Available online at www.sciencedirect.com
ScienceDirect
Fisheries Research 90 (2008) 296–304
FISHERIES RESEARCH
www.elsevier.com/locate/fishres

Short communication

Habitat variability in young-of-the-year winter flounder, *Pseudopleuronectes americanus*, in Maine estuaries

Mark A. Lazzari *

Maine Department of Marine Resources, P.O. Box 8, West Boothbay Harbor, ME 04575, USA

Received 11 May 2007; received in revised form 9 November 2007; accepted 12 November 2007

Abstract

The Magnuson-Stevens Fishery Conservation and Management Act defines essential fish habitat (EFH) as "the waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity" and the protection of nursery areas has become a key element in US Federal fisheries management. Distribution and abundance by habitat for age-0, young-of-the-year (YOY) winter flounder, *Pseudopleuronectes americanus*, were compared for 28 Maine estuaries to help define essential fish habitat for this life history stage. The Maine coast was divided into three broad geographic zones based upon geological features and sampled over 5 consecutive years; during April–November of 2000 in the Mid-coast, in 2001 and 2002 along the Southwest coast and in 2003 and 2004 along the Eastern Maine coast. One beam trawl (2.0 m width, 3 mm mesh) sample was collected in one to four habitats in estuaries: eelgrass (*Zostera marina*), kelp (*Laminaria longicruris*), drift algae (*Phyllophora* sp.) and unvegetated sand/mud. Fish were sampled every 2 weeks, April–November 2000–2004. Abundance of YOY winter flounder was greatest in Mid-coast estuaries between Casco and Penobscot Bays and was significantly lower in Southwest and Eastern estuaries. Abundance was similar across all four habitats in Mid-coast estuaries in 2000. In the other years, YOY were found in higher abundance in eelgrass relative to other habitats. A logistic regression model based on nearshore habitat characteristics was developed to predict the distribution of this species along the three broad geological zones of the Maine coast with the physical and biological variables most important in discriminating between habitats with and without individual fish identified. This logistic regression model correctly classified winter flounder 72.4% of the time based on the year, zone, the physical habitat variables (temperature, salinity, depth) and the presence–absence of submerged aquatic vegetation (eelgrass, kelp or algae). These results indicate that the type of habitat most important to YOY winter flounder varies among estuaries and EFH for this species and life stage must be defined with care. Published by Elsevier B.V.

Keywords: Juvenile fishes; Submerged aquatic vegetation; Recruitment

1. Introduction

Habitat quality for young-of-the-year (YOY) fishes is difficult to determine because the relationships between fishes and their habitat are complex and dynamic (Gibson, 1994; Able, 1999), however, this understanding is necessary to define nursery habitat quality (Beck et al., 2001). The protection of nursery areas considered to be essential fish habitat (EFH) has become a key element in US Federal fisheries management through amendments to the 1996 Magnuson-Stevens Fishery Conservation and Management Act (Rosenberg et al., 2000) with EFH is defined as "the waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity". A nursery for fishes has been identified on four comparative factors (1) density, (2) growth, (3) survival and (4) movement to adult habitat, i.e., contribution to the adult population (Beck et al., 2001). Habitat features that characterize fish distribution and abundance have become a common focus of research as populations of recreational and commercial species decline since fishery managers must understand the environmental characteristics that control habitat and fish populations.

Information on the nearshore distribution of YOY winter flounder, *Pseudopleuronectes americanus*, is critical due to the importance of shallow inshore habitats as nurseries and feeding grounds, the environmental variability of these areas, and the potential for anthropogenic impact (Warfel and Merrimen, 1944; Pearcy, 1962; MacDonald et al., 1984). Winter flounder are considered to be estuarine-dependent during their early life history (Able and Fahay, 1998) and are of economic importance in the northeastern US and Canada (Bigelow and Schroeder,

* Tel.: +1 207 633 9569; fax: +1 207 633 9579.
E-mail address: mark.lazzari@maine.gov.

0165-7836/$ – see front matter. Published by Elsevier B.V.
doi:10.1016/j.fishres.2007.11.020

1953; Grosslien and Azarovitz, 1982; Scott and Scott, 1988). The YOY occur in estuaries with variable anthropogenic influence (Able and Fahay, 1998; Able et al., 1998; Duffy-Anderson and Able, 1999; Howell et al., 1999) and from a wide variety of habitats (Able and Fahay, 1998). Many previous studies of fish species have described distribution and abundance in a single estuarine system (Pearcy, 1962; Heck and Orth, 1980; Heck et al., 1989; Sogard and Able, 1991; Lazzari and Tupper, 2002), however, recent investigations over larger spatial scales have found both intra-estuarine and inter-estuarine differences in fish abundance within seagrasses and bare sand habitats (Ferrell and Bell, 1991; Gray et al., 1996; Goldberg et al., 2002; Lazzari et al., 2003). Habitat usage by YOY winter flounder in the literature exhibits spatial and temporal variability that has been related to fluctuations in environmental conditions or sampling design. Comparative observations in multiple estuaries are necessary to determine if there are distinct patterns of habitat use.

