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Using a remote drift underwater video (DUV) to examine dredge impacts on demersal fishes and benthic habitat complexity in Foveaux Strait, Southern New Zealand

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ABSTRACT

Foveaux Strait is a shallow body of water at the southern tip of New Zealand. It supports nationally significant dredge oyster *Ostrea chilensis* and blue cod *Parapercis colias* fisheries. Fish counts and benthic habitat descriptions from drift underwater video (DUV) transects conducted in two seasons over an area of recovering biogenic reef and an adjacent recently dredged area are presented. Over all, seven demersal fish species (5.10 per 100 m^2, 75% *P. colias*) were recorded on the recovering area surveyed, whereas only three species (0.47 per 100 m^2, 91% spiky dogfish *Squalus acanthias*) were recorded on the recently dredged area. There were few seasonal differences except for *S. acanthias*. Descriptions of benthic habitat derived from video stills showed topographic complexity was greater on the recovering area; general epifauna cover, sponge cover and macro-algal cover were also greater on the recovering area, but with seasonal interactions. In contrast, the numbers of tunicates and ophiuroids were higher on the dredged area. Sponge cover (absent from the dredged area) was also correlated with the abundance of leather jackets *Parika scaber* and scarlet wrasse *Pseudolabrus miles* as well as all color phases of *P. colias*. Topographic complexity, general epifauna cover, and macro-algae cover were also positively correlated with the abundance of adult *P. colias* and *P. scaber*. The drifting video methodology was able to estimate densities of demersal fish and make broad-brush measures of benthic habitat capable of demonstrating the importance of benthic habitat complexity to demersal fish in Foveaux Strait. The potential mitigation of reduced benthic habitat complexity from oyster fishing is then discussed.

1. Introduction

Many studies have observed a relationship between various characteristics of benthic habitat structure and the abundance and diversity of demersal fish assemblages (Jones and Syms, 1998). Habitat can directly regulate the number of fish if the availability of essential resources, such as food or refuges, influences rates of recruitment or mortality (Jones, 1988a; Johnson, 2006). The distributions of fishes can also be modified through movements via the selection of preferred habitats (Jones, 1991). However, fish-habitat linkages are poorly understood for most species, especially in temperate areas.

Numerous studies have described depth-related patterns in fish abundance, and both biotic and abiotic habitats may vary with depth (e.g. Ruitton et al., 2000; Stoner et al., 2007). However, fish may also respond to specific characteristics of habitat structure, including both lithic elements of the substrata, such as the sediment type/form (Stoner et al., 2007), proportion of sand, rock, crevices (Jones, 1988a); or to biological elements of the epibenthos, such as macro-algae (Choat and Ayling, 1987), worm tubes (Stocksmith et al., 2006; Stoner et al., 2007) and corals (listed in Jones and Syms, 1998). Both biological and lithic elements of benthic habitat may also contribute to measures of topographic complexity (rugosity), which numerous studies have found to be both positively and negatively correlated with demersal fish abundance (listed in Jones, 1988b; Friedlander et al., 2003).

Both biological and lithic habitat features may be susceptible to degradation such as sedimentation in estuaries (Peterson et al., 2000), or loss of coral habitat from both bleaching (Booth and Beretta, 2002) and mining (Dawson Shepherd et al., 1992). Degradation of habitat features may potentially reduce the abundance of demersal fish. However, the best-known source of anthropogenic degradation of seabed habitat and associated benthic communities is mobile bottom fishing gear (Dayton et al., 1995; Jennings and Kaiser, 1998; Thrush and Dayton, 2002). Of the mobile fishing methods, dredging for shellfish is the most non-selective and damaging to benthic organisms and substrate (Currie and Parry, 1994; Collie et

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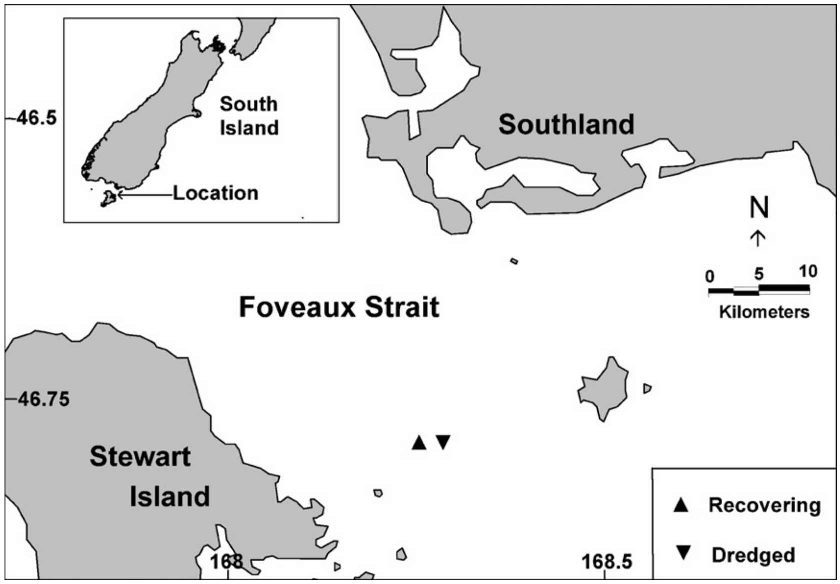

