



RESEARCH NOTE

Observations on spiny dogfish (*Squalus acanthias*) captured in late spring in a North Carolina estuary [v1; ref status: approved 1, approved with reservations 1, <http://f1000r.es/412>]

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Abstract

Five spiny dogfish were captured in early-mid May during gillnet and longline sampling targeting juvenile coastal sharks in inshore North Carolina waters. Dogfish captures were made within Back Sound and Core Sound, North Carolina. All dogfish were females over the size at maturity, and were caught at stations 1.77-2.74 m in depth, with temperatures 22.9-24.2 °C, 32.8-33.4 ppt salinity, and 6.9-8.0 mg/L dissolved oxygen. Stations where dogfish were captured were approximately 6.5-15.7 km from the nearest inlet and 43.4-247.1 m from the nearest seagrass bed. These observations are among the latest in the spring for spiny dogfish in the southeastern U.S. and occurred at higher temperatures than previously recorded for this species. It is unclear whether late-occurring spiny dogfish in this area represent a cryptic late-migrating or resident segment of the Northwest Atlantic population.



This article is included in the **Elasmobranch Biology & Conservation Collection**

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Referee Status:

	Invited Referees	
	1	2
version 2 published 13 Oct 2014	REVISED	 report
version 1 published 12 Aug 2014	 report	 report

- 1 **Bryan Frazier**, South Carolina Department of Natural Resources USA
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Introduction

The spiny dogfish (*Squalus acanthias*) is a small, highly migratory coastal shark common in Northwest Atlantic waters from Newfoundland to Cape Hatteras (Stehlik, 2007). After signs of population disturbance resulting from overfishing, stringent fishery management regulations were put in place for this species, and the population was considered recovered within ten years of implementing a fishery management plan (Rago & Sosebee, 2010). Such a swift recovery was unexpected for this species due to its life history characteristics: spiny dogfish in the Northwest Atlantic are not reproductively mature until an age of 12 years, have a 2-year gestation period, and give birth to only 1–15 young (Nammack *et al.*, 1985).

A possible hypothesis for swifter than expected recovery is that currently cryptic migratory behavior moves some portions of the spiny dogfish population out of range of both fishing pressure and fishery-independent surveys used to assess spiny dogfish stocks. According to data from the National Marine Fisheries Service (NMFS) trawl survey, spiny dogfish exhibit a general north-south migration pattern along the U.S. Atlantic coast, occurring in North Carolina and Virginia waters south to Cape Hatteras during the winter and spring, and moving north to the Gulf of Maine and Canadian waters in the summer and fall (Stehlik, 2007). However, spiny dogfish movements and distribution may not conform to this pattern. Mark-recapture studies based in both the U.S. and Canada provide evidence for more complex migratory behavior, with little migratory overlap between the Gulf of Maine and Atlantic waters south of Cape Cod and inshore-offshore migrations among dogfish remaining in Canadian waters year-round (Campana *et al.*, 2007). More recently, spiny dogfish tagged with pop-up satellite tags in the Gulf of Maine were tracked moving off the continental shelf, providing more evidence for inshore-offshore migrations (Sulikowski *et al.*, 2010).

Spiny dogfish also occur south of Cape Hatteras, with large aggregations encountered during the winter and early spring from Cape Lookout to Cape Fear in North Carolina waters (Rulifson & Moore, 2009) and along the South Carolina coast (Ulrich *et al.*, 2007). Spiny dogfish south of Cape Hatteras tend to occur in shallower water closer to shore than conspecifics north of Cape Hatteras (Rulifson & Moore, 2009, Rulifson *et al.*, 2012). Acoustic telemetry data suggest that these sharks are part of the population that migrates between Cape Hatteras and Cape Cod (Rulifson *et al.*, 2012), and seem to occupy southern waters between November and April (Ulrich *et al.*, 2007, Rulifson *et al.*, 2012). Despite this consistent behavior among acoustically tagged sharks, Rulifson *et al.*, (2012) captured several spiny dogfish by hook and line at Cape Lookout on June 1, 2010, long after the end of the overwintering period for this species. Here we report further observations of spiny dogfish occurring in southern waters long after their expected migration north.

