ASVs for Hydrographic Surveying

NOAA Hydrographic Services Review Panel

September 11, 2017

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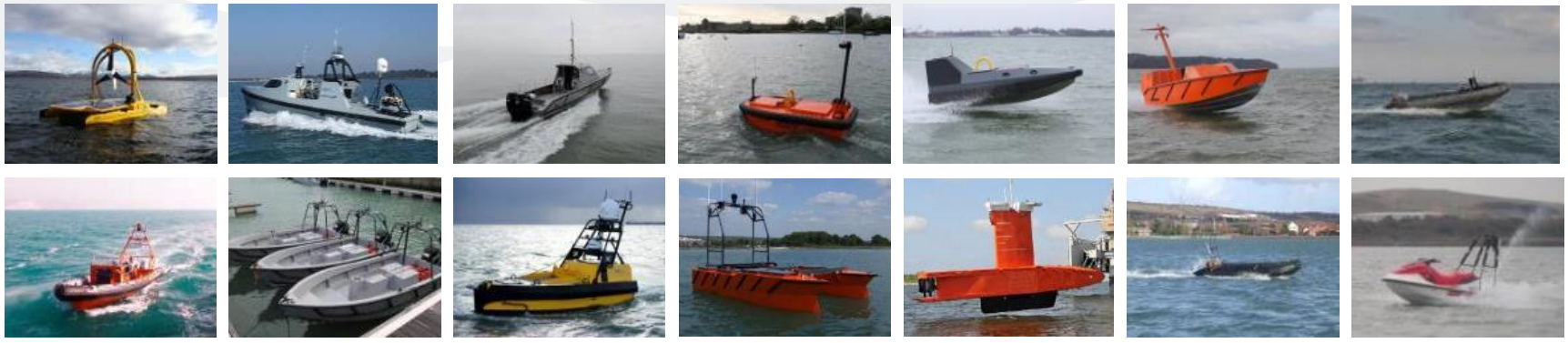
ASV unmanned marine systems

ASV unmanned marine systems

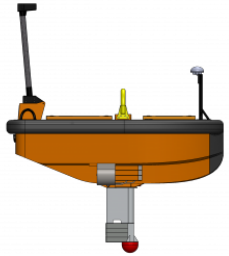



- **ASV Global designs, builds, sells, leases, and supports ASVs**
- **Founded in 2010, 110 Employees, US Owned, Offices in US and UK**
- **Provide ASVs for Commercial and Military Applications Worldwide**
- **Unmanned & Optionally Manned New Builds, Conversions**
- **Delivered over 90 systems from 6’ to 42’ in length**
- **Powered by Diesel, Solar, Wind, Battery; Endurance up to 60 days**
- **Supervised Autonomous Operations w/ Radio Telemetry or Satellite**
- **Advanced Payloads, LARs, Reliability, Collision Avoidance / COLREGS**