Fig. 1. Location of dredged and recovering sampled areas in Foveaux Strait where DUV transects were done in two seasons. Insert shows the South Island of New Zealand.

al., 2000a,b; Eleftheriou, 2000). The main and most apparent effects of continued dredging are the reduced abundance of species and the alteration of benthic community structure (e.g. Kaiser, 2000, 2003). Several studies have further illustrated the impact of benthic habitat modification by bottom fishing gear on populations of demersal fish, such as the reduced survival of juvenile Atlantic cod Gadus morhua in aquarium (Lindholm et al., 1999) or the lowered abundance and diversity of west Florida reef fish demonstrated by Koenig et al. (2000).

Fishers have dredged Foveaux Strait (Fig. 1) for oysters *Ostrea chilensis* for over 130 years. As a consequence, there is little, if any, seafloor in Foveaux Strait that remains undisturbed (Cranfield et al., 1999). The seafloor of Foveaux Strait possibly once supported extensive bryozoa/mollusc dominated epifaunal reefs, formed mainly by the bryozoan Cinctipora elegans (Fleming, 1952). Those biogenic reefs were targeted by fishers for their dense oyster populations, and initial dredging of an epifaunal reef seems to quickly reduce species diversity (Cranfield et al., 1999). Recently, however, concerns have been raised about the damage caused by long-term oyster dredging throughout Foveaux Strait. There is also interest in understanding the wider ecological value of the original benthic habitat of Foveaux Strait (Cranfield et al., 1999).

Co-existing with the Foveaux Strait oyster fishery is one of New Zealand's largest blue cod *Parapercis colias* fisheries (Langley, 2005; Ministry of and Fisheries, 2008). Endemic to New Zealand, this relatively common fish is not a true cod, but a weever (Family Pinguipedidae) which supports nationally significant recreational (~1500 t) and commercial fisheries (~2500 t) (Ministry of and Fisheries, 2008). Although distributed from the shore to the shelf edge of New Zealand's entire coastline, *P. colias* is most abundant around the South Island (Anderson et al., 1998) (Fig. 1). Found on reef edges, biogenic structures, shingle, gravel or sand close to rocky outcrops, *P. colias* are territorial (Mutch, 1983), short ranging (Cole et al., 2000; Carbines, 2004) benthic carnivores (Jiang and Carbines, 2002). In previous studies, the effect of habitat modification from oyster dredging in Foveaux Strait was examined in the diet (Jiang and Carbines, 2002) and growth (Carbines et al., 2004) of *P. colias*. Fish from areas of relatively complex recovering biogenic habitat had a more diverse diet than those taken from dredged areas of low habitat complexity. Population growth models also differed between some areas of contrasting habitat complexity, with the youngest *P. colias* sampled (age 3) on average 20% larger in complex recovering areas. Catch-per-unit-effort, as a proxy for *P. colias* abundance, was also almost five times higher in recovering complex habitat than in an adjacent recently dredged area (Carbines et al., 2004).

To date, direct and quantifiable observations of *P. colias* have only been possible through diver transects (Mutch, 1983; Cole et al., 2006), but this method is not suitable to survey the relatively deep (>30 m) and extremely tidal waters of Foveaux Strait. Video transect methods such as a camera sled (Spencer et al., 2005; Stocksmith et al., 2006; Stoner et al., 2007; Rosenkranz et al., 2008) are likely to struggle in areas of rugosity and will most likely attract mobile fish like *P. colias* through contact with the seabed. Other methods such as baited video (Willis et al., 2000) might give relative estimates of abundance, but it is uncertain over what distance bait might attract an individual. The DUV allows habitat and fish relationships to be more closely linked, the major advantage being that it is possible to make direct observations of the habitat seen underneath a fish. To quantitatively demonstrate the impact of oyster dredging an alternative method was required to directly assess demersal fishes and benthic habitat in Foveaux Strait. A drift underwater video (DUV) system was developed to utilize the strong tidal flows and compare areas of Foveaux Strait.

DUV transects were conducted in two adjacent areas of Foveaux Strait with contrasting oyster fishing history. Fish counts and measures of habitat features taken from video were compared between these areas in two seasons to determine if the DUV could be used as a tool for documenting the impact of habitat change on demersal fish populations in Foveaux Strait.

2. Methods and materials

2.1. Description of Foveaux Strait

Foveaux Strait is a shallow body of water at the southern tip of New Zealand (Fig. 1). It separates the South Island and Stewart Island, and is about 80 km long and 23–53 km wide. The seafloor is principally alluvial gravel, locally overlaid with sand; it slopes gently from 50 m deep in the west to 20 m in the east. Islands and reefs extend northwards across Foveaux Strait's shallow eastern entrance, northeast of Stewart Island. As Foveaux Strait separates the Tasman Sea from the South Pacific Ocean, it is subject to extremely strong tidal flows. It is also subject to the influence of