui, la plupart des agriculteurs se sont converti à la culture sans labourage, ce qui a pu affecter la diversité des vers de terre disponibles pour la bécasse. En février 2009 et en février-mars 2010, nous avons échantillonné les vers de terre aux sites de l'étude précédente, dans l'est de la Caroline du Nord. Nous avons recueilli 2102 vers de terre, parmi lesquels nous avons identifié 13 espèces, dont 81.3 % appartenaient à *Aporrectodea* ou *Diplocardia*. La richesse en espèces de nos échantillons, comparée à celle de l'étude précédente, laisse croire que la conversion de la pratique agricole avec labourage conventionnel vers celle sans labourage a augmenté la richesse en espèces de vers de terre dans les zones d'alimentation de la Bécasse d'Amérique ou que cette dernière consomme les espèces de vers de terre de façon sélective.

Mots clé: Bécasse d'Amérique, vers de terre, Caroline du Nord, *Scolopax minor*, zones d'hivernage.

RESUMEN

Aves costeras migratorias americanas (*Scolopax minor*) desde 1968 han experimentando una pérdida anual en su población de 1.1%. El recurso primario de alimentación de estas aves en sus territorios invernales es la lombríz de tierra, aunque pocos estudios han identificado las especies disponibles. Investigaciones previas sobre estas aves migratorias en el este de Carolina del Norte, reportaron que las aves buscaban alimentarse sobre lombrices de tierra en terrenos con poroto de soja cultivados mediante el método convencional. Además informaron que el 90% de lombrices consumidas por las aves fueron *Aporrectodea* o *Diplocardia* spp. Hoy la mayoría de los agricultores han cambiado los métodos de cultivo lo cual ha afectado la diversidad de lombrices disponibles para estas aves migratorias. Durante Febrero de 2009 y Febrero-Marzo de 2010, colctamoss lombrices en el este de Carolina del Norte en el mismo sitio de las estudios anteriores. Colectamos 2102 lombrices de tierra e identificamos 13 especies de las cuales 81.3% fueron *Aporrectodea* y *Diplocardia* spp. La riqueza de especies de lombrices en nuestros muestreos, comparados con los anteriores, sugieren que el cambio de prácticas agrícolas convencionales a las no convencionales han incrementado la riqueza de especies de lombrices de tierra en terrenos donde las aves migratorias buscan lombrices para alimentarse. También sugieren que las aves podrían alimentarse de manera selectiva sobre algunas especies de lombrices.

Palabras claves: Aves costeras migratorias americanas, lombrices de tierra, Carolina del Norte, *Scolopax minor*, terrenos invernales.

INTRODUCTION

American woodcock *(Scolopax minor)* are nocturnal, migratory shorebirds that have declined by 1.1 % annually since 1968 (Cooper and Parker, 2009), largely because of the loss of early-successional habitat (Dessecker and McAuley, 2001). On their northern breeding grounds, American woodcock feed on a variety of items including earthworms, insects, and vegetable matter (Sperry, 1940), whereas on the southern wintering grounds they feed almost exclusively on earthworms (Glasgow, 1958). However, while many studies have documented that woodcock forage on earthworms (Pettingill, 1939; Sheldon, 1967; Liscinsky, 1972; Owen and Galbraith, 1989), few have identified the earthworm species available to woodcock.

Although prior studies surveyed earthworm communities within the American woodcock wintering range [*i.e.*, Maryland (Reynolds, 1974), Tennessee (Reynolds *et al.*, 1974; Reynolds, 1977a; Reynolds, 1978), North Carolina (Reynolds, 1994a), Virginia (Reynolds, 1994b), Florida (Reynolds, 1994c), Mississippi (Reynolds, 1994d), Alabama (Reynolds, 1994e), South Carolina (Reynolds, 2001), Arkansas (Reynolds, 2008a), Louisiana (Reynolds, 2008b), Kentucky (Reynolds, 2008c), Missouri (Reynolds, 2008d), Georgia (Reynolds, 2009), South Carolina (Reynolds and Reeves, 2004), east Texas (Damoff and Reynolds, 2009) and Oklahoma (Reynolds and Damoff, 2010)], to our knowledge no studies have documented the earthworm species available in land cover types known to be used by woodcock for foraging.