Methods

Spiny dogfish were captured during a survey designed to assess habitat selection by juvenile coastal sharks in North Carolina inshore

waters. The sampling area encompassed the entirety of Back Sound from Beaufort Inlet to Cape Lookout, and extended north through the southern extent of Core Sound into Jarrett Bay (Figure 1). Sampling also occurred within Newport River from Beaufort Inlet to the Newport Marshes. Sampling locations were chosen with the goal of sampling three different habitat types; seagrass beds, shallow sand flats, and deep channels.

Sharks were captured using bottom-set longline and gillnet gear. Longline gear consisted of a 274.32 m mainline 6.35 mm in diameter with 50 gangions comprised of a longline clip with a swivel, a 1 m leader of 136.08 kg test monofilament line, and a size 12/0 circle hook, attached at 5–7 m intervals. Gillnet gear measured 50 m in length and 2.4 m in height, and was comprised of eight panel sections of monofilament mesh measuring 7.5, 10, 12.3, 15.5, 17.1, 21, 25.6, and 31 cm stretched, respectively. Both gears were soaked for 30–60 minutes. Where space allowed, both gears were deployed within 100 m of each other and allowed to soak simultaneously; otherwise only one of the gear types was deployed. At each sampling location, depth (m) was recorded using an onboard depth sounder, and temperature (°C), salinity (ppt), and dissolved oxygen (mg/L) were measured using a YSI model 85. Distance from the nearest inlet and distance from the nearest mapped seagrass bed were calculated by plotting the sampling locations in ArcGIS 10.1 and measuring the straight-line distance (m) between the sampling stations and those geographic features. Mapped seagrass locations were taken from ArcGIS shapefiles of submerged aquatic vegetation generated by the Albemarle-Pamlico National Estuary Partnership (APNEP, 2008).

All captured sharks were identified to species and sex, fork length (FL, mm), and total length (TL, mm) were recorded. Signs of life-history stage such as umbilical scarring and visible pregnancy were also recorded. All batoids were identified, and sex and disc width (DW, mm) were recorded for each individual. All other bycatch organisms were identified, counted, and released.

Results

A total of 52 stations were sampled from March 21 to July 1, 2014, 12 of which were sampled using longline gear and 31 of which were sampled by gillnet. Sampling encompassed Newport River, the western half of Back Sound through Middle Marsh, and Core Sound between Cape Lookout and Jarrett Bay (Figure 1).

Spiny dogfish were captured in May during two gillnet sets (Figure 2, Data Set 1). The first capture event took place on May 6 during a gillnet set deployed at the northeast corner of Middle Marsh. The gear was deployed at 1325 hours and allowed to soak for 30 minutes. Four adult female spiny dogfish ranging from 849–905 mm TL were captured. The site of capture was 2.74 m in depth, with a temperature of 22.9°C, salinity of 32.8 ppt, and 8.0 mg/L dissolved oxygen. A bluntnose stingray (*Dasyatis say*, DW = 450 mm) and a bullnose ray (*Myliobatis freminvillei*, DW = 458 mm) were also captured in this set. Spatial analysis showed that this site was 6526.40 m from the nearest inlet and 43.43 m from the nearest mapped seagrass area.

