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Using smooth sheets to describe groundfish habitat in Alaskan waters, with specific application to two flatfishes

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ABSTRACT

In this analysis we demonstrate how preferred fish habitat can be predicted and mapped for juveniles of two Alaskan groundfish species – Pacific halibut (*Hippoglossus stenolepis*) and flathead sole (*Hippoglossoides elassodon*) – at five sites (Kiliuda Bay, Izhut Bay, Port Dick, Aialik Bay, and the Barren Islands) in the central Gulf of Alaska. The method involves using geographic information system (GIS) software to extract appropriate information from National Ocean Service (NOS) smooth sheets that are available from NGDC (the National Geophysical Data Center). These smooth sheets are highly detailed charts that include more soundings, substrates, shoreline and feature information than the more commonly-known navigational charts. By bringing the information from smooth sheets into a GIS, a variety of surfaces, such as depth, slope, rugosity and mean grain size were interpolated into raster surfaces. Other measurements such as site openness, shoreline length, proportion of bay that is near shore, areas of rocky reefs and kelp beds, water volumes, surface areas and vertical cross-sections were also made in order to quantify differences between the study sites. Proper GIS processing also allows linking the smooth sheets to other data sets, such as orthographic satellite photographs, topographic maps and precipitation estimates from which watersheds and runoff can be derived. This same methodology can be applied to larger areas, taking advantage of these free data sets to describe predicted groundfish essential fish habitat (EFH) in Alaskan waters.

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1. Introduction

The National Marine Fisheries Service (NMFS) is required to delineate essential fish habitats (EFH, defined as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity”, U.S. Congress, 2006) for commercially managed species, along with the habitats of commercially impacted bycatch species such as corals and sponges (NMFS, 2002; U.S. Congress, 2006), but the most appropriate method for fulfilling this mandate has not been identified. In the Gulf of Alaska (GOA), defining EFH is especially daunting due to the amount of detail required for describing the niches of different life stages of commercially managed species and the vast NMFS management area (320,000 km^2; von Szalay et al., 2010). High-resolution seafloor survey tools such as multibeam sonar, sidescan sonar, LIDAR and laser line scan, combined with seafloor groundtruthing methods such as underwater video and sediment sampling, can be integrated to provide the necessary details for these analyses. However, these tools are expensive and limited in availability, with intensive data-collection and processing periods. It would take many years, or perhaps many decades, to complete maps for the GOA NMFS management area, which are only incompletely described by small-scale National Ocean Service (NOS) navigational charts.

In addition to collecting fish habitat data, these data also need to be classified for use. Brown et al. (2011) provides a thorough review which contrasts two general classification methods for this type of data: unsupervised and supervised. The unsupervised classification system, such as that proposed by Greene et al. (1999, 2008), where habitat divisions are based on geological divisions, has been the standard used in the eastern Pacific region (see Greene et al., 2011; O'Connell et al., 2007). Supervised methods, where the seafloor mapping information is viewed and organized through the known preferences of an organism, is much less common, in part, because the niche of an organism needs to be clearly defined (Brown et al., 2011).

It is hypothesized that demersally-oriented, juvenile fishes (here termed groundfishes) in the GOA are transported as larvae from offshore, deep water spawning areas into shallow, onshore waters (Bailey and Picquelle, 2002), where successful settlement as juveniles onto appropriate substrates can influence year-class strength. Little is known about this larval process. Staaterman et al. (2012) showed that oriented-swimming of larvae toward preferred habitat, perhaps in response to acoustic cues, may be