Stribling and Doerr (1985) noted that woodcock in eastern North Carolina moved at night from bottomland forests to feed on earthworms in adjacent agricultural fields, especially conventionally-tilled soybean fields. However, since the 1970s, farming technology has switched from conventional-tilled to no-till agriculture. Fields no longer are plowed every winter and as a result, soil communities remain intact (Smith *et al.*, 2008). Therefore, the earthworm species present in agricultural fields may have changed with the evolving agricultural practices. Our objectives were to determine the earthworm species available to American woodcock and explore whether new farming technology has impacted earthworm communities on the wintering grounds in coastal North Carolina.

STUDY SITE

Our research was conducted in the same fields as previous woodcock research in eastern North Carolina (Stamps and Doerr, 1976; Connors and Doerr, 1982; Stribling and Doerr, 1985). Nocturnal feeding habitat included agricultural fields south of Lake Mattamuskeet National Wildlife Refuge and US-264 near New Holland in Hyde County, North Carolina (Figure 1). Field types in our focal area included no-till soybean (n=37), winter wheat (n=14), disked corn (n=9), corn with standing stalks (n=6), conventionally-tilled soybean (n=3), and cotton (n=3) for a total of 72 fields in February 2009 and no-till soybean (n=31), disked corn (n=21), corn with standing stalks (n=13), winter wheat (n=7), and cotton (n=l) for a total of 73 fields in February-March 2010.

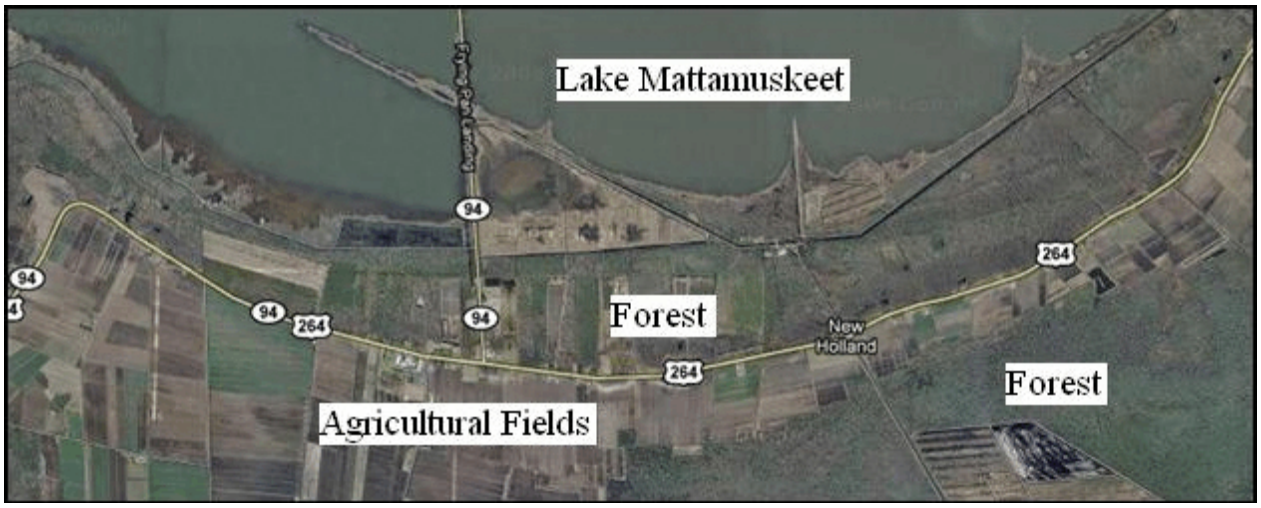

Figure 1. Study site near New Holland in eastern North Carolina, 2009-2010. American woodcock nocturnal foraging habitat included agricultural fields south of Lake Mattamuskeet National Wildlife Refuge and US-264.

