USES OF UNDERWATER REMOTELY OPERATED VEHICLES IN FISHERIES AND AQUATIC SCIENCES: POTENTIAL AND LIMITATIONS

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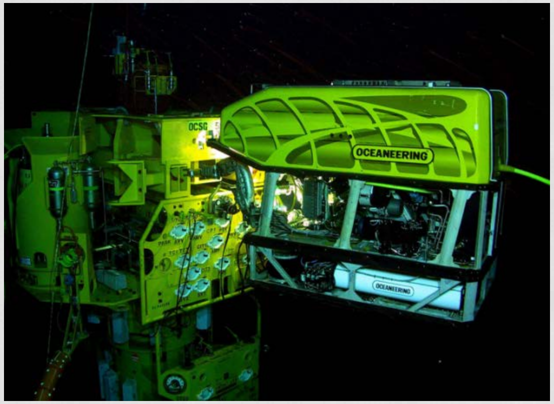
WFCA 5th Field Technology for Data Collection in Forestry, Fisheries, and Natural Resources

Introduction to ROVs

- "Remote-operated vehicle"
  - Underwater use
  - External visual display/control
  - Tethered cable: control unit → robot

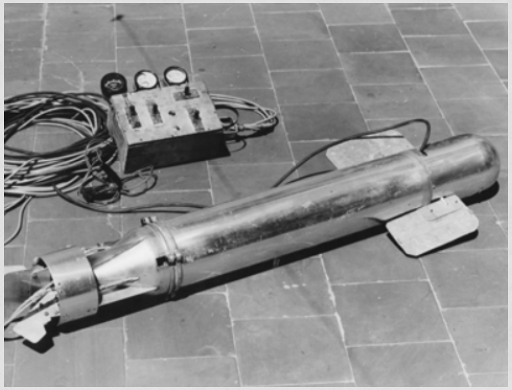


- Intended to replace underwater manned vehicles (submarines)

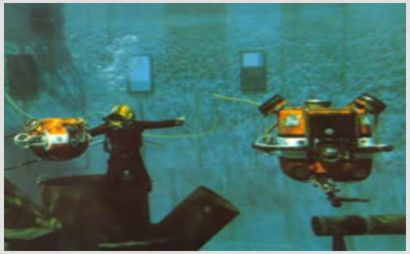
- Variety of forms and functions

A Quick History Lesson…

- **1953** – "Poodle"



- **1961** – XN-3 (underwater camera)
  - US Navy; military operations
- **1966** – "CURV" (cable controlled underwater recovery vehicle)
  - Recovered lost hydrogen bomb



- **1970s and 1980s** – ROV-225 and ROV-150
  - Offshore (oil) operation
- **2009** – "Nereus" explores the Mariana Trench (6.8 miles)

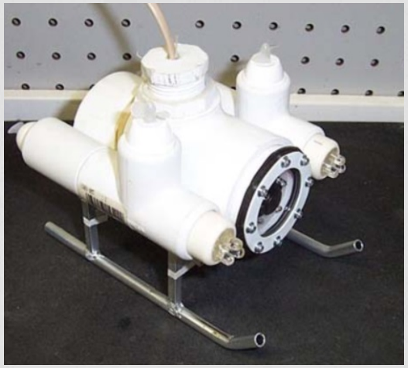
Different classes of ROVs

- Light, Medium, and Heavy work class

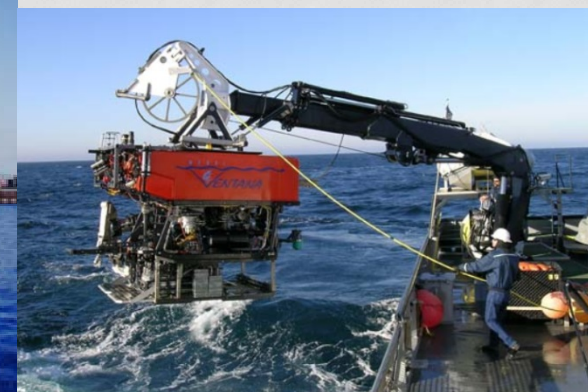
Class	Type	Power (hp)
Micro Observation (<100 meters)	Low Cost Small Electric ROV	<5
Mini Observation (< 300 meters)	Mini (Small & #9;(Electric))	<10
Light/Medium Work Class (<2,000 meters)	Medium (Electro/Hyd)	<100
Observation/Light Work Class (< 3,000 meters)	High Capacity Electric	<20
Heavy Work Class /Large Payload (<3,000 meters)	High Capacity (Electro/Hyd)	<300
Observation/Data Collection (>3,000 meters)	Ultra-Deep (Electric)	<25
Heavy Work Class /Large Payload (>3,000 meters)	Ultra-Deep (Electro/Hyd)	<120
Trenching and Burial	Bottom Crawlers and Plows	
Towed Systems	Towed Systems	

