Title
Developing an Instrument for Counting Fish Eggs

Author
Checkley, David

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Developing an Instrument for Counting Fish Eggs

David Checkley

University of California, San Diego—Scripps Institution of Oceanography

Development of New Technology

The Continuous Underway Fish Egg Sampler (CUFES) is a ship-mounted oceanographic instrument that collects pelagic fish eggs and ancillary data. The system operates continuously under nearly all sea conditions, providing a real-time estimate of the volumetric abundance of pelagic fish eggs from the surface to the instrument's pump depth at 3 meters. CUFES is capable of drawing about 650 liters of seawater a minute into an egg collection chamber.

At present, biologists manually count egg samples—a time-intensive and tedious process—to investigate spawning habitat and spawning biomass, both of which are important pieces of information for managing fisheries.

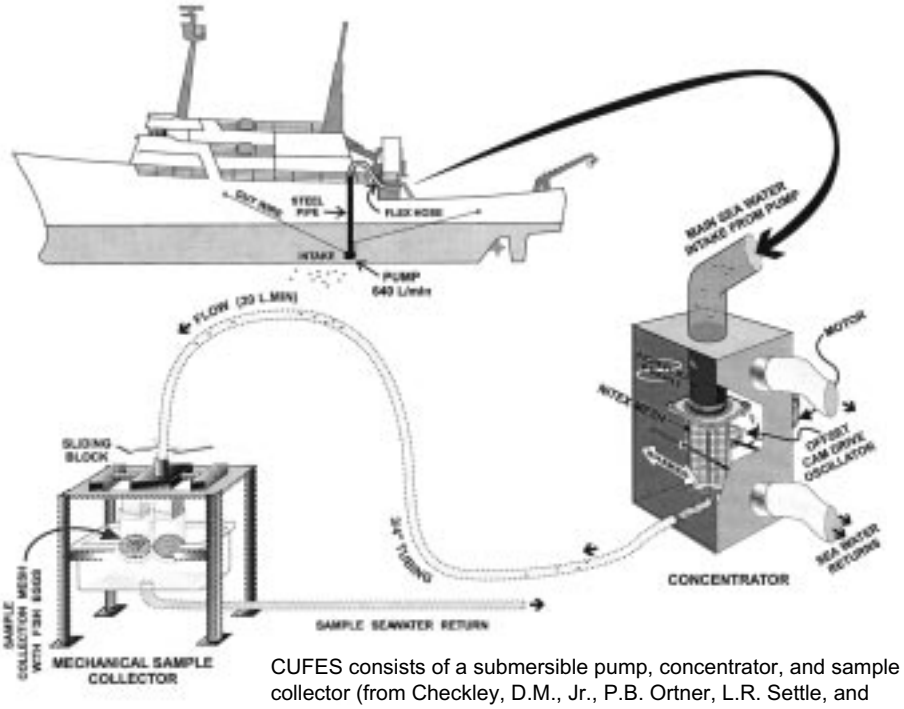
CUFES has been used to sample the eggs of menhaden, pinfish, sardine, anchovy, round herring, and mackerel off the coasts of the United States, Mexico, Peru, Chile, France, Spain, Portugal and South Africa.

Mackerel haul in Peruvian waters. Photo: Teobaldo Dioses, NOAA Fisheries digital collection

Projects

California Sea Grant funded part of the development of CUFES and its use in estimating the spawning biomass of Pacific sardine in California from the "daily egg-production method." David Checkley, a biologist at Scripps Institution of Oceanography, was then able to use CUFES to estimate sardine and anchovy egg mortality rates.

California Sea Grant has more recently funded Checkley to automate the identification and counting of fish eggs collected by CUFES. Checkley is leading this effort in cooperation with scientists from NOAA Fisheries. The automated fish egg counter that he is developing is called the Real-Time Flow Imaging and Classification System or REFLICS. It consists of a line-scan video camera, jacketed flow cell, illuminator and housing. The most challenging aspect of developing the instrument is writing software for analyzing digital images collected by REFLICS. Eventually, this algorithm will be able to speciate and count sardine and anchovy eggs in real time, as a ship is underway.