METHODS

During February 2009, we collected earthworm samples from three conventionally-tilled soybean and cotton fields, and five no-till soybean, corn with standing stalks, disked corn, and winter wheat fields, and added three extra sampling fields of common field types (*i.e.*, no-till soybean, disked corn, and winter wheat) for a total of 35 fields. During February-March 2010, we collected earthworms at all 73 fields in our focal area. During both seasons and in each field, we collected earthworms from six 0.5-m^2 plots, for a total of 210 sample plots in 2009 and 438 sample plots in 2010. We spaced sample plots 15 meters apart and oriented on a diagonal to assure that sampling was conducted across rows. We collected samples between rows when present, because woodcock were observed roosting and feeding between rows. We sampled to a depth of 7.6 cm, the maximum distance that woodcock can probe into soil (Rabe *et al.*, 1983). We collected samples from dusk until midnight to mimic woodcock feeding habits (Glasgow, 1958) and preserved earthworms in 70% ethanol to be identified to species (Dr. John W. Reynolds' Oligochaetology Laboratory, Ontario). Voucher specimens are deposit-ed in the collections of the New Brunswick Museum, Saint John, NB, Canada.

RESULTS AND DISCUSSION

We identified 13 species from 2102 individual earthworms: *Aporrectodea trapezoides* (n=1424), *Amynthas diffringens* (n=279), *Diplocardia caroliniana* (n=260), *Allolobophora chlorotica* (n=72), *Bimastos parvus* (n=22), *Aporrectodea turgida* (n=20), *Eukerria saltensis* (n=16), *Octolasian tyrtaeum* (n=2), *Aporrectodea tuberculata* (n=2), *Aporrectodea rosea* (n=2), *Aporrectodea longa* (n=l), *Amynthas hupeiensis* (n=1), and *Bimastos tumidus* (n=1).

We collected three state-wide common species *(Aporrectodea trapezoides, Amynthas diffringens,* and *Octolasion tyrtaeum),* four species common in the northern half of North Carolina *(Allolobophora chlorotica, Aporrectodea rosea, Aporrectodea turgid a,* and *Bimastos tumidus),* and two species located only in coastal North Carolina (*Eukerria saltensis,* and *Amynthas hupeiensis*) (Reynolds, 1994a). The third most abundant species in our samples *(Diplocardia caroliniana)* has only been detected in the Piedmont and Blue Ridge Mountain regions of North Carolina. In addition, *Apporectodea longa* was previously only recorded in one county in the Blue Ridge region, and *Apporectodea tuberculata* was mainly detected in Blue Ridge counties, with one specimen in Chowan County in the Coastal Plain. Finally, *Bimastos parvus* was previously located only in Columbus, Granville, and Pitt Counties (Reynolds, 1994a).

The earthworm species we identified differ from the earthworm species eaten by woodcock on the breeding grounds, as would be expected based on different local environmental conditions and earthworm species' ranges. On the breeding grounds in Maine, Minnesota, New Brunswick and Quebec, woodcock only consumed *Apporrectodea tuberculata, Dendro-*

baena octaedra, Lumbricus rubellus and *Dendrodrilus rubidus* (Reynolds, 1977b). Reynolds (1977b) predicted the species available to American woodcock in the Southeast, namely *Aporrectodea trapezoides,* and members of the *Amynthas, Metaphire, Pheretima, Diplocardia, Bimastos,* and *Eisenoides* genera. Although we did not collect any *Metaphire, Pheretima* or *Eisenoides* specimens, we did collect *Aporrectodea trapezoides, Amynthas, Diplocardia,* and *Bimastos*.

At the same study sites 25 years ago, Stribling and Doerr (1985) reported that 99% of earthworms ingested by woodcock (n=12) were *Apporectodea* and *Diplocardia;* 81.3% of the specimens we collected were of these two genera. It is possible that woodcock select genera *Apporectodea* and *Diplocardia* when they feed, but the small sample size of Stribling and Doerr (1985) likely was not representative of the full range of earthworm species consumed by woodcock.