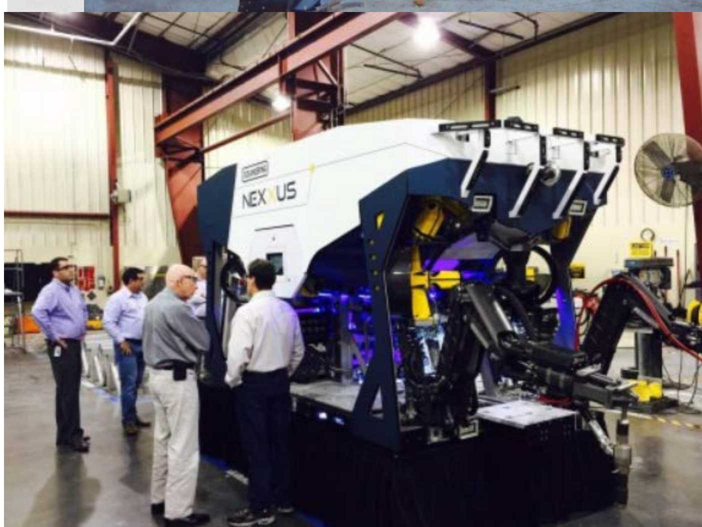
ROV.org

Light/Observational Class



Heavy Work class

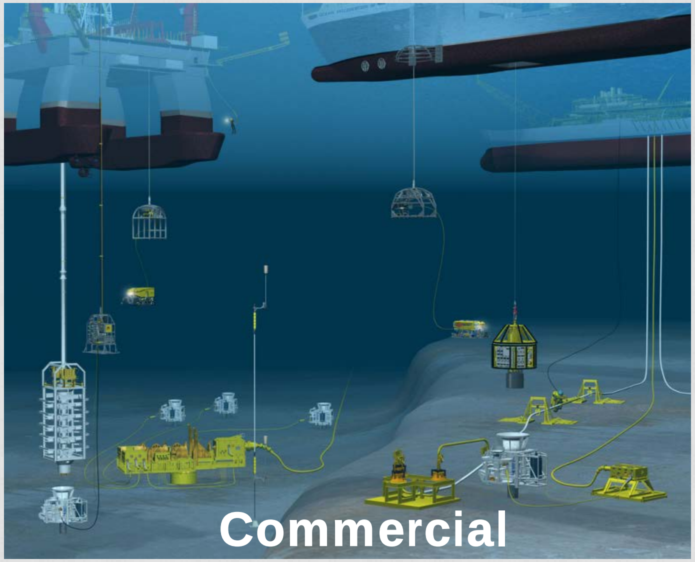


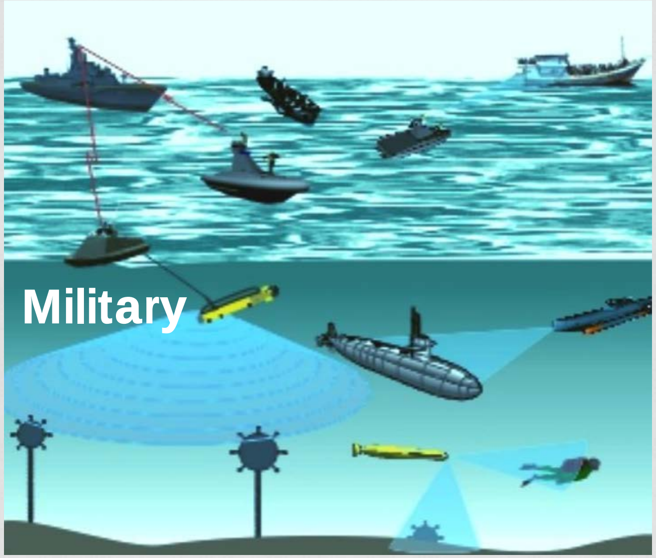


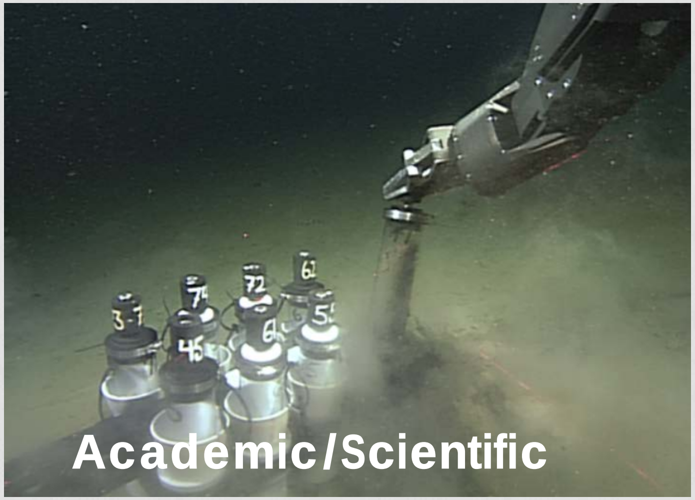
ROV Catalog

- http://digital.oceannews.com/publication/?i=264011

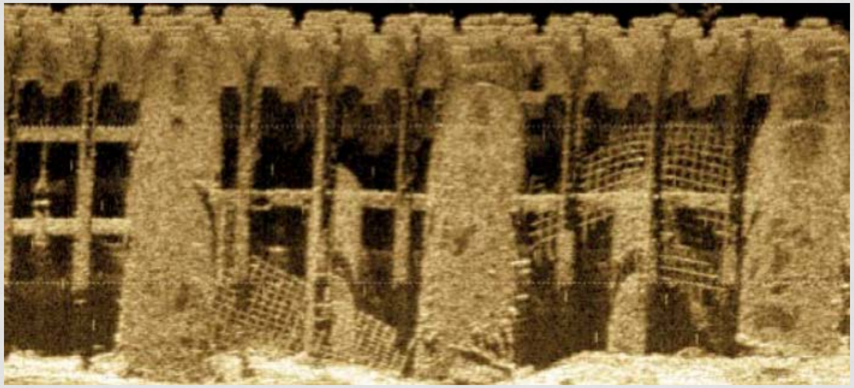
Applications of ROVs



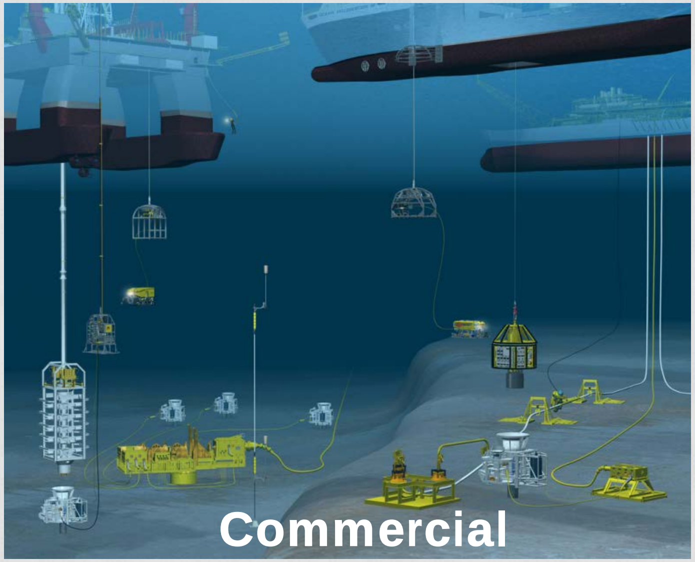


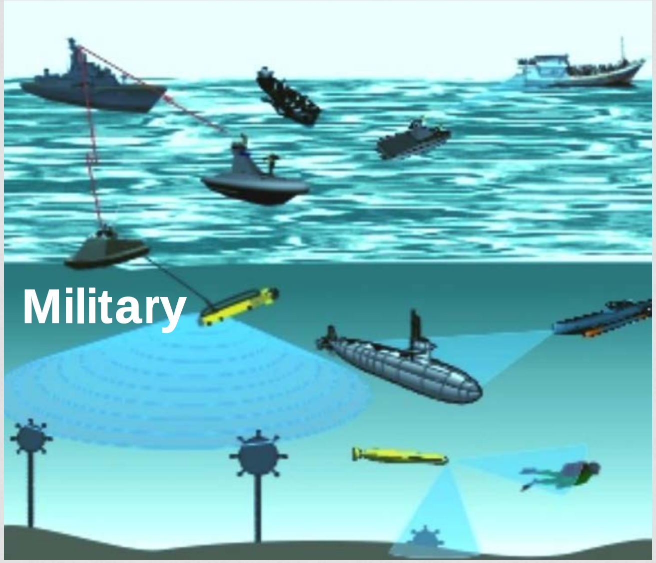


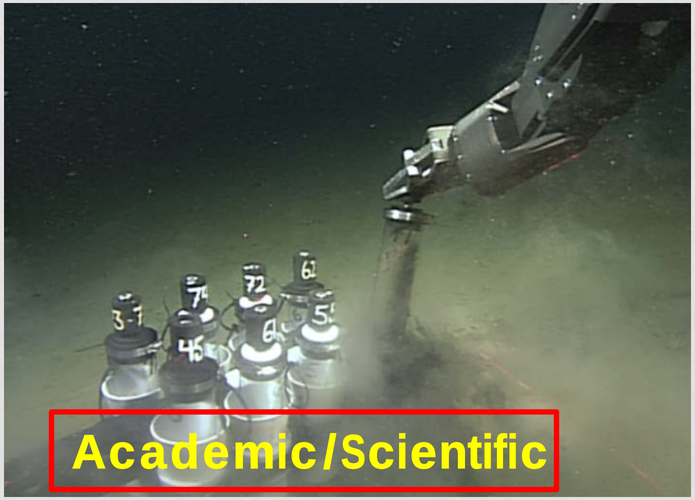
Applications of ROVs



Applications of ROVs







Applications of ROVs in Fisheries/ Aquatic Science

Marine Habitat Mapping Technology for Alaska, J.R. Reynolds and H.G. Greene (eds.) 109
Alaska Sea Grant College Program, University of Alaska Fairbanks. doi:10.4027/mhmta.2008.08

Conducting Visual Surveys with a Small ROV in Shallow Water

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Abstract

Small remotely operated vehicles (ROVs), sometimes described as low-cost (<$150,000) ROVs, have become valuable tools in the study of marine organisms and their habitats. The versatility and relative simplicity of these vehicles is enabling scientists and fishery managers to develop a better understanding of the marine ecosystem that has not cialized teams to operate, the greater affordability, lower operating costs, and relative simplicity of small ROVs makes them