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HICO Data User's proposal

Are island wakes hotspots for juvenile fishes in the Southern California Bight?

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Abstract/ Project summary:

Absence of information on the fate of juvenile fishes of commercially exploited species off California is recognized to be an important gap in understanding the effects of environmental conditions on the recruitment and biomass of small pelagic fishes and rockfishes. **We will test an hypothesis** that both wind and current wakes around islands in the Southern California Bight provide hotspots for the survival of juvenile fishes of mackerels and rock fishes. We predict that (1) the density of larval and juvenile fishes will be higher in the wakes, (2) the size distributions of larval and juvenile fishes will be relatively larger in the wakes, and (3) that the condition of juvenile fishes will be higher in the wakes, due to enhanced production.

Wakes exhibit both surface and sub-surface features (Barton 2001, Caldeira et al. 2005). The wakes are expected to be relatively small, with complex sub-mesoscale structure, and strong temporal variability (DiGiacomo and Holt 2001). By combining intensive sub-surface and surface sampling over a period of a week, with repeated glider sections crossing these features over several months, and high-resolution hyperspectral imagery, we expect to resolve the features sufficiently to be able to test our hypothesis.

Expected outputs from this project will be a publication in a peer-reviewed journal that will include both imagery and frontal analyses calculated from the HICO 250 m resolution data.

Statement of work/ Project description:

The effects of (1) currents flowing over variable topography and (2) winds on the ocean in the lee of the hills on islands creates different kinds of eddies due to currents, and to stratification of the water column due to shelter from prevailing winds (Heywood et al. 1990, Dong and McWilliams 2007,). Current wakes increase mixing and enhance production (Johnson and Read 2007, Suthers et al. 2004), while wind wakes produce patches of warmer water (Caldeira et al. 2005). Both increased production and warmer water may be favorable to the growth and survival of larval and juvenile fishes.

The purpose of the high resolution island wakes survey is to **test the hypothesis** that both wind and current wakes provide hotspots for the survival of larval and juvenile fishes. We predict that (1) the density of larval and juvenile fishes will be higher in the wakes, (2) the size distributions of larval and juvenile fishes will be relatively larger in the wakes, and (3) that the condition of juvenile fishes will be higher in the wakes.

Wakes exhibit both surface and sub-surface features. Subsurface features will be sampled with multi-frequency acoustics, CTD profiles, pairovet and bongo nets sampling different components of the ichthyoplankton and zooplankton assemblages. Juvenile fishes will be sampled with an Isaacs-Kidd mid-water trawl (IKMT). Repeat passes of a glider across the area will provide detailed sections of temperature, salinity, fluorescence, velocity and acoustic backscatter. Surface features will be sampled with manta nets, the Continuous Underway Fish Egg Sampler, thermo-salinograph, and remote sensing. The wakes are expected to be relatively small, with complex sub-mesoscale structure, and strong temporal variability.

Over the period of one week we will conduct high resolution sampling on either side of, and within, current and wind wakes off Catalina and San Clemente Islands, and to the south of San Nicolas Island in the Southern California Bight, as time permits. Exact sampling locations will be based on the best remote sensing and Spray glider information prior to the cruise, as well as upon the predicted locations of the wind and current wakes based on previous studies in the literature. As a result, the survey design will be flexible and cannot be detailed in advance here. A satellite image of the wakes is shown in Figure 1.

The primary species focus of this study is small pelagic fish, rockfishes, and squids. However, the full ichthyoplankton community will be counted according to usual protocols, and all species from the IKMT will be identified, counted and preserved. Calibrated acoustic backscatter data will be interpreted using catches from bongo nets and IKMT and predicted frequency-dependent scattering. CUFES data will be

enumerated and samples preserved according to normal protocols.

