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Coastal spawning by winter flounder and a reassessment of Essential Fish Habitat in the Gulf of Maine

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ABSTRACT

With the exception of fish in the Georges Bank stock, it is widely believed that adult winter flounder (*Pseudopleuronectes americanus*) in US waters move inshore into estuaries and coastal embayments to spawn. However, there have been many indications that this paradigm may not apply to populations in the Gulf of Maine. To understand winter flounder spawning movements and habitat use more clearly, 40 ripe, pre-spawning adult fish were tagged with acoustic transmitters offshore and tracked in 2009 in the western Gulf of Maine. In addition, winter flounder collected by bottom trawl in the offshore study area were tagged with conventional tags, examined to quantify how the reproductive status of the general population changed over time, and released.

Peak spawning of winter flounder in Ipswich Bay occurred in late April to early May. Only six fish (16%) were detected entering estuaries between the end of April and August, indicating that the majority of the tagged fish did not spawn in estuaries but remained in deeper, coastal waters. Surveys made within a New Hampshire estuary when one tagged female was present (May–June) revealed that all captured adults had already spawned and were actively feeding.

As of May 2012, conventional tagging returns (395 fish tagged, 5% return rate) show both long and short movements. Fish have been recaptured approximately 0.6–57.2 km from their tagging sites in depths of 2–75 m. Days at liberty range from 33 to 453 days, with an average of 171 days. Recaptured fish in the study area in the subsequent year adds to the evidence that winter flounder may display spawning site fidelity. However, relocations of fish well outside of Ipswich Bay suggest mixing of populations of winter flounder is likely. Based on the results of this study, consideration should be given to extending the Essential Fish Habitat for Gulf of Maine winter flounder to include near-shore coastal waters during the spawning season.

1. Introduction

Winter flounder, *Pseudopleuronectes americanus*, is a commercially and recreationally important demersal flatfish found along the northwestern Atlantic coast; ranging from Georgia, USA to Labrador, Canada (Scott and Scott, 1988); it is most common from Nova Scotia to New Jersey (Perlmutter, 1947). It is a long-lived flatfish and can reach a maximum age of 15 years and a maximum length of 58 cm (Fields, 1988). The biology and ecology of winter flounder have been well studied (see reviews by Klein-MacPhee, 2002; Able and Fahay, 1998; Pereira et al., 1999). In the US, winter flounder are federally managed as three stocks: the Gulf of Maine (GOM) stock, Georges Bank (GB) stock, and Southern New England/Mid-Atlantic (SNE/MA) stock (Pereira et al., 1999). As with most groundfish species, catches have declined precipitously in recent years. Total commercial landings of all three stocks in 1981 were about 17,575 mt. Since then, catches have declined dramatically to 1858 mt in 2010 (NEFSC, 2011).

The general decline in fisheries resources, including those for winter flounder, prompted regulators to broaden their view of management beyond simply regulating fishing effort. In particular, there is a recognition that "the long term viability of living marine resources depends on protection of their habitat" (NMFS, 2007). As a result, Essential Fish Habitat (EFH), defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" was incorporated into fisheries management plans. Consequently, the Sustainable Fisheries Act, signed in 1996, required the eight regional fishery management councils to: (1) describe and identify EFH in their regions; (2) take actions

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that conserve and enhance the EFH; and (3) minimize the adverse effect of fishing on EFH as they develop their fishery management plans. Given this federal requirement, the National Marine Fisheries Service has prepared a series of Essential Fish Habitat Resource Documents, including one for winter flounder authored by Pereira et al. (1999) and updated in 2004 (Pereira, 2004).

The spawning season for winter flounder typically lasts for two to three months in the winter and spring, depending on location (DeCelles and Cadrin, 2011). In the SNE/MA stock, reproductively isolated adult populations generally undergo onshore migrations in early spring into specific estuaries or coastal embayments where spawning occurs (Lobell, 1939; Perlmutter, 1947; Saila, 1961b) and the young-of-the-year remain for their first two years before moving offshore (Pereira et al., 1999). As such, these estuaries and inshore areas have been recognized as EFH for winter flounder (Saila, 1961a). While this paradigm has been well documented for SNE/MA populations through tagging studies (Perlmutter, 1947; Saila, 1961b; Howe and Coates, 1975; Phelan, 1992), this may not be the case for the GOM populations of winter flounder. Indeed, the GOM stock appears to have a fundamentally different spawning habitat from the more well-studied SNE/MA stock.