especially suited for use by natural resource agencies and academic institutions operating on limited budgets and with minimal resources (i.e., vessels, personnel). Unlike large ROVs that typically require a large, dedicated support vessel, a small ROV can be deployed from a range of platforms that

First attempt to use a remotely operated vehicle to observe soniferous fish behavior in the Gulf of Maine, Western Atlantic Ocean

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Abstract Underwater sound and video observations were made at noon, sunset, and midnight in sand, gravel, and boulder habitat in the Stellwagen Bank National Marine Sanctuary, Gulf of Maine, USA in October 2001 using a remotely operated vehicle (ROV). Seventeen species of fish and squid were observed with clear habitat and time differences. Observations of feeding behavior, disturbance behavior, and both interspecific and intraspecific interactions provided numerous opportunities for potential sound production; however, sounds were recorded only during a single dive. Although high noise levels generated by the ROV and support ship may have masked some sounds, we conclude that fish sound production in the Gulf of Maine during the fall is uncommon. The recorded fish sounds are tentatively attributed to the cusk *Brosme brosme*. Cusk sounds consisted variously of isolated thumps, widely spaced thump trains, drumrolls, and their combinations. Frequency peaks were observed at 188, 539, and

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Volume 32, No. 3, Fall 1998, pp. 37-47.

Oceanographic Research Using Remotely Operated Underwater Robotic Vehicles: Exploration of Hydrothermal Vent Sites On The Mid-Atlantic Ridge At 37°North 32°West

R. Bachmayer, S. Humphris, D. Fornari, C. Van Dover, J. Howland, A. Bowen, R. Elder, T. Crook, D. Gleason, W. Sellers, and S. Lerner

Abstract

This paper describes three 6000 meter tethered underwater vehicles - DSL-120 sonar, ARGO II mapping system and Jason/Medea remotely operated vehicle - used during the summer of 1996 for an oceanographic expedition to investigate hydrothermal vent sites at the "Lucky Strike" segment (37°N 32°W) of the Mid-Atlantic Ridge as part of the RIDGE (Ridge Inter-Disciplinary Global Experiment) Initiative (RIDGE,1993). This suite of vehicles has dramatically augmented the suite of deep submergence vehicles available to oceanographers and has resulted in new approaches to deep-sea research.

1. INTRODUCTION

The last decade of oceanographic research has seen underwater remotely operated vehicle (ROV) technology evolve from fragile laboratory engineering prototypes

limit the performance of operational underwater ROV systems in scientific missions.

