Fisheries Research 99 (2009) 83–89

Contents lists available at ScienceDirect

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres

An analysis of the impacts of long-term climate variability on the commercial barramundi (*Lates calcarifer*) fishery of north-east Queensland, Australia

Jacqueline Balston[a,b,*]

[a] *Queensland Climate Change Centre of Excellence, P.O. Box 937, Cairns, QLD 4870, Australia*
[b] *James Cook University, School of Earth and Environmental Sciences, P.O. Box 6811, Cairns, QLD 4870, Australia*

ARTICLE INFO

Article history:
Received 20 February 2009
Received in revised form 1 May 2009
Accepted 4 May 2009

Keywords:
Decadal
Fisheries
Barramundi
Management
Sustainable

ABSTRACT

Significant relationships between long-term climate indices such as the Interdecadal Pacific Oscillation and fisheries catch have been shown for a number of oceanic species such as herring, cod, sardine and anchovy that are dependant on oceanic upwelling for food chain nutrients. However, there are no similar studies between long-term climate cycles and estuarine species. In this study, barramundi (*Lates calcarifer*) landings as recorded by the Fish Board across north-east Queensland were found to be significantly correlated with an index of the Quasi-biennial Oscillation at lags of three to four years and the latitude of the sub-tropical ridge one to four years prior to catch. These results indicate that long-term climate cycles may affect the early life cycle stages of the species by influencing climate variables such as rainfall, stream flow and temperature and hence nutrient availability and nursery habitat suitability. Significant relationships between long-term climate cycles and barramundi catch may provide an opportunity to predict catch a number of years in advance.

© 2009 Published by Elsevier B.V.

1. Introduction

Analyses of long-term (intra- and inter-decadal) climate variations and the concurrent fluctuations in fisheries populations as measured by catch, can identify causal links and so provide an opportunity to forecast catch a number of years in advance. Decadal climate oscillations in the Pacific Ocean such as the Interdecadal Pacific Oscillation (IPO) and Pacific Interdecadal Oscillation (PDO), have been shown to have large-scale impacts on some of the pelagic fisheries of the world including the Norwegian and Icelandic herring, Norwegian cod and Peruvian anchovy (e.g. Klyashtorin, 1998). In fact, it is now proposed that the whole ecosystem balance of the Pacific Basin oscillates between an "anchovy regime" and a "sardine regime" every 50 years or so in response to these multi-decadal climate cycles, a phenomena that appears to have occurred for hundreds of years (Chavez et al., 2003; Sandweiss et al., 2004). Although a number of similar relationships have been found for a variety of pelagic fisheries, few studies have linked inshore, and more particularly, catadromous and anadromous fisheries with long-term climate cycles.

One study of variations in the catch of anadromous salmon (Chinook, Sockeye and Pink salmon) in Oregon, California, Alaska and Washington found a significant relationship with the IPO (Mantua et al., 1997). Changes in coastal sea and continental air surface temperatures, air pressure, rainfall and stream flow altered mean salmon catch by −64.4% to +251%. These changes in catch may not be driven by direct changes in the climate, however, but by more complex interactions. A study of the survival of juvenile Coho salmon (*Oncorhynchus kisutch*) in Oregon and Washington, for example, showed that rather than environmental conditions directly affecting the food supply, reduced survival was due to higher levels of predation when earlier decreases in primary production in the marine environment followed a reduction in upwelling (Fisher and Pearcy, 1988).

No studies that examine the link between long-term climate cycles and catadromous or anadromous species have been undertaken for fisheries in the Australasian region. A study of barramundi catch data in the Fitzroy River area of central Queensland noted a 15–20 year cycle that the authors propose was driven by summer rainfall and flow three to four years earlier (Robins et al., 2005). However, the spatial extent of this oscillation in catch, or possible connections with long-term climate cycles, was not explored. If long-term, large-scale climate patterns were driving these cycles in catch, there may be the capacity to extend temporally and spatially the forecast of catch depending on the species.

In Queensland, the catadromous barramundi is a valuable fin fish species found in coastal waters, estuaries, tidal creeks and lagoons, ponded pastures, supralittoral saltpans, flood plains and rivers in both clear and turbid water that ranges in temperature from 15 to 39 °C (Garrett and Russell, 1982). Populations are absent in areas

* Present address: P.O. Box 48, Glenside, SA 5065, Australia. Tel.: +61 8 83385815; mobile: +61 488010466.
E-mail address: jacqueline.balston@jbalston.com.

0165-7836/$ – see front matter © 2009 Published by Elsevier B.V.
doi:10.1016/j.fishres.2009.05.001