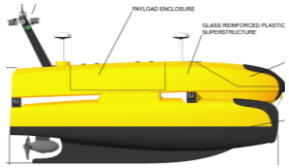


Commercial and Scientific

C-Stat 2
2 built



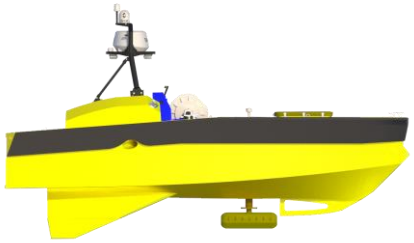
C-Cat 3
1 built

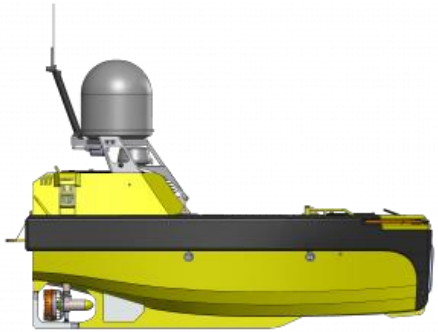


C-Enduro
3 built

C-Worker 4
1 built

C-Worker 5
4 built





C-Worker 6
2 built
1 in build

C-Worker 7
2 in build

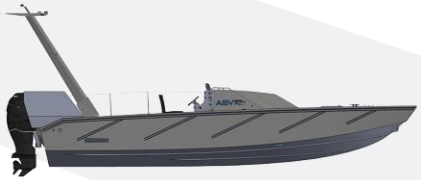
C-Worker 8
8 in build

C-Worker 12
1 built

Military and Security

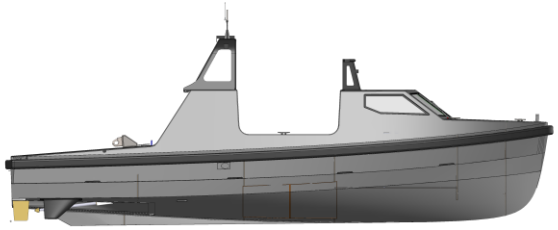
C-Target 3
2 built

C-Target 6
21 built

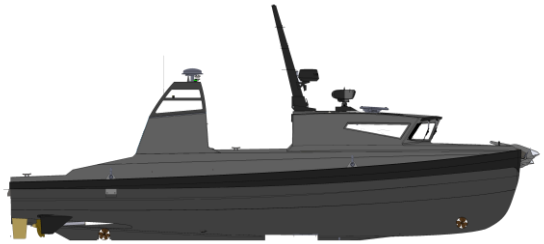


C-Target 9
6 built

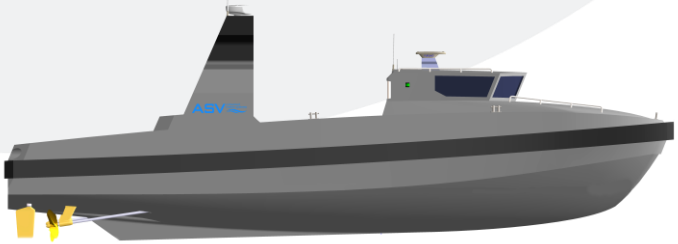
C-Target 13
6 built



Halcyon
1 built



Halcyon Mk II
2 in build



15m MMCM
Designed

These USVs are not detailed in this document.
Information is available upon request

ASV Conversions to Optionally Unmanned








Base Systems / Standard Features

USV

ASView-Core
Vehicle System

Radio Comms

Sat Comms

AIS Transponder
Forward Daylight EO Camera
Nav lights
Horn
Iridium
IP Line of Sight Telemetry
Depth Sounder
DGPS
Fluxgate Compass
MEMS IMU
Documentation
Misc. Cables, antennas,
Initial Consumables