2. DEEP-OCEAN SCIENTIFIC FIELD

Development of a Remotely Operated Vehicle Based Methodology to Estimate Fish Community Structure at Artificial Reef Sites in the Northern Gulf of Mexico

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ABSTRACT

A remotely operated vehicle (ROV) based methodology was developed to estimate reef fish community structure at artificial reef sites off Pensacola, Florida in the northern Gulf of Mexico. The method is based on the visual census technique developed by Bohnsack and Bannerot (1986), with a key departure being that sampling was conducted with a micro ROV instead of divers. A VideoRay Pro III ROV equipped with a red laser scale (distance between lasers = 10 cm) was employed to sample fish communities and estimate the size distribution of fishes at study sites. Pool experiments were conducted to examine the effect of distance from target (1, 2.5, and 5 m) and laser angle of incidence (0°, 5°, 10°, 15°, 20°, and 30° from perpendicular) on the accuracy of estimating fish length with the laser scale. Results indicate that fish length estimated with the laser scale was accurate (i.e., mean absolute error < 5%) for distances < 5 m and angles of incidence ≤20° from perpendicular. In the field, the ROV was used to sample a 15-m wide cylinder around artificial reefs from the seafloor through the water column. Two readers independently analyzed video samples (n = 24) in which all fishes were identified to the lowest taxonomic level possible and counted. Average percent error between readers among all samples was 7.4%; the correlation coefficient between taxa-specific counts was 0.997 ($p < 0.001$). Overall, results suggest that micro ROVs can be used to estimate reef fish community structure precisely at artificial reef sites, as well as to estimate size distributions accurately of fishes present.