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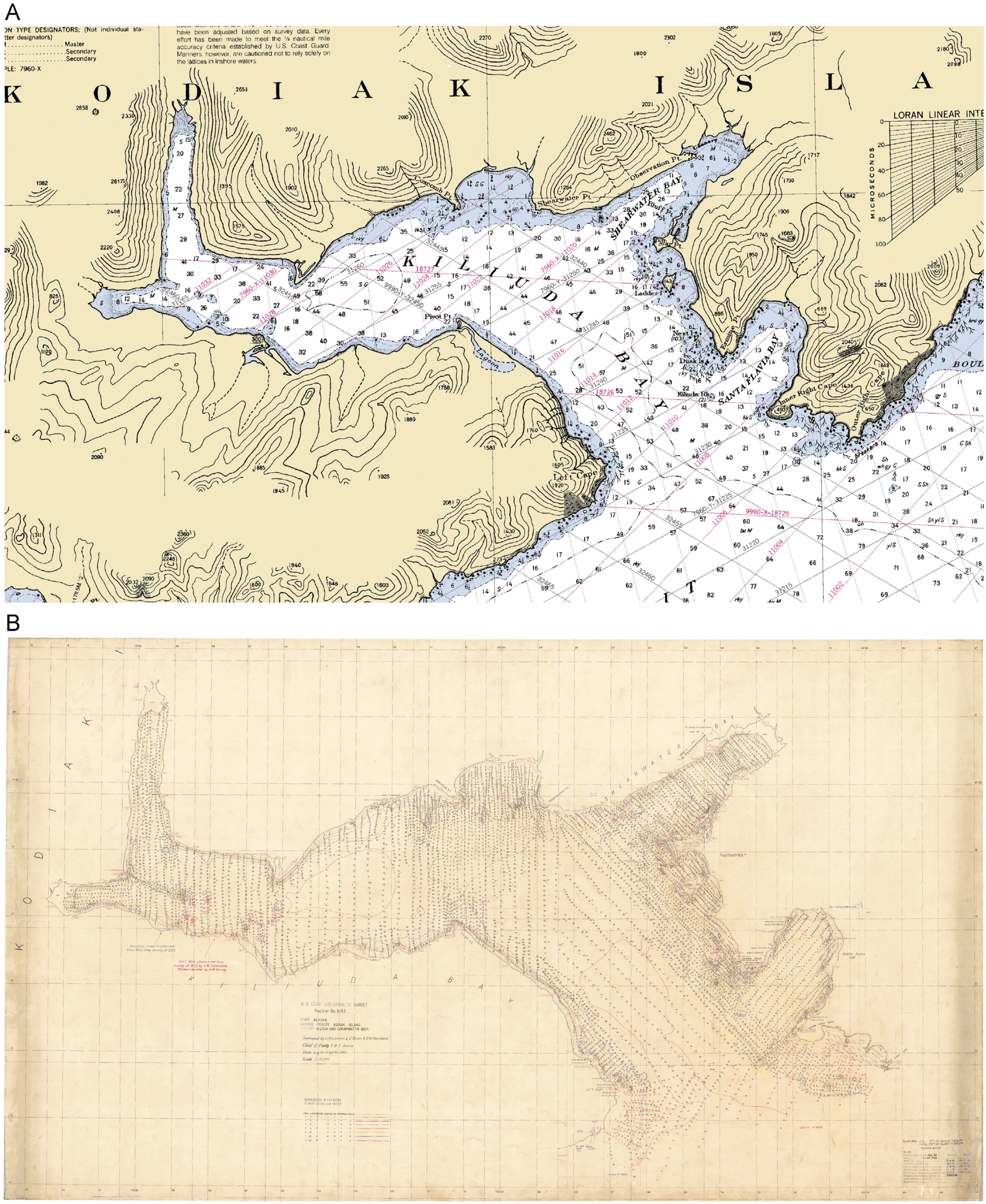

Fig. 1. Detail of Kiliuda Bay, Kodiak Island from (A) National Ocean Service (NOS) navigation chart 16592 (Scale 1:80,728) depicting scarce soundings and substrates. (B) NOS smooth sheet H05152 (Scale 1:20,000) has roughly 30 times as many soundings and 17 times as many substrates for the same location.