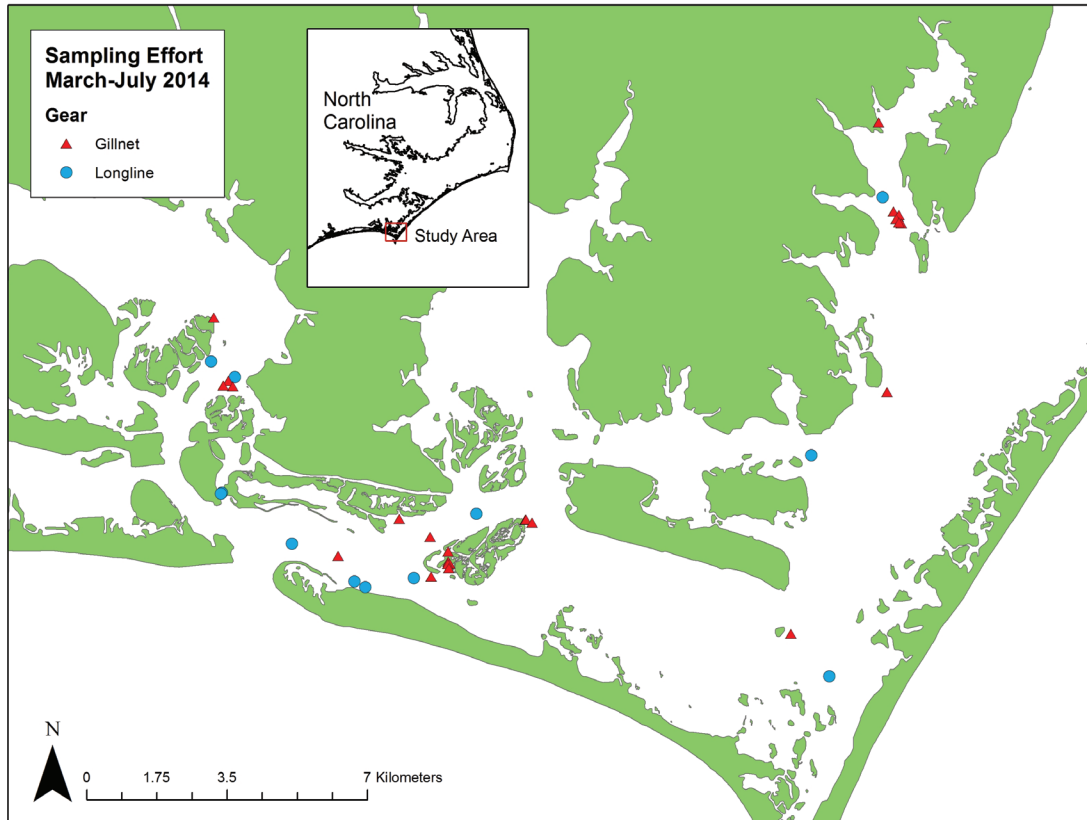


Figure 1. Gillnet and longline sampling stations within Back Sound and lower Core Sound from March 21 – July 1, 2014.

Dataset 1. Date, time, and location of spiny dogfish captures in gillnet gear, with size, sex, and environmental data taken at each station

<http://dx.doi.org/10.5256/f1000research.4890.d33066>

TL: total length; FL: fork length. The last spiny dogfish escaped alongside boat.

The second capture event occurred on May 18 on the north side of Davis Island in Jarrett Bay. Time of gillnet deployment was 1442 hours and soak time was limited to 30 minutes. One spiny dogfish was snared in the mesh by its dorsal spines but was able to break free and escape before it could be brought aboard. Visual estimate placed the TL of this shark within the range of those captured earlier (850–900 mm). A depth of 1.77 m, temperature of 24.2°C, salinity of 33.4 ppt, and dissolved oxygen of 6.88 mg/L were recorded at this site. Other species captured at this site included one cownose ray (*Rhinoptera bonasus*, DW = 414 mm), one bullnose ray (DW = 458 mm), and four harvestfish (*Peprilus alepidotus*). This site was 15670.63 m from the nearest inlet and 247.08 m from the nearest mapped seagrass bed.

Discussion

These observations represent the highest reported temperatures and latest occurrence for spiny dogfish in their overwintering habitat off the Southeastern U.S., with the exception of those captured on June 1, 2010 by [Rulifson et al., \(2012\)](#). The presence of these sharks in North Carolina waters in late May at temperatures above 22°C is inconsistent

with current information on spiny dogfish distribution and environmental preferences. Whether these observations point to unique behavior among spiny dogfish occurring near Cape Lookout or the limitations of other sampling efforts for this species is uncertain.

Spiny dogfish have been consistently observed overwintering south of Cape Lookout. [Bearden, \(1965\)](#) reported that spiny dogfish were captured in trawl surveys within South Carolina waters as far south as Port Royal Sound between December and March at water temperatures ranging 7.5–12.0°C. Year-round gillnet and longline sampling along the South Carolina coast only captured spiny dogfish at temperatures below 14°C between January and March ([Ulrich et al., 2007](#)). In the vicinity of Cape Fear, North Carolina, [Thorpe & Beresoff, \(2000\)](#) captured spiny dogfish in commercial gillnet gear from December–April, though the sharks were most abundant in February and March and at temperatures less than 13.9°C. In contrast, only one spiny dogfish was captured during gillnet sampling from May–September in the same area ([Thorpe et al., 2004](#)). [Schwartz, \(2003\)](#) reported that spiny dogfish could occasionally be encountered along the coast of the Carolinas until May, but temperatures higher than 18°C triggered migration offshore and northward.