KEY WORDS: Artificial reef, reef fish, Remotely Operated Vehicle

Applications of ROVs in Fisheries/Aquatic Science

Aquaculture

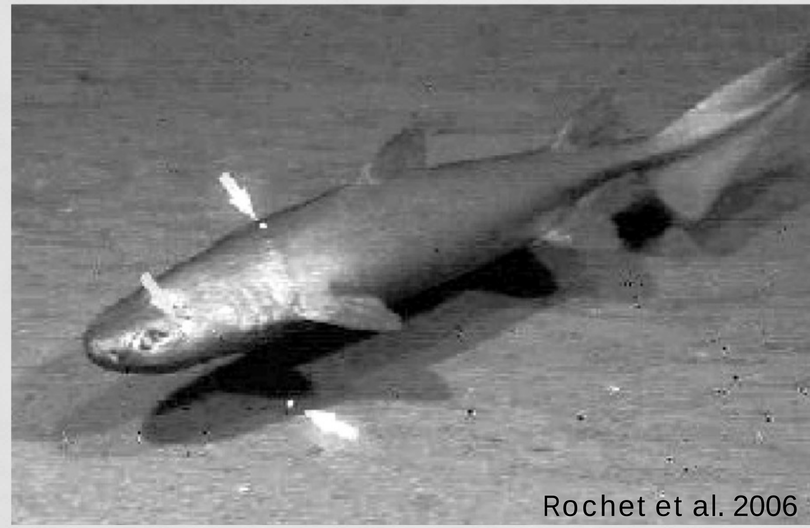
Deep sea observation

Sediment sampling

Coral reefs

Applications of ROVs in Fisheries/ Aquatic Science

Patterson et al. 2008


Rochet et al. 2006

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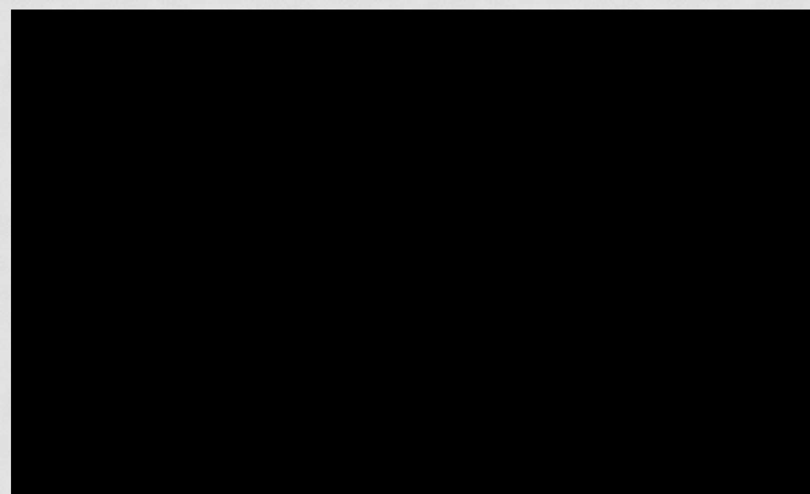
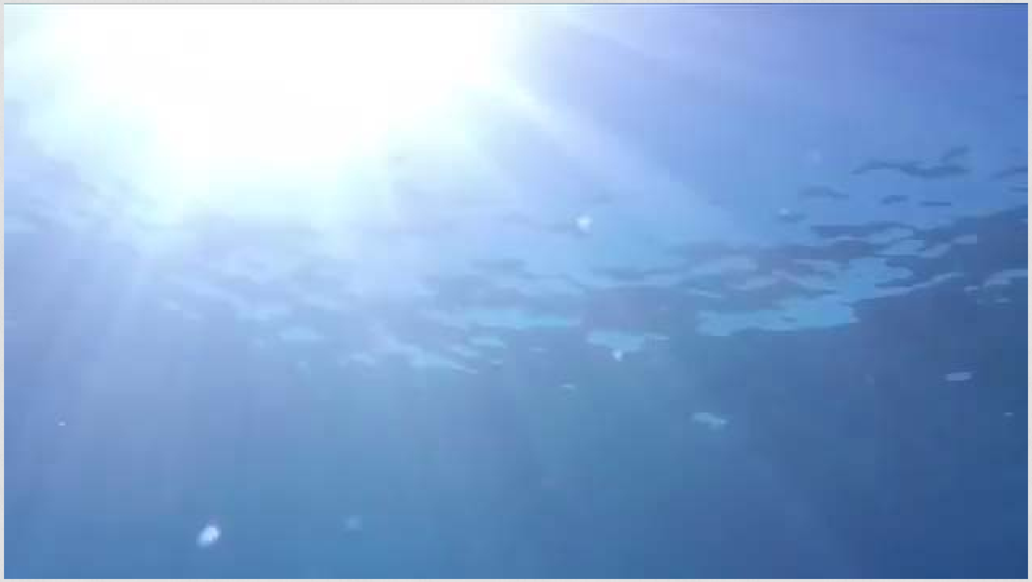


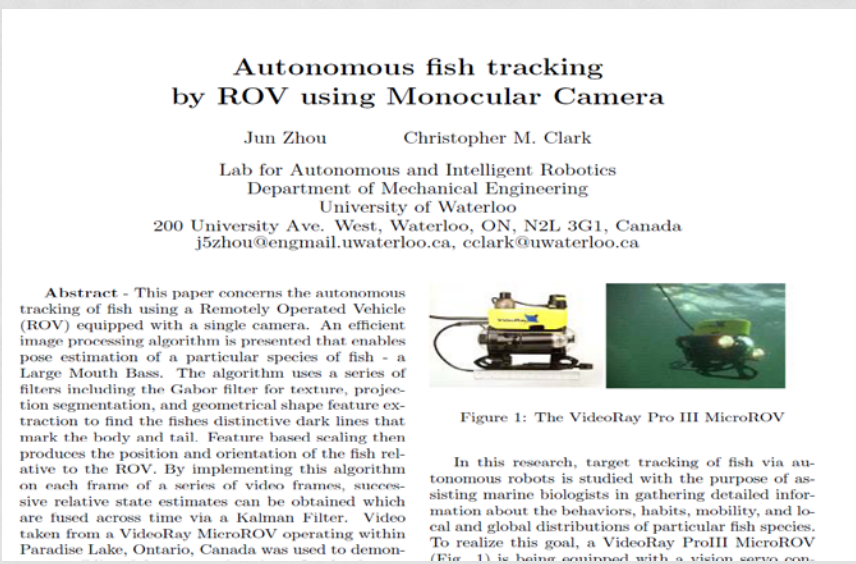
Advancements in ROV technology

- Open source ROVs (OpenROV.com)
  - Customization/programming (Arduino electronic platform)
  - Kickstarter project: raised several hundred thousands $$$
  - Kits for self construction
  - Low-cost ($1,200)



Advancements in ROV technology

- Development of autonomous undersea vehicles (AUVs)
  - Habitat mapping
  - Seafloor survey
  - Fish tracking?
  - Invasive species control?



