Emigration, Immigration, and Internal Movements of Dolphinfish (*Coryphaena hippurus*) in the Bahamas

Movimientos de Emigración, Inmigración, e Internos de Dorado (*Coryphaena hippurus*) en Relación a las Bahamas

Émigration, Immigration et les Mouvements Internes de Coryphène (*Coryphaena hippurus*) aux Bahamas

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ABSTRACT

We used a combination of conventional mark and recapture data (n = 35 recaptures), satellite data (n = 2 transmitters), and surface drifter data (n = 144) to examine dolphinfish (*Coryphaena hippurus*) movements relative to the Bahamian archipelago. Movement speeds and headings were dependent upon the location of tagging. Movements within the Bahamas were to the south within the archipelago in the Tongue of the Ocean (TOTO), Northeast Providence Channel, and Exuma Sound (ES), ranging from 4-23 days at liberty (DAL). However, the majority of dolphinfish released in the TOTO showed little net dispersal (< 1 km) after 5 - 77 DAL with only three movements to locations outside. Emigration from the Bahamas toward the U.S. east coast was not random and occurred most frequently for fish released north of Great Abaco and Eleuthera Islands; fish were recaptured near Cape Canaveral, FL, Charleston, SC, Wilmington and Hatteras Bight, NC, and southeast of George's Bank after 14 - 58 DAL. Fishery-dependent and independent movements, and surface drifters, revealed dolphinfish enter the Bahamas via the Northwest Providence Channel in the west, north of the Little Bahama Bank, northeast of Eleuthera to Long Island, and east from north or south of Grand Turk, Turks and Caicos. Understanding the movements of dolphinfish relative to the Bahamas should facilitate regional stock assessments by revealing regional stock connectivity through in space and time. Importantly, these observations are potentially key for understanding large scale dolphinfish movements and stock structure in the northwest Atlantic and northern Caribbean.

KEY WORDS: Dolphinfish, movements, migrations

INTRODUCTION

The dolphinfish (*Coryphaena hippurus*) is a highly migratory species distributed throughout the world's subtropical and tropical oceans (Oxenford and Hunte 1986). Within the western central Atlantic (WCA), dolphinfish are ranked among the top seven open ocean pelagics landed recreationally, and are targeted increasingly targeted , including the U.S. and Venezuelan pelagic long-line fleets, with catches increasing steadily since 1980 (NMFS 2007). In order to improve regional stock assessments, quantification of regional exchange between fisheries, including inter and intra-regional immigration and emigration, movement routes, and the seasonal timing of arrival of dolphinfish to different areas within the region are needed. A recent study reported dolphinfish could travel the entire U.S. east coast (Florida Keys to Mid-Atlantic Bight) on average in less than two months, exit the U.S. east coast south of Hatteras Bight, North Carolina, and a small but significant proportion of fish tagged off Florida moved to the south within the Florida Straits (Merten et al. in press). While this information described movement patterns within the U.S. Exclusive Economic Zone (EEZ), the results did not reveal inter-regional connectivity patterns between other EEZs including The Bahamas or Caribbean nations.

Here we investigate the movements of dolphinfish relative to The Bahamas utilizing conventional and satellite tagging data from 2004 until 2012. The primary goals are to were to:

i) Examine the emigration, immigration and internal movements of Bahamian dolphinfish,
ii) Relate the movements to potential controlling factors: location, geomorphology, and large-scale current patterns, and
iii) Portray how Bahamian dolphinfish are linked to other regions throughout the WCA.

MATERIALS AND METHODS

Conventional mark and recapture (n = 36) and satellite tagging (n = 2; Hi-rate Xtags, MTI, Inc.) data relative to the Bahamian archipelago were provided by the Dolphinfish Research Program (DRP) from 2004 until 2012. All movements were spatially analyzed using ArcGIS 10.0, and compared to surface drifter tracks (n = 144) obtained from the National Oceanographic and Atmospheric Administration's Atlantic Oceanographic and Meterological Laboratory (NOAA AMOL).

RESULTS

Dolphinfish (24 - 36 cm FL) movements available for The Bahamas ranged between 2 - 318 DAL (days at liberty). Movements within The Bahamas constituted 57% (n = 20) of all recaptures within the region (Figure 1). Of these, 85% (n = 17) were recaptured in the Tongue of the Ocean (TOTO), of which 12 were marked and recaptured less than a kilometer from the north, central, or south AUTEC buoys (Figures 1a,b,c). Movements from The Bahamas to the U.S east coast constituted 23% (n = 8) of the available data (Figure 1b), and movements to The Bahamas constituted the remaining 20% (n = 7) (Figure 1c). Within the Straits of Florida, there were 91 drifters that traveled to the north from 2002 until 2011. Of these, 12.0% (n = 11) traveled to The Bahamas (range: 30 - 1136 d; 397.81 ± 320.23 d). From east of The Bahamas, 25 drifters traveled towards The Bahamas north of Grand Turk and 11 from south.