Few studies have examined adult winter flounder movements in the GOM, and most of these were conducted over 30 years ago using conventional tagging techniques (Perlmutter, 1947; McCracken, 1963; Howe and Coates, 1975). Both McCracken (1963) and Howe and Coates (1975) noted different winter flounder seasonal movements north and south of Cape Cod. South of Cape Cod, the SNE/MA stock migrates inshore in winter or spring to spawn in the estuaries, and then moves back offshore, identical to what is reported in Pereira et al. (1999). North of Cape Cod, in the GOM, fish remain offshore during the winter and undergo limited seasonal migrations. None of these earlier studies addressed spawning locations, which have not been documented for winter flounder north of Cape Cod. There are, however, several lines of evidence that winter flounder do not spawn in the estuaries along the GOM. These include:

(1) Trawl surveys conducted just outside of the Hampton-Seabrook Estuary (HSE) along the NH/MA coast by Normandeau Associates Inc. (NAI) for >20 years have caught few adult winter flounder, and even fewer in spawning condition. In 2006 for example, only five adults were caught in the spring, and four of these had already spawned (NAI, 2006). The one ripe female was tagged with an acoustic transmitter and released by Walsh and Howell (2007), but it never entered the estuary.
(2) Few adults have been found in either the HSE (Fairchild et al., 2008) or Great Bay Estuary, NH (Armstrong, 1997). These findings suggest that the vast majority of adults and spawning fish are somewhere other than the estuaries associated with the western GOM.
(3) Commercial fishermen report, and UNH scientists have documented, that spawning winter flounder are found in offshore locations. From 1995 to 2012, ripe and running ripe winter flounder have been caught each March in the southern part of Jeffreys Ledge for related research projects (Fairchild, unpublished data). Contrary to what is reported in the scientific literature, these commercial fishermen have found that GOM winter flounder are spawning in deeper waters (20–30 m) offshore. These aggregations of fish are found on gravel and pea-stone, and seldom on finer substrates. For instance, fishermen's observations indicate adult winter flounder start appearing around southern Jeffreys Ledge in 50 m deep waters in December. They gradually become more abundant and move into shallower waters (20–30 m) through March.
(4) The GOM Industry Based Survey indicates that the largest aggregations of adult winter flounder caught during the pre-spawning months are not found near the mouths of estuaries, but rather in coastal locations further offshore (Hoffman et al., 2006; Fig. 1).
(5) DeCelles and Cadrin (2010) acoustically tracked 72 adult winter flounder during 2007 and 2009 in Plymouth Bay and Estuary, in MA north of Cape Cod, and found that the fish displayed two movement patterns during spawning season. A small group migrated into the estuary, but the majority of tagged winter flounder remained in the coastal bay waters.

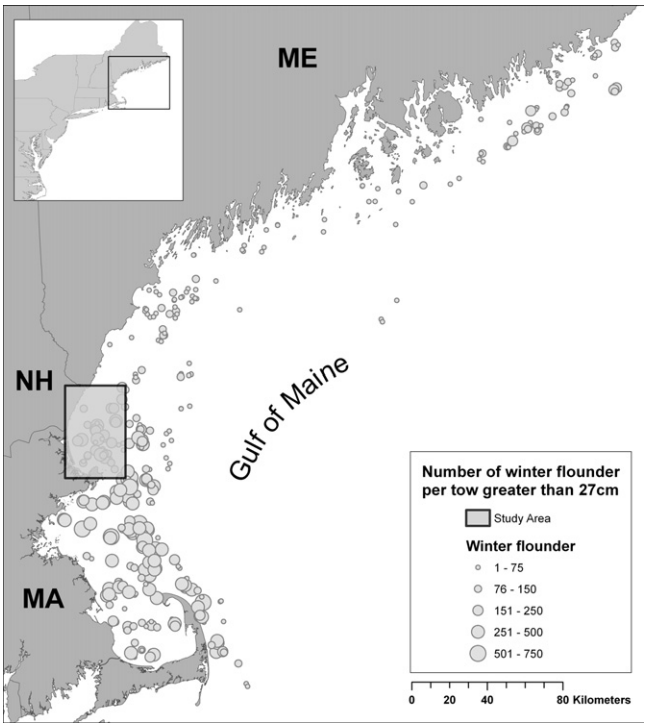

Fig. 1. Relative abundance and location of adult (>27 cm TL) winter flounder captured per 30-min tow, March through June 2004–2007 in the GOM Industry Based Survey. Tows were conducted from 18 to 128 m from the Canadian/US border south to 42°30′N. The polygon shows the Ipswich Bay study area in the current study. Data from Hoffman et al., 2006.

The overall goal of this study was to determine if winter flounder in the western GOM, particularly in Ipswich Bay, are spawning offshore rather than in estuaries by: (1) mapping the spatial distribution and movements of adult winter flounder during the spawning season using telemetry; (2) sampling the adult winter flounder from March to June to quantify how the reproductive status of these fish changes over time in an offshore study area; and (3) determining how the spatial distribution of spawning fish relates to attributes of the spawning habitat.

2. Materials and methods

2.1. Study area

Winter flounder were studied in Ipswich Bay, in the western Gulf of Maine (Fig. 2). The bay is contained by the Isles of Shoals to the north, Cape Ann to the south, and Jeffreys Ledge to the east. Despite its name, Ipswich Bay is entirely oceanic, and does not include the estuaries associated with it. The 35 km^2 offshore study area, ranging from 40 to 60 m deep, was selected for several reasons. First, it was one of several places identified by fishermen as an area where adult pre-spawning winter flounder are abundant. Second, it has a variety of substrate types, varying from sandy mud to gravel to exposed ledge, most of which has been reported as suitable for