Remote Supervision

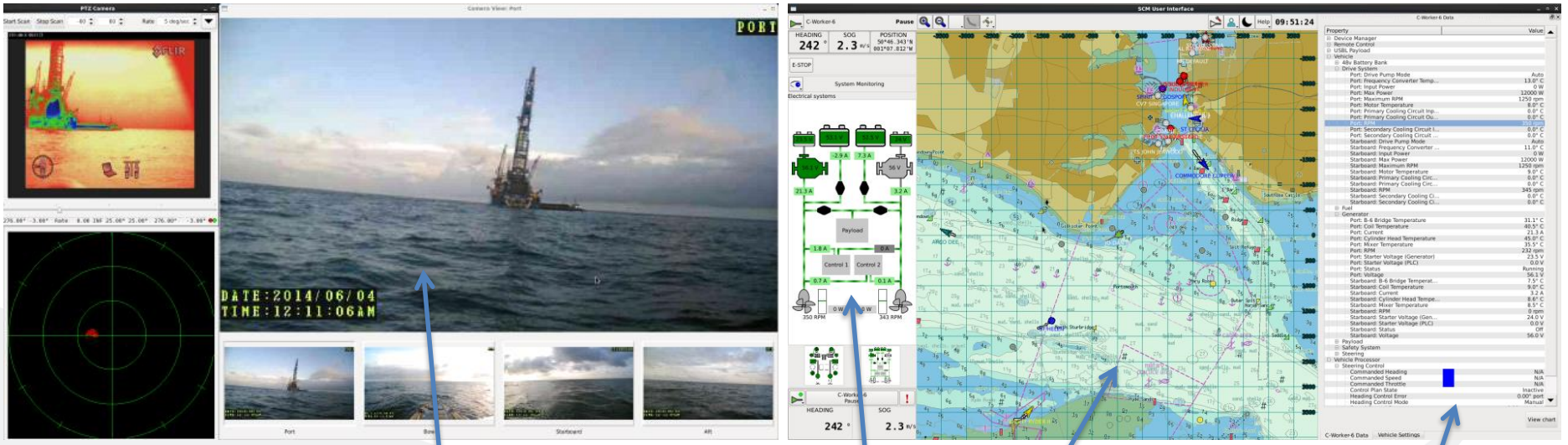
ASView-Base
Pelican Case

ASView-Bridge
User Interface

ASView-Helm
Remote Control

ASView-Base
Radio Enclosure

ASView – Vehicle Control System - UI



Machine Vision Feedback

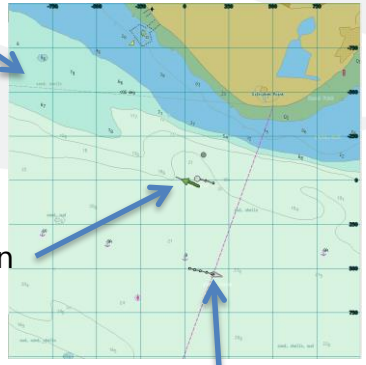
Critical Data Display

Main Display
Clear navigation data
Full S57 ENC's displaying
Vessel position and heading
Vessel track
AIS targets from receiver on USV
Radar overlay
Mission plans