Autonomous fish tracking by ROV using Monocular Camera

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Abstract - This paper concerns the autonomous tracking of fish using a Remotely Operated Vehicle (ROV) equipped with a single camera. An efficient image processing algorithm is presented that enables pose estimation of a particular species of fish - a Large Mouth Bass. The algorithm uses a series of filters including the Gabor filter for texture, projection segmentation, and geometrical shape feature extraction to find the fishes distinctive dark lines that mark the body and tail. Feature based scaling then produces the position and orientation of the fish relative to the ROV. By implementing this algorithm on each frame of a series of video frames, successive relative state estimates can be obtained which are fused across time via a Kalman Filter. Video taken from a VideoRay MicroROV operating within Paradise Lake, Ontario, Canada was used to demon-

Figure 1: The VideoRay Pro III MicroROV

In this research, target tracking of fish via autonomous robots is studied with the purpose of assisting marine biologists in gathering detailed information about the behaviors, habits, mobility, and local and global distributions of particular fish species. To realize this goal, a VideoRay ProIII MicroROV (Fig. 1) is being equipped with a vision servo con-

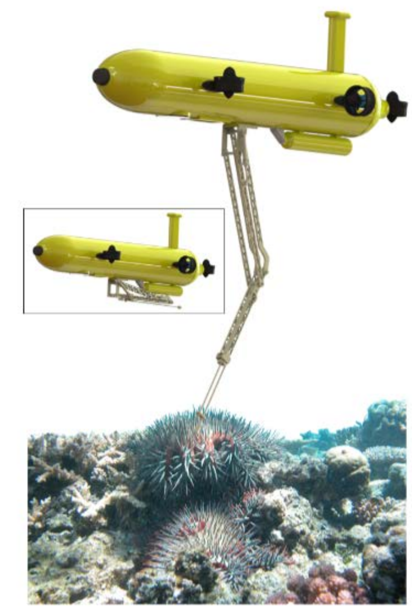
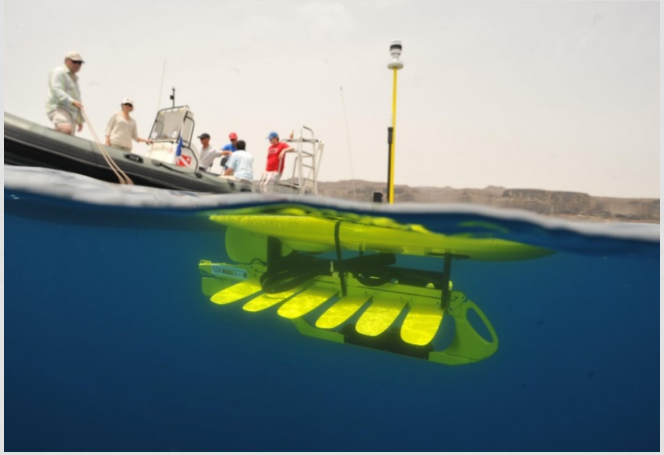
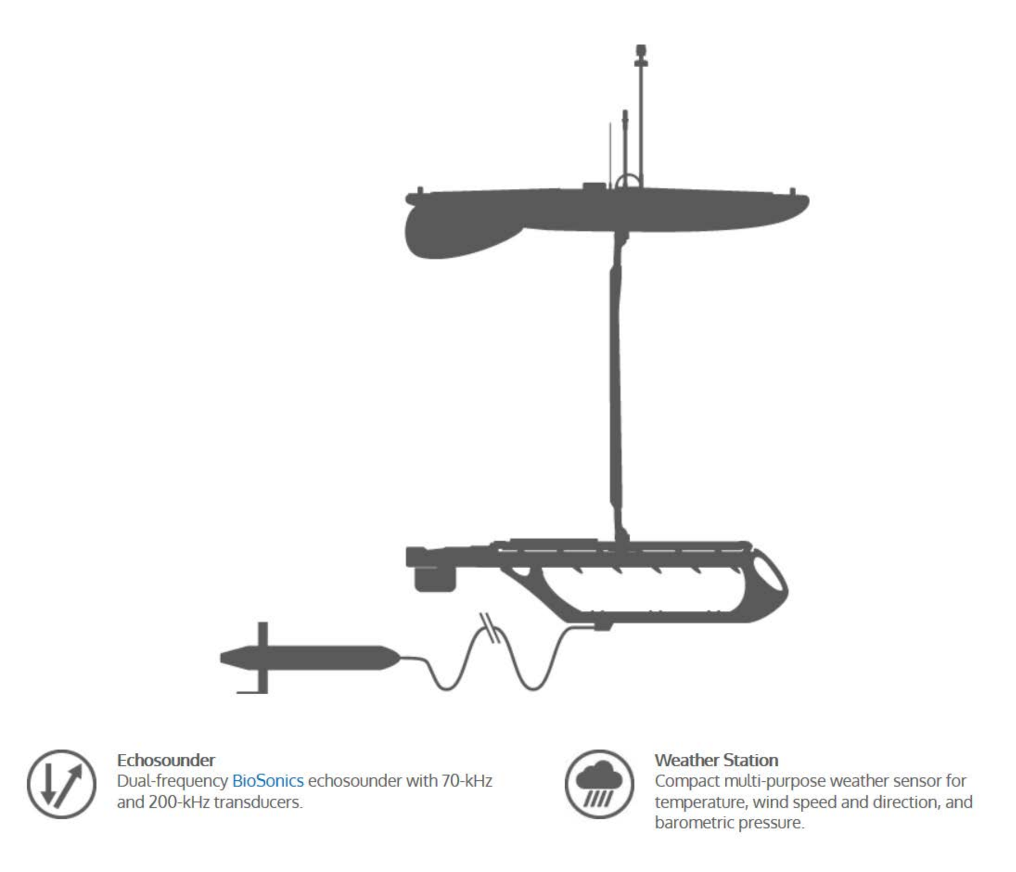