Seasonal habitat preferences inferred from trawl survey and mark/recapture studies focused on the area between Cape Hatteras and the Scotian Shelf are consistent with observations from areas further south. Spiny dogfish occurring between Cape Hatteras and the Gulf of Maine mostly occurred in North Carolina waters during winter and spring, and were distributed between New England and Canadian waters during summer and autumn ([Campana et al., 2007](#),



Figure 2. Capture locations of spiny dogfish in gillnet sets within Back Sound and lower Core Sound in May 2014.

Stehlik, 2007). Within this area, spiny dogfish were captured primarily in the 5–17°C temperature range (Sagarese *et al.*, 2014). Spiny dogfish occurred at temperatures up to 20°C in Massachusetts inshore waters in autumn, but were most abundant within the 6–15°C range (Stehlik, 2007). Acoustically-tagged spiny dogfish were only detected near the Hatteras Bight between mid-December and early April, with the majority of detections occurring in February and March, and appeared to make inshore-offshore movements in search of cooler temperatures (Rulifson *et al.*, 2012).

Though the observed presence of spiny dogfish was inconsistent with previously documented environmental preferences, observations were consistent with other aspects of spiny dogfish behavior. All of the measured sharks were female and well within size at maturity for this species (799 mm TL, Nammack *et al.*, 1985). This is consistent with observations from nearshore South Carolina waters, where 91.9% of spiny dogfish captured during shark surveys were females, and 80% of females were mature (Ulrich *et al.*, 2007). Size is inversely correlated with depth in spiny dogfish, with the largest individuals occurring in shallow, nearshore waters (Methratta & Link, 2007), and mature females occur at significantly higher temperatures and lower depths than other demographic groups

(Sagarese *et al.*, 2014). Dell’Apa *et al.*, (2014) observed a greater proportion of females among spiny dogfish captured by gillnet and longline in Massachusetts Bay, an area with a gradually sloping depth profile, than along the eastern shore of Cape Cod, where depth drops rapidly near shore. Spiny dogfish feed primarily on schooling pelagic fishes (Link *et al.*, 2002), and the harvestfish co-occurring with them in Core Sound may represent a potential food source within this estuary.

Little is currently known about spiny dogfish habits within estuarine waters. Spiny dogfish observed during this survey penetrated relatively far into the estuary (6–15 km from the nearest inlet) and were captured close to seagrass habitat areas. Sharks can exert top-down influences that can have far-reaching direct and indirect effects on the ecology of estuarine environments (Heithaus *et al.*, 2012). Determining whether spiny dogfish are ecologically important within North Carolina inshore waters will require further observation.

It is unclear whether these late-occurring spiny dogfish represent a fluke occurrence or previously unrecognized behavior. Spiny dogfish remaining within North Carolina waters into May and June have also been reported by Rulifson *et al.*, (2012) and Schwartz, (2003), but have not been documented by most studies. The NMFS seasonal

trawl surveys only sample North Carolina waters during the early spring and autumn and may not account for spiny dogfish occurring in the area at other times of the year, but migration out of southern waters in spring has also been suggested by gillnet and longline surveys capable of capturing sharks year-round (Thorpe & Beresoff, 2000, Thorpe *et al.*, 2004, Ulrich *et al.*, 2007), as well as acoustic telemetry (Rulifson *et al.*, 2012). Our observations also represent the highest temperatures reported for this species in the southeastern U.S., suggesting that the thermal range for this species may be wider than previously estimated.

Previous studies have shown that spiny dogfish migration and habitat use patterns may be more complex than previously thought (Campana *et al.*, 2007, Rulifson & Moore, 2009, Sulikowski *et al.*, 2010). The presence of a late-migrating or resident population segment near Cape Lookout may have important implications for spiny dogfish fishery management. Future year-round surveys conducted in tandem with telemetry studies focused on late-season individuals may help explain the unusual spiny dogfish behavior in this area.

Data availability

F1000Research: Dataset 1. Date, time, and location of spiny dogfish captures in gillnet gear, with size, sex, and environmental data taken at each station, [10.5256/f1000research.4890.d33066](https://doi.org/10.5256/f1000research.4890.d33066) (Bangley & Rulifson, 2014).