Vehicle Data Display

Infrared PTZ camera view and control

ENC Charts



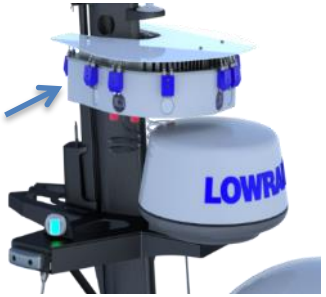
ASV Position

AIS Target

Radar view

Multiple cameras

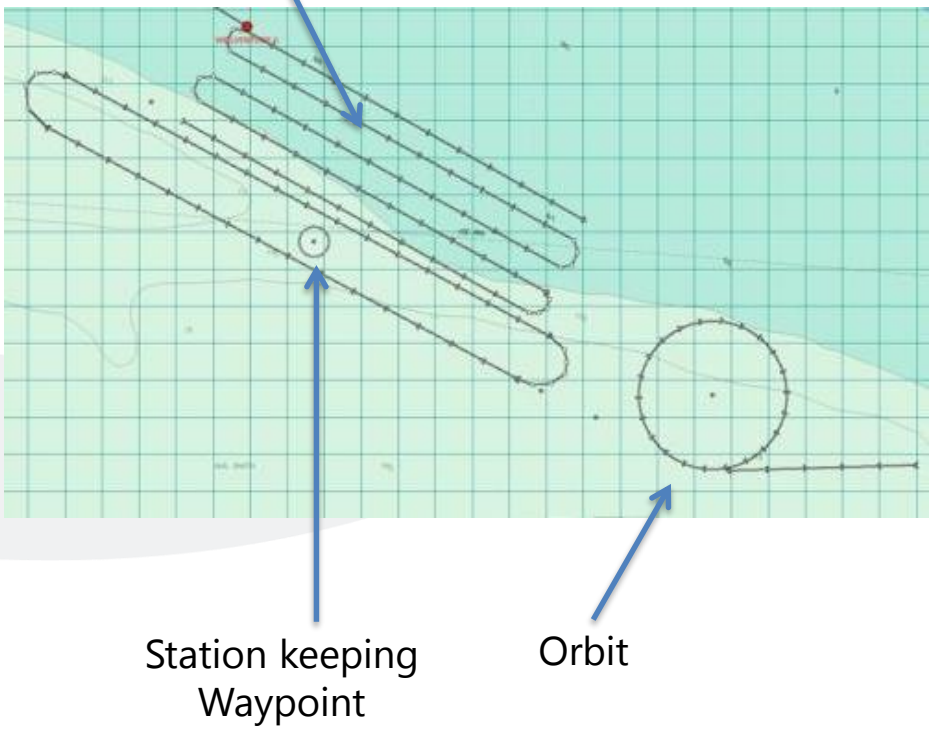
Optional 360 Degree Daylight & Infrared



ASView – Vehicle Control System - Functionality

Control functions

- Basic vehicle control – Start/stop, e-stop, payload, etc.
- Direct remote control (over low latency links)
- Assisted remote control
  - Heading hold
  - Speed hold
- Mission plan
  - Autopilot follows mission plan comprising any combinations of;
    - Lines (multiple route of waypoints)
    - Orbit's (Circular orbit at defined radius around a waypoint)
    - Station keeping waypoints (vessel station keeps at waypoint)
    - Imported mission
- Coms loss plan
- Geo-fencing tools to set operating and exclusion zones.



Mark 2 Belly Pack

WiFi Enabled

Optional Items*

Situational Awareness Package
- Radar
- Daylight 360 EO System
- Forward IR

Advanced Situational Awareness Package
- Radar
- Daylight 360 EO System
- Nightime 360 IR System
- Millimeter Wave Solid State Radar

Collision Avoidance Software Packages
- AIS
- Radar
- Camera

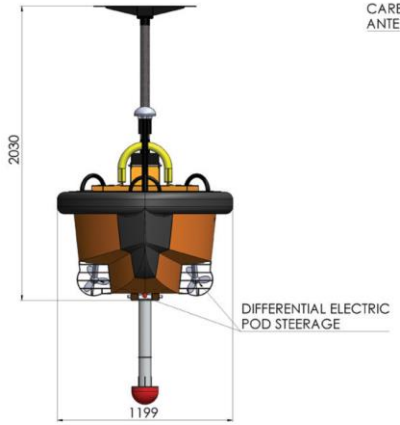
Advanced Spares Packages

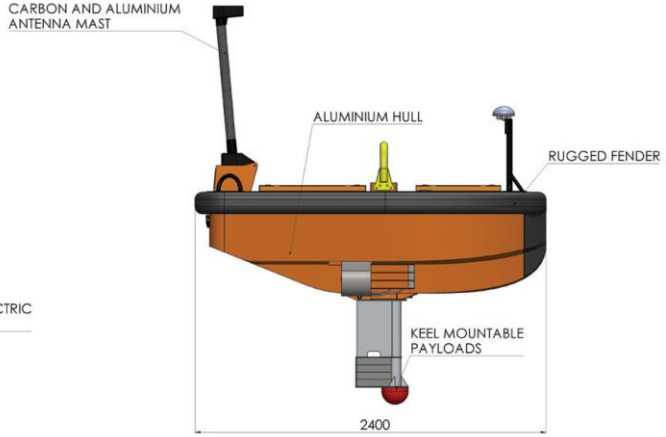
Satellite Communications Systems
- Single
- Dual

Other Optional Items:
- Boat Trailer
- Boat Cradle
- LARS
- Active Radar Reflector
- Hailing system
- Voice over IP VHF
- Custom Payload Integration
- Training Packages
- Field Operational Support
- Mission Control Monitoring Services
- Mission Control Room
- Payload Integration
- Payload Winch
- Articulating Transducer Ram
- Articulating A-Frame