Fig. 2: Concept AUV with a vison-guided robotic arm extended to inject and control COTS numbers in reef environments (inset: injection arm in retracted position).

Video

Advancements in ROV technology



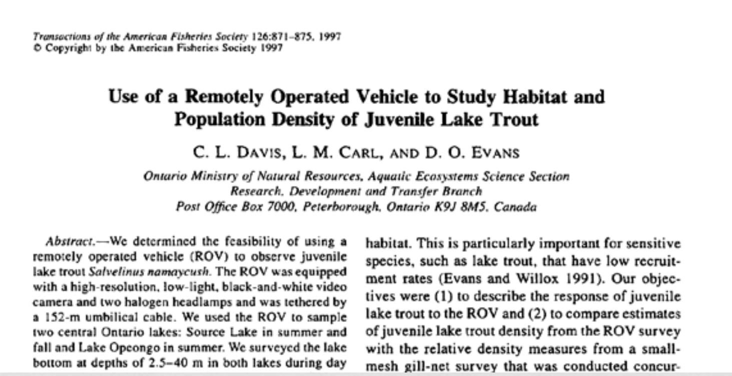


Cornell Project

Advancements in ROV technology

Discussion

- Limited use of ROVs in Freshwater systems
  - Limitations?
- Potential uses?
  - Population estimates, fish attractor surveys, water monitoring, habitat mapping?



Transactions of the American Fisheries Society 126:871–875, 1997

Use of a Remotely Operated Vehicle to Study Habitat and Population Density of Juvenile Lake Trout

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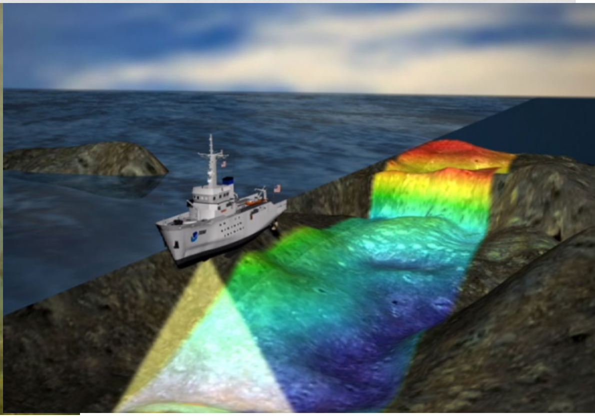
Abstract.—We determined the feasibility of using a remotely operated vehicle (ROV) to observe juvenile lake trout *Salvelinus namaycush*. The ROV was equipped with a high-resolution, low-light, black-and-white video camera and two halogen headlamps and was tethered by a 152-m umbilical cable. We used the ROV to sample two central Ontario lakes: Source Lake in summer and fall and Lake Opeongo in summer. We surveyed the lake bottom at depths of 2.5–40 m in both lakes during day

habitat. This is particularly important for sensitive species, such as lake trout, that have low recruitment rates (Evans and Willox 1991). Our objectives were (1) to describe the response of juvenile lake trout to the ROV and (2) to compare estimates of juvenile lake trout density from the ROV survey with the relative density measures from a small-mesh gill-net survey that was conducted concur-



POTENTIAL LIMITATIONS?

- Cost?
- Battery life?
- Depth?
- Capabilities?
- User friendliness?
- Standardized methods?
- Positional accuracy
- Training?
- Tethering

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Alaska Sea Grant College Program, University of Alaska Fairbanks. doi:10.4027/mhmta.2008.08

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