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[Reference Source](#)

Author contributions

CB conceived of the survey, performed field and laboratory duties, and prepared the manuscript. RR contributed to the survey design, provided expertise in spiny dogfish migration patterns, and revised the manuscript.

Competing interests

No competing interests were disclosed.

Grant information

This project was supported by internal funding from the East Carolina University Institute for Coastal Science and Policy.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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Open Peer Review

Current Referee Status:



Version 1

Referee Report 22 September 2014

doi:10.5256/f1000research.5222.r6101



Walter Bublely

Marine Resources Research Institute, South Carolina Department of Natural Resources, Charleston, USA

This is an informative manuscript detailing previously unrecorded maximum water temperatures in which Spiny Dogfish, *Squalus acanthias*, have been encountered during a standardized survey off the coast of North Carolina. I believe though that the authors need to pare back the content in the methods section to that relevant to the main focus of the paper and not overstate the findings as they relate to habitat use within the estuary in the results and discussion sections. The information obtained in this manuscript has importance in documenting previously unknown temperatures but the authors need to understand that this is the importance and not try to interpret minimal data for habitat use.

- Abstract
 - Remove sentence beginning with "Stations where dogfish..." as there are not enough samples to make any sort of inference to estuary or habitat use
- Methods
 - Remove the sentence in the first paragraph beginning with "Sampling locations were chosen..." as this is not relevant to the capture of the Spiny Dogfish.
 - Remove the mention and description of longline gear use in the second paragraph, as the spiny dogfish were all caught using gillnets. While the survey may have utilized both gear types, the Spiny Dogfish focused on in this paper were not caught with longline.
 - Remove all sentences beginning with "Distance from the nearest inlet..." through the remainder of the second paragraph, as this information is not utilized in the analysis.
 - Remove the sentences beginning with "All batoids were identified..." through the end of the paragraph as this is not relevant to the topic of this manuscript.
- Results
 - Remove all mention of other species captured concurrently with Spiny Dogfish.
 - Remove sentences referring to capture site in relation to inlets and seagrass areas. There is not enough information to do analysis in regards to habitat use.
- Discussion
 - Remove the sentence in the fourth paragraph beginning with "Spiny dogfish feed primarily on..." as this is way too speculative based on the catch of a few harvest fish in one net that also caught spiny dogfish.
 - Remove the fourth paragraph as there are too few samples collected to make any inferences about habitat use for this manuscript.

In general, the manuscript provides useful information in regards to new maximum temperatures recorded for spiny dogfish catch, but I want to emphasize that I would caution the authors from making too many speculative assertions based on limited catch at these temperatures.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Competing Interests: No competing interests were disclosed.

Referee Report 10 September 2014

doi:10.5256/f1000research.5222.r5786



Bryan Frazier

South Carolina Department of Natural Resources, Columbia, SC, USA

This research note presents observations on the temporal and spatial distribution of spiny dogfish, *Squalus acanthias*, in the western North Atlantic Ocean. Specifically the note documents presence and environmental data associated with the capture of spiny dogfish in the Back and Core Sound, North Carolina. While spiny dogfish have been documented later in the year (as late as June 1), associated environmental data have not been published. The findings published are of importance as they document the occurrence of mature female spiny dogfish in water temperatures above previously published thermal thresholds. Given recent management actions, these data are important as spiny dogfish may occur in their southern range well outside of periods where they are sampled.

These data are clear and concise and appropriate for publication as a research note. The data are straightforward, and I recommend indexing the article, although the authors should consider the following minor revisions.

Abstract: Report ranges and mean lengths for spiny dogfish captured. Length at maturity should state length at 50% maturity. Significant digits for depth should be reported to the nearest tenth of a meter, this should also be corrected throughout the manuscript.

Methods: Paragraph two, the authors should clarify if total length measurements are natural total length, or stretch total length. If they are estimating maturity based on length this could affect estimates.

Results: Significant digits need to be corrected, again depths should reported to the nearest tenth of a meter, also DO significant digits are reported to the nearest tenth in one instance and the nearest one hundredth in the next.

For capture events it isn't necessary to report additional catch (batoids) as these data do not contribute to the note.

Discussion: If temperature data are available for the Rulifson et al. (2012) reported June encounters of spiny dogfish, these data should be reported.

For Nammack *et al* reference, report what metric of length at maturity this is (median or length at 50% maturity)

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Competing Interests: No competing interests were disclosed.