*** These items are not include in the base packages, but are available on most platforms for an extra cost.**

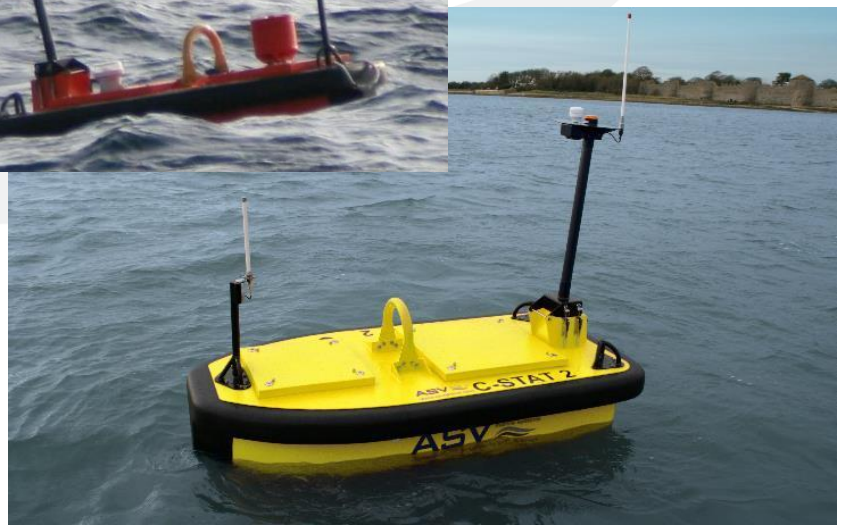
C-Stat 2 (2.4m / 8')





Primary Advantages: Station Keeping Buoy, 4 day Endurance Holding Station, Interchangeable Payload, Transducer Ram, Larger Versions available with Weeks of Endurance and Optional Anchor

Base Specs	C-Stat
Length:	2.4m
Beam:	1.2m
Height:	1.7m
Draft*	0.7m
Weight	450kg lightship
Propulsion:	Diesel generator, battery and 2 x DC thrusters
Speed:	Up to 3.7 knots
Approximate endurance and range:	4 days @ 1.8 knots = 172 NM 2 days @ 2.8 knots = 134 NM
Fuel capacity:	75 liters
Payload capacity (weight, power):	20kg, 300w



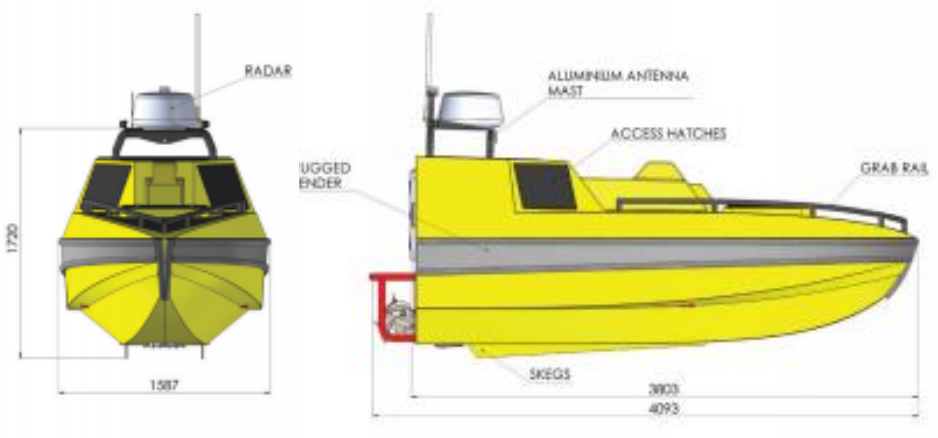
C-Cat 3 (2.4m / 8’)

Primary Advantages: Very Shallow Draft, Fits in a Pickup Truck, Endurance up to 6 hours with Lithium Battery Pack, Speeds up to 5 knots, Supports Various Payloads, Elastomer Coated Closed Cell Foam Hulls