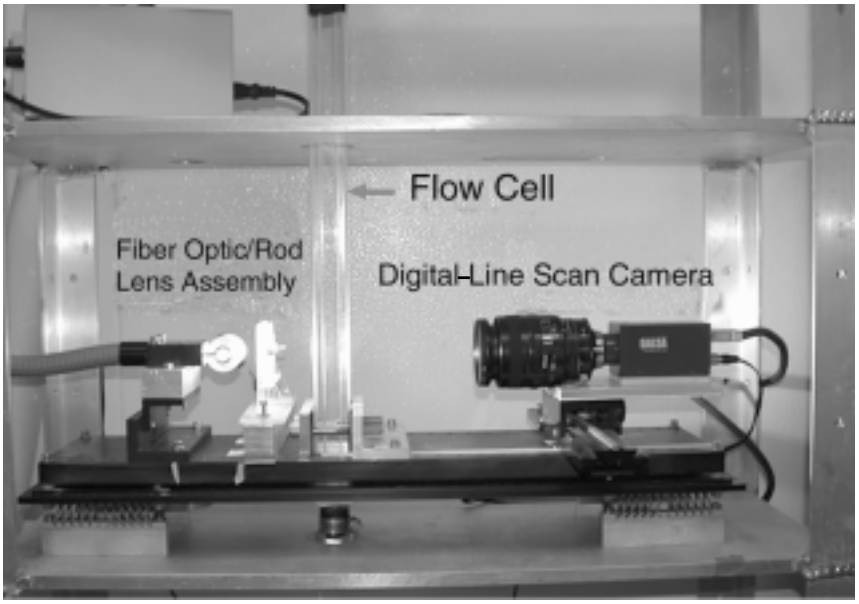


CUFES consists of a submersible pump, concentrator, and sample collector (from Checkley, D.M., Jr., P.B. Ortner, L.R. Settle, and S.R. Cummings. 1997. A continuous, underway fish egg sampler. *Fish. Oceanogr.* 6(2):58–73).

Applications

In 2003 and 2004, the autonomous fish egg counter was field-tested during spring cruises of the California Cooperative Oceanic Fisheries Investigations (CalCOFI). During these cruises, it was able to take millions of digital images of eggs and other small particles in seawater samples. Scientists are in the process of comparing computer interpretations of these images to human counts.

Checkley currently has California Sea Grant funding to characterize the spawning habitats of small



REFLICS: Water from CUFES concentrator passes upward through the flow cell at 20 l min^{-1} and on to CUFES sample collector (see illustration on previous page). Particles are backlit by the illuminator and imaged by the line-scan camera. Data are transferred from camera to computer for real-time acquisition and analysis. Photo: Jesse Powell, UC San Diego

Biologist David Checkley

pelagic fish off California using newly developed techniques.

Industrial Applications

Ocean Instruments in San Diego now manufactures and sells CUFES. Checkley anticipates REFLICS will become commercially available in a few years. A commercial version of REFLICS, he said, would be able to count different types of eggs, as well as copepods.

Fisheries Management

The data gathered by CUFES and REFLICS will be of immediate use by NOAA Fisheries and the California Department of Fish and Game. Both agencies are involved in managing California sardine and anchovy.

Co-Principal Investigators

Pam Cosman and Mohan Trevidi, Department of Electrical and Computer Engineering, UC San Diego

Collaborating Institutions

California Cooperative Fisheries Investigations (CalCOFI)
Datacube, Inc., Danvers, Massachusetts
Hubbs-SeaWorld Fish Hatchery, Carlsbad, California
Integrative Oceanography Division, UC San Diego
Southwest Fisheries Science Center, La Jolla

Trainees

Katherine A. Curtis
Sadahiro Iwamoto
Stephen Krotosky
David Levenson

Publications

Iwamoto, S., D.M. Checkley, Jr., and M.M. Trivedi. 2001. REFLICS: Real-time flow imaging and classification system. *Mach. Vision Appl*. 13:1–13.

Curtis, K.A. Fine scale pattern of Pacific sardine (*Sardinops sagax*) and northern anchovy (*Engraulis mordax*) eggs. *Fish. Oceanogr*. In Press.

Presentations

Powell, J., D. Checkley, S. Krotosky, B. Ochoa, and P. Cosman. OCEANS 2003 Marine Technology and Ocean Science Conference. *Detection and Identification of Sardine Eggs at Sea Using a Machine Vision System*. September 23, 2004, San Diego, California.

Checkley, D. CalCOFI Annual Symposium. *Sampling Zooplankton with the OPC and Fish Eggs with CUFES in CalCOFI*. November 5, 2003, Monterey, California.

Checkley, D., P. Ayon, T. Baumgartner, and M. Braun. GLOBEC Small Pelagic Fish and Climate Change Meeting. *Spawning of Anchovy, Mackerel, and Sardine in the California and Humboldt Currents*. January 14, 2004, Concepción, Chile.

Curtis, K.A., D. Checkley, and J. Powell. American Society of Limnology and Oceanography and the Oceanography Society Combined Annual Meeting. *Connecting Dimensions: The Challenge of Horizontal and Vertical Sampling of Pelagic Fish Eggs*. February 15–20, Honolulu, Hawaii.

For more information:
Dr. David Checkley
Scripps Institution of Oceanography
University of California, San Diego
Tel.: (858) 534-4228
Email: dcheckely@ucsd.edu

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