Because of new farming technology, the earthworm species available in agricultural fields in eastern North Carolina may have changed since Stribling and Doerr's (1985) research. Historically, soil was tilled to plant crops, which created a ridge and furrow structure in fields. Today, no-till technology allows crops to be planted with minimal soil disturbance. In eastern North Carolina, corn fields still are planted with traditional tillage, but nearly all farmers have switched to no-till technology for soybeans. Annual tillage negatively impacts earthworms by effecting soil moisture and organic matter content, and by exposing the earthworms to predation (Edwards *et al.*, 1995). Additionally, fertilizers and herbicides used on tilled fields can change soil pH and organic matter content, and reduce soil surface residue and cover, negatively effecting earthworm habitat quality (Smith *et al.*, 2008). Smith *et al.* (2008) determined that no- till systems had higher earthworm abundance and richness than conventionally-tilled systems. Similarly, Edwards and Lofty (1982) noted that earthworm populations were 30 times higher in no-till compared to tilled fields. Thus, the widespread conventional-tillage practices used thirty years ago and the recent switch to no-till technology may explain the increased richness of our sample compared to Stribling and Doerr (1985).

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LITERATURE CITED

Connors, J.L. and P.D. Doerr. 1982. Woodcock use of agricultural fields in coastal North Carolina. U.S. Fish and Wildlife Service, Wildlife Research Report Number 14: 139-147.

Cooper, T.R. and K. Parker. 2009. American woodcock population status, 2009. U.S. Fish and Wildlife Service, Laurel, Maryland. 15 pp.

Damoff, G.A. and J.W. Reynolds. 2009. The earthworms (Oligochaeta: Acanthodrilidae, Eudrilidae, Lumbricidae, Megascolecidae, Ocnerodrilidae, and Sparganophilidae) of east Texas, USA. Megadrilogica 13(8): 113-140.

Dessecker, D.R. and D.G. McAuley. 2001. Importance of early successional habitat to ruffed grouse and American woodcock. Wildlife Society Bulletin 29: 456-465.

Edwards, C.A. and R. Lofty. 1982. The effect of direct drilling and minimal cultivation on earthworm populations. Journal of Applied Ecology 19: 723-734.

Edwards, C. A., P. J. Bohlen, D. R. Linden and S. Subler. 1995. Earthworms in Agroecosystems. Pp. 185-213, *In:* P. F. Hendrix, (*ed*.). Earthworm Ecology and Biogeography in North America. Boca Raton: Lewis Publishers, 244 pp.

Glasgow, L.L. 1958. Contributions to the Knowledge of the Ecology of the American Woodcock, *Philohela minor* (Gmelin), on the Wintering Range in Louisiana. Ph.D. dissertation, College Station: Texas A&M University, 153 pp.

Liscinsky, S.A. 1972. The Pennsylvania woodcock management study. Pennsylvania Game Commission Research Bulletin 171, 95 pp.

Owen, R.B., Jr. and W.J. Galbraith. 1989. Earthworm biomass in relation to forest types, soil and land use: implications for woodcock management. Wildlife Society Bulletin 17: 130-136.

Pettingill, O. S., Jr. 1939. Additional information on the food of the American woodcock. Wilson Bulletin 51: 78-82.

Rabe, D. L., H.H. Prince and D.L. Beaver. 1983. Feeding-site selection and foraging strategies of American woodcock. The Auk 100: 711-716.

Reynolds, J.W. 1974. The earthworms of Maryland (Oligochaeta: Acanthodrilidae, Lumbricidae, Megascolecidae and Sparganophilidae. Megadrilogica 1(11): 1-12.

Reynolds, J.W. 1977a. Earthworms utilized by the American woodcock. Proc. Woodcock Symp. 6: 161-169.

Reynolds, J.W. 1977b. The earthworms of Tennessee (Oligochaeta). III. Komarekionidae, with notes on distribution and biology. Megadrilogica 3(4): 65-69.

Reynolds, J.W. 1978. The earthworms of Tennessee (Oligochaeta). IV. Megascolecidae, with notes on distribution, biology and a key to the species in the state. Megadrilogica 3(7): 117-129.

Reynolds, J.W. 1994a. Earthworms of North Carolina (Oligochaeta: Acanthodrilidae, Komarekionidae, Lumbricidae, Megascolecidae, Ocnerodrilidae and Sparganophilidae). Megadrilogica 5(6): 53-72.

Reynolds, J.W. 1994b. Earthworms of Virginia (Oligochaeta: Acanthodrilidae, Komarekionidae, Lumbricidae, Megascolecidae and Sparganophilidae). Megadrilogica 5(8): 77-94.