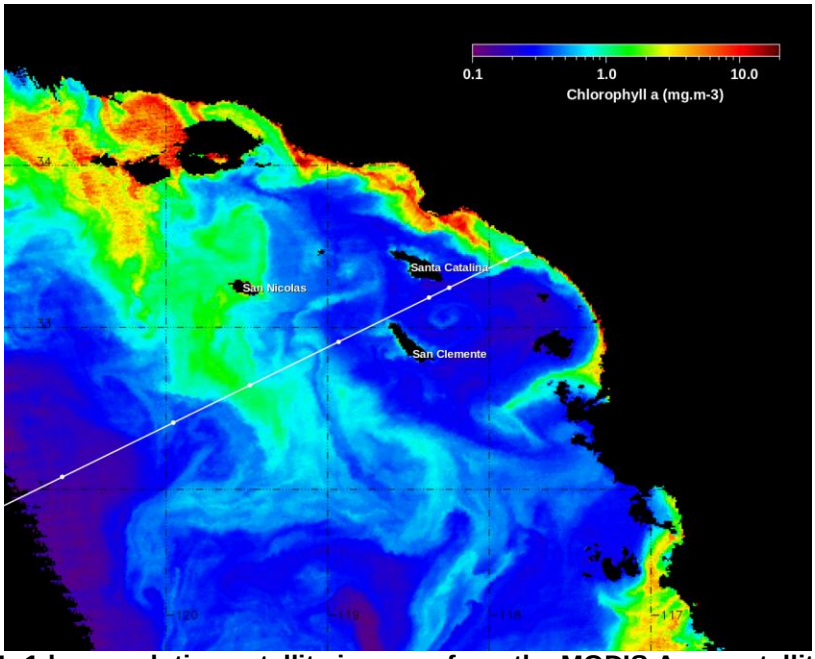

Figure 1: 1-km resolution satellite imagery from the MODIS Aqua satellite sensor on July 15, 2010 showing pigment enrichment in island wakes to the south of San Nicolas Is, and to the west and north of San Clemente and Santa Catalina Islands. CalCOFI line 90 with stations is also shown.

Previous studies on island wakes have been carried out around Catalina Island and modeling studies have been published. As far as we are aware there are no previous studies that have addressed the question of whether island wakes in the Southern California Bight create conditions supporting anomalously high concentrations of juvenile fishes. This is a question of considerable interest both from an oceanographic point of view and with regard to its relevance to the recruitment success of commercially exploited fishes.

High resolution HICO ocean color data would permit us to resolve the surface expression of the island wakes in greater detail than we can obtain from the 1-km MODIS chlorophyll imagery (Figure 1). We anticipate that the features will be dynamic, forced by the residual currents, tidal flows and wind stress. By obtaining one high resolution image per day, we hope to resolve some of the temporal variability on a synoptic scale that we cannot adequately resolve with either the research vessel or the glider transect. In addition, we will use recently improved frontal detection algorithms (Nieto et al. 2012) to calculate the position of any fronts generated by the wakes around the islands. As far as we are aware, this will be the first time objective frontal detection methods will have been applied to HICO data.

Requested target areas:

CatalinaIsland_CA_asc	USA (California)	33.2790	-118.6837	active
CatalinaIsland_CA_des	USA (California)	33.7995	-118.7084	active
CA_SantaCatalinaIs_asc	USA (California)	33.3000	-118.5000	active
Los_Angeles_Harbor	USA (California)	33.7309	-118.1679	active
SanClemente_CCE_LTER	USA (California)	33.0040	-118.8556	inactive

OPERATIONS

The research vessel *Ocean Starr* will conduct intensive sampling of island wakes near Catalina and San Clemente Islands, and to the south of San Nicolas Island in the Southern California Bight (Figure 1).

Currents - *Ocean Starr* does not have an ADCP. Current velocities will be determined from repeat passes of a spray glider that will be deployed on CalCOFI line 90 (Figure 1) both before and after the island wake survey. In addition, 15 drifters will be deployed to either side of Catalina and San Clemente Islands to track surface water advection during and after the survey.