DISCUSSION

Movements relative to The Bahamas only constituted 9% of all recaptures recorded in the WCA since 2002, yet identified specific movement patterns and corridors, and suggested aspects of current flow that may influence these. The high residency times (22.50 ± 21.15 d) for dolphinfish moving within the central Bahamas is likely a result of island geomorphology and bathymetry, and the variable movements of surface currents within the archipelago (Colin 1995). Immigration movements to the Bahamas support the region as a model for how dolphinfish may disperse around the WCA and Caribbean Sea. Surface drifters provide visual evidence of specific paths and time frames that can be realistically compared to and support dolphinfish movements. Observed and suggested dolphinfish migration patterns indicate significant regional linkage confirming the resource as a shared commodity among 32 jurisdictions in the WCA including the Caribbean Sea. The shared nature of this species requires a regional approach to resource management.

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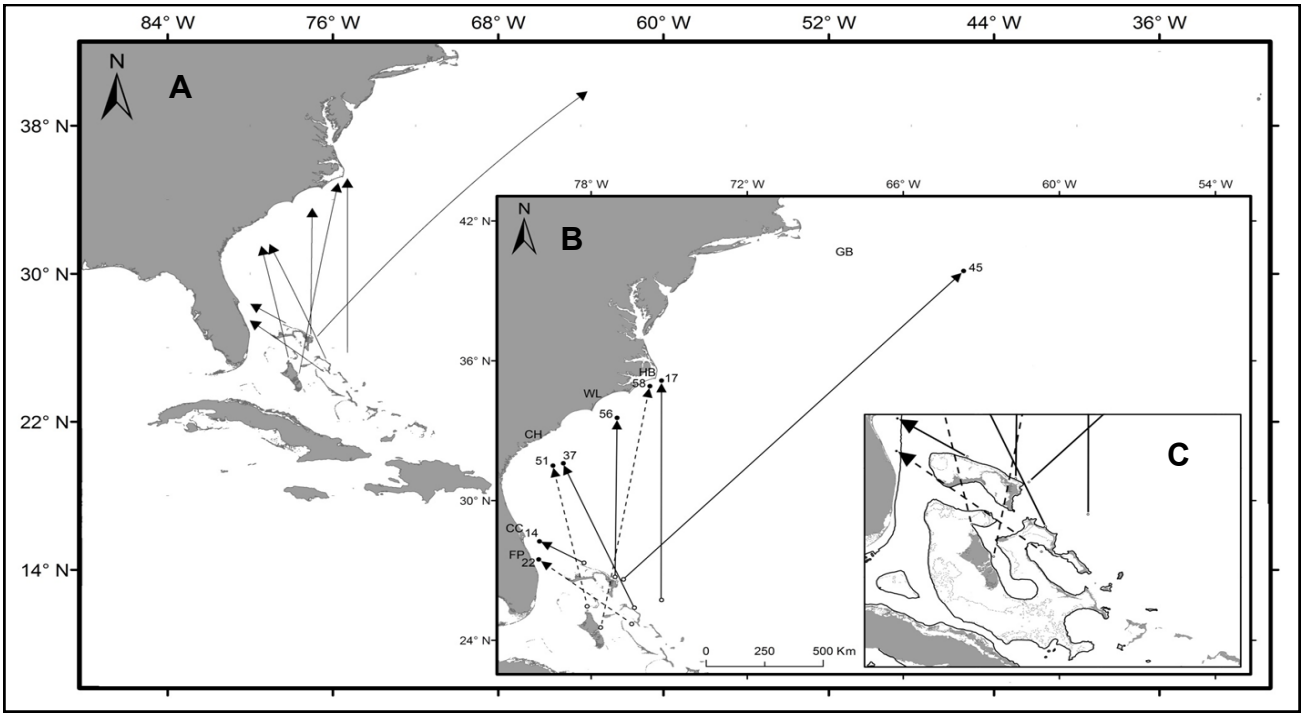

Figure 1. All fish released along the Bahamian escarpment (solid arrow) dispersed to the U.S. east coast versus only 10% (n = 3) tagged within the Central Bahamas (dashed arrow). Numbers indicate days at liberty. FP: Fort Pierce, FL; CC: Cape Canaveral, FL; CH: Charleston, SC; WL: Wilmington, NC; HB: Hatteras Bight, NC.