Reynolds, J.W. 1994c. Earthworms of Florida (Oligochaeta: Acanthodrilidae, Eudrilidae, Glossoscolecidae, Lumbricidae, Megascolecidae, Ocnerodrilidae, Octochaetidae and Sparganophilidae). Megadrilogica 5(12): 125-141.

Reynolds, J.W. 1994d. Earthworms of Mississippi (Oligochaeta: Acanthodrilidae, Lumbricidae, Megascolecidae, Ocnerodrilidae and Sparganophilidae). Megadrilogica 6(3): 21-33.

Reynolds, J.W. 1994e. Earthworms of Alabama (Oligochaeta: Acanthodrilidae, Eudrilidae, Lumbricidae, Megascolecidae and Sparganophilidae). Megadrilogica 6(4): 35-46.

Reynolds, J.W. 2001. The earthworms of South Carolina (Oligochaeta: Acanthodrilidae, Lumbricidae, Megascolecidae, Ocnerodrilidae and Sparganophilidae). Megadrilogica 8(7): 25-36.

Reynolds, J.W. 2008a. The earthworms (Oligochaeta: Acanthodrilidae, Lumbricidae, Megascolecidae and Sparganophilidae) of Arkansas, USA, revisited. Megadrilogica 11(11): 115-130.

Reynolds, J.W. 2008b. The earthworms (Oligochaeta, Acanthodrilidae, Lumbricidae, Lutodrilidae, Megascolecidae and Sparganophilidae) of Louisiana, USA revisited. Megadrilogica 12(3): 31-60.

Reynolds, J.W. 2008c. The earthworms (Oligochaeta, Acanthodrilidae, Komarekionidae, Lumbricidae, Megascolecidae and Sparganophilidae) of Kentucky, USA. Megadrilogica 12(5): 73-88.

Reynolds, J.W. 2008d. The earthworms (Oligochaeta: Acanthodrilidae, Lumbricidae, Megascolecidae, and Sparganophilidae) of Missouri, USA, revisited. Megadrilogica 12 (6): 89-104.

Reynolds, J.W. 2009. The earthworms (Oligochaeta: Acanthodrilidae, Eudrilidae, Lumbricidae, Megascolecidae, Ocnerodrilidae, and Sparganophilidae) of Georgia, USA. Megadrilogica 13(7): 85-111.

Reynolds, J.W. and G.A. Damoff. 2010. The earthworms (Oligochaeta: Acanthodrilidae, Lumbricidae, Megascolecidae and Sparganophilidae) of Oklahoma, USA. Megadrilogica 13(12): 173-193.

Reynolds, J.W. and W.K. Reeves. 2004. Additional earthworms records (Oligochaeta: Acanthodrilidae, Lumbricidae, Megascolecidae, Ocnerodrilidae and Sparganophilidae) from South Carolina. Megadrilogica 9(12): 99-110.

Reynolds, J.W., E.E.C. Clebsch and W.M. Reynolds. 1974. The earthworms of Tennessee (Oligochaeta). I. Lumbricidae. Contr. N. Amer. Earthworms, No. 3, Bull. Tall Timbers Res. Stn., No. 17, *viii* + 133 pp.

Sheldon, W.G. 1967. The book of the American woodcock. Amherst: The University of Massachusetts Press, *xvii* + 227 pp.

Smith, R.G., C.P. McSwiney, A.S. Grandy, P. Suwanwaree, R.M. Snider and G.P. Robertson. 2008. Diversity and abundance of earthworms across an agricultural land-use intensity gradient. Soil and Tillage Research 100: 83-88.

Sperry, C.C. 1940. Food habits of a group of shorebirds: woodcock, snipe, knot and dowitcher. U.S. Biological Survey, Wildlife Research Bulletin 1.

Stamps, R. T., and P. D. Doerr. 1976. Woodcock on North Carolina wintering grounds. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 30: 392-399.

Stribling, H. L. and P.D. Doerr. 1985. Nocturnal use of fields by American woodcock. Journal of Wildlife Management 49: 485-491.

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http://www.inhs.uiuc.edu/~mjwetzel/Megadrilogica.home.html