CTD/Rosette - consisting of 24 10-liter hydrographic bottles will be lowered to 500 meters (depth permitting) at each station to measure temperature, salinity, oxygen and fluorescence.
CalCOFI Bongo net tow - standard oblique plankton tow with 300 meters of wire out, depth permitting, using paired 505 µm mesh nets with 71 cm diameter openings. The technical requirements for this tow are: Descent wire rate of 50 meters per minute and an ascent wire rate of 20 meters per minute. All tows with ascending wire angles lower than 38° or higher than 51° in the final 100 meters of wire will be repeated. Additionally, a 45° wire angle should be closely maintained during the ascent and descent of the net frame. The port side sample will be preserved in buffered ethanol at every station.

Manta net (neuston) tow - using a 505 µm mesh net on a frame with a mouth area of 0.1333 m^2. Tows are 15 minutes in duration at a towing speed of approximately 1.5 - 2.0 knots. Wire angles should be kept between 15° and 25°.

Pairovet net - will be fished from 70 meters to the surface (depth permitting) using paired 25 cm diameter 150 µm mesh nets at all stations. The technical requirements for Pairovet tows are: Descent rate of 70 meters per minute, a terminal depth time of 10 seconds and an ascent rate of 70 meters per minute. All tows with wire angles exceeding 15° during the ascent will be repeated.

Thermosalinometer sampling – SWFSC will provide a thermosalinometer (TSG), in calibrated and working order, for continuous measurement of surface water temperature and salinity. The Scientific Computing System (SCS) will serve as the main data collection system.. All SCS data will be provided to SWFSC personnel at the completion of the cruise.

Acoustics – Calibration of the Simrad EK-60 echosounder previously performed at the beginning of the cruise (requiring 6-12 hours) will be applied to this cruise leg.

The EK-60 echosounder will be operated at 38, 70, 120 and 200 kHz and interfaced to a data acquisition system to estimate small pelagic and krill biomass between 10 and a maximum of 250 m. Ping rate will be optimized small pelagic fishes in the upper water column. The vessel's EQ-50, ES-60 or Skipper depth sounder may be used minimally at the discretion of the Commanding Officer, but will normally remain off while underway. The ship shall inform the Cruise Leader of any use of the vessel's sounders, as it interferes with the signals received on the scientific EK-60 that will be used continuously.

CUFES - The egg pump mounted inside the ship's hull drawing water from a depth of three meters. During the grid occupation, the pump will run continuously between stations to sample any pelagic fish eggs. Approximately 640 liters/minute is sent through a concentrator which filters all material larger than 505µm. The sieved material is then collected and identified. All fish eggs are identified to lowest taxa, counted and entered into the data acquisition software. Each sample entry is coupled with sea surface temperature, geographical position, wind speed and direction, date and time, and surface salinity. Sampling intervals will vary in length, depending on the number of fish eggs seen, from five to 30 minutes.

IKMT net sampling for juvenile fishes – During leg 2, an Isaacs-Kidd Mid-water Trawl (IKMT) will be deployed between the hours of approximately 1800 and 0600 PST at locations around Catalina and San

Clemente Islands, and to the south of San Nicolas Island in the Southern California Bight at positions determined by prevailing oceanographic conditions just prior to the cruise. These conditions will be assessed based on the most recent available 1-km remote sensing imagery and line 90 spray glider data just prior to the cruise. The positions may be changed at the discretion of the Chief Scientist or Cruise Leader.

Biographical sketch and available facilities:

Sam McClatchie is a fisheries oceanographer who has regularly used ocean color remote sensing in his publications. Recent publications using ocean color imagery are available at <www.fishocean.info>.

Karen Nieto is an NRC postdoctoral fellow in McClatchie's laboratory at NOAA SWFSC. She is a remote sensing scientist specializing in using high resolution ocean color and SST imagery, and altimetry data to study mesoscale features such as eddies and fronts (see Nieto et al. 2012 in reference list). Nieto is expert in IDL programming and is provided with current licenses for IDL and ENVI running under Linux on a 64-bit computer at SWFSC. She has been working on California Current system remote sensing data for the past 30 months at SWFSC, and is currently funded through September 2013.

Output and deliverables:

- A publication in a peer-reviewed journal
- A test of the application of an improved objective frontal detection algorithm (Nieto et al. 2012) to HICO data.
- Presentation of results to the HICO annual meeting.

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