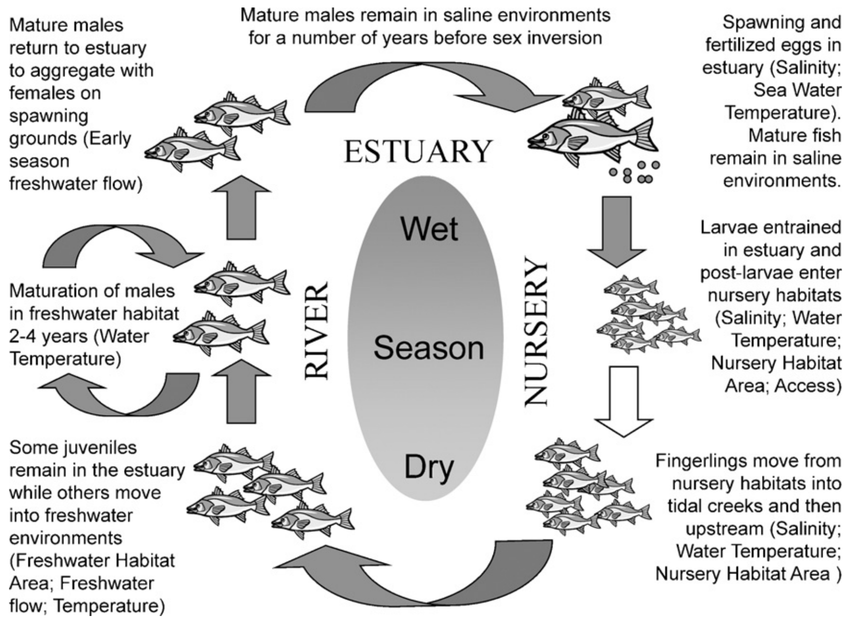

Fig. 1. Conceptual model of north-east Queensland barramundi life cycle and climate influences (Balston and Williams, 2005).

without permanently flowing rivers (Dunstan, 1959; Grey, 1986) and are isolated by highly saline water (Keenan, 1994; Shaklee et al., 1993). A protandrous hermaphrodite and pelagic spawner, the barramundi has a complex life cycle that is detailed elsewhere (e.g. Balston, 2007; Garrett, 1986) but is summarised here in a conceptual model (Fig. 1) that includes climatic conditions known from previous research to affect each life cycle stage. Barramundi caught in the Fitzroy area commercial fishery in central Queensland were found to be at least two years of age before reaching the minimum legal size, and some were as old as 32 years (Staunton-Smith et al., 2004). However, for most years sampled, the two to five year old fish were the most abundant and accounted for more than 40% of the catch.

Consistent findings from research to date suggest that survival of barramundi eggs and larvae is increased in high salinity environments (Davis, 1985; Garrett et al., 1987; Moore, 1982; Schipp, 1996), dispersal of eggs, larval stages and adults during extreme flood events is increased (Keenan, 1994; Kingsford and Suthers, 1994), growth rates in years of high freshwater flows is increased (Davis, 1982; Robins et al., 2006; Sawynok, 1998), and barramundi landings are increased in response to higher flows in the year of catch (Dunstan, 1959; Platten, 1996; Robins et al., 2005). In north-east Queensland, warm sea surface temperatures, high rainfall, increased fresh water flow and low evaporation were all correlated with an increase in catch two to three years later (Balston and Williams, 2005). Each of these climatic conditions is conducive to a successful spawning event or extensive and productive nursery habitat and suggests that young barramundi survival is enhanced under these conditions. Catchability was significantly increased with high fresh water flow and rainfall events in the year of catch. In addition, a forward stepwise ridge regression model built using two climate variables predicted half the variance in commercial barramundi landings two years in advance. This study investigates the possible relationship between long-term climate systems (the latitude of the sub-tropical ridge, the Southern Annular Mode, the Inter-decadal Pacific Oscillation or the Quasi-biennial Oscillation) and the commercial catch of barramundi along the east coast of Queensland, Australia to determine if there are any significant relationships that might be considered in the modelling of species catch a number of years in advance.

2. Data and methods

2.1. Study region

North-east Queensland as defined in this study spans over eight degrees of latitude from Port Douglas in the north, to Bundaberg in the south between the Great Dividing Range and the Coral Sea (Fig. 2). The study region is diverse in topography, geology, vegetation and land use (Crimp et al., 2003). Rivers are affected by the strong seasonality of the tropical climate systems that affect air temperature, salinity, water quality and sediment load. A number of the rivers and streams across the study region have been impounded for the generation of hydro-electricity, irrigation and urban needs. Other changes that have impinged on the barramundi populations in the region include the drainage of wetlands for sugar cane and urban expansion, clearing of trees and riparian areas for grazing and agriculture, introduction of barramundi fingerlings and selective catch of fish by recreational fishers, deterioration of water quality due to agricultural and urban runoff, sediment, fertilizer and chemical inputs or boating activities (DPI, 1995; Heap et al., 2001). In some cases these modifications have been extensive, and have affected fresh water flows, wetlands and estuarine fisheries habitats. Fisheries between Townsville and Cairns in particular have seen a dramatic decline in barramundi catch (Midgley, 1987).

Most of the year the south-east trade winds dominate the region (Downey, 1983). Air temperatures range from a mean maximum of 32 °C in Cairns during the summer months to a mean minimum of 9 °C at Rockhampton over winter (BOM, 1988). Water temperatures inside the Great Barrier Reef Lagoon range from about 23 °C in July–August to 28 °C in January–February. Inshore areas generally exhibit a greater seasonal range than those offshore (Wachenfeld et al., 1998).

2.2. Fisheries data

Fish Board data is a record of the total weight of fish landed in each financial year (1 July–30 June) from 1945/46 to 1980/81 for depots along the Queensland coast (Fig. 3). There is no measure of effort. Changes that may have impacted on fisheries catch over the

Download English Version:

https://daneshyari.com/en/article/4544196

Download Persian Version:

https://daneshyari.com/article/4544196

Daneshyari.com