The primary objective of this study was to determine if YOY winter flounder within and among Maine estuaries are associated with specific habitats to better define EFH. This study analyzes the YOY component of the winter flounder data that was reported in Lazzari and Stone (2006). Logistic regression models based on nearshore habitat characteristics were developed to predict the distribution of this species along the Maine coast. Relationships were determined among habitat descriptors by year, coastal zone, temperature, salinity, depth, the occurrence of submerged aquatic vegetation (SAV) and the presence of winter flounder.

2. Materials studied

2.1. Study descriptions

The Maine coast was divided into three broad geographic zones based estuarine geological characteristics for sampling over the 5 years of this study. Twenty eight estuarine locations with eelgrass, *Zostera marina*, kelp, *Laminaria longicruris* and/or algae, *Phyllophora* sp. located along the entire Maine coast from the Piscataqua River (70°43′,43°04′) to Cobscook Bay (67°10′,44°50′) were sampled in this study (Fig. 1). Generally, Maine's coastline has been divided into three geological zones based on the bedrock structure, and resulting coastal morphology (Johnson, 1925; Kelley et al., 1986; Shipp et al., 1989) with differences in sediment supply, structure, wave climate, tidal range and barrier positions between zones an important influence on the structure of estuarine and nearshore systems. The Southwest zone of Maine's coastline, from Kittery to Cape Elizabeth, is characterized by arc-shaped embayments with intervening rock headlands and sediment derives from wave reworking of offshore deposits of sand. The Mid-coast (Casco to Penobscot Bays) is characterized by alternating, northeasterly aligned peninsulas and deep, narrow, strike-aligned estuaries (Belknap et al., 1986). These two regions are characterized by low relief, moderate *Spartina alterniflora* salt marsh, expansive areas of eelgrass and adjacent mudflat and sandy areas. Fresh water input from most rivers with the exception of the Kennebec River, is moderate and surface salinities are high (>25 PSU) except immediately following rainfall. Tides

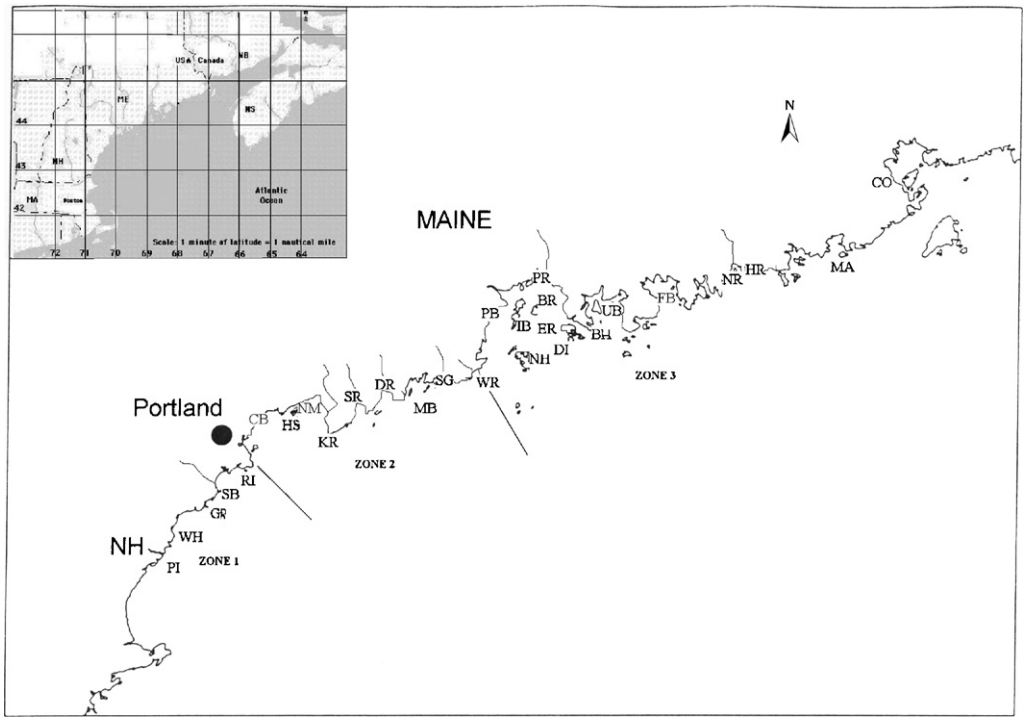

Fig. 1. Map of Maine coast showing the estuaries sampled with 2.0 m beam trawl from April 2000 through November 2004. The locations in each zone are listed in Table 1. Estuarine sampling occurred in the Mid-coast (Zone 2) in 2000, along the Southwest coast (Zone 1) in 2001 and 2002 and along the East coast (Zone 3) in 2003–2004. Inset shows the location of the Maine coast.