Base Specs	C-Cat 3
Length:	2.86m
Beam:	1.46m
Height:	1.37m
Draft*	0.27m
Weight	Lightship 185kg, fully laden 235kg
Propulsion:	2 x DC electric motors driving 3 blades propellers
Speed:	Up to 6 knots
Approximate endurance and range:	4.5 h @ 3 knots = 13.5 NM 1.5 h @ 5 knots = 7.5 NM
Range at slow speed:	15nmi
Fuel capacity:	n/a
Payload capacity (weight, power):	~50kg

The C-Cat 3 is an evolution of the successful C-Cat 2

C-Worker 4 (4m / 13’)



Primary Advantages: Small Size, 2 day Endurance at 3 knots, Shallow Draft Jet Drive, Interchangeable Payload, Transducer Ram

Base Specs	C-Worker 4
Length:	4.17m
Beam:	1.58m
Height:	0.4m
Draft*	2.026m
Weight	786kg lightship
Propulsion:	30HP Marine diesel engine driving waterjet
Speed:	Up to 6.5 knots
Approximate endurance and range:	2 days @ 3 knots = 144 NM 0.5 days @ 6 knots = 72 NM
Range at slow speed:	150nmi
Fuel capacity:	100 liters
Payload capacity (weight, power):	30kg, 500w 19" rack 8U's Moonpool 0.8x0.59x0.5m (LxWxD)

C-Cat 4 (4.3m / 14’)


C-Cat 4 performing water quality monitoring in Japan.

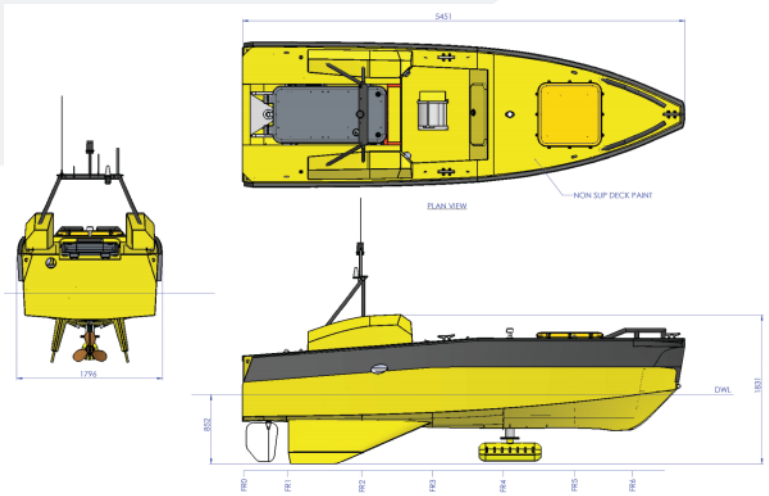
Primary Advantages: Shallow Draft, Endurance up to 48 hours with Diesel Generator, Speeds up to 6 knots, Supports Various Payloads, Collapses into a Standard 20’ Shipping Container

Base Specs	C-Cat 4
Length:	4.3m
Beam:	2.9m
Height:	2.5m
Draft*	0.6m
Weight	850 kg lightship
Propulsion:	Diesel generator w/ dual electric propulsion
Speed:	Up to 6 knots
Approximate endurance and range:	2.5 days @ 4 knots 6 days @ 2 knots
Range at slow speed:	
Fuel capacity:	
Payload capacity (weight, power):	

C-Worker 5 (5.5m / 18’)

Primary Advantages: **Force Multiplier, Interchangeable Payload, Winch Bay, Transducer Pole, Direct Drive Diesel, 30% Smaller than Manned Launch, trailerable.**

Base Specs	C-Worker 5
Length:	5.5m
Beam:	1.7m
Height:	0.9m
Draft*	1.8m
Weight	2100kg
Propulsion:	Direct driver fixed propeller 1 x Yanmar 57hp diesel engine
Speed:	Up to 9 knots
Approximate endurance and range:	14 days @ 3.5 knots = 1760 NM 5 days @ 6 knots = 720 NM
Fuel capacity:	800 liters
Payload capacity (weight, power):	800w



C-Worker 6 (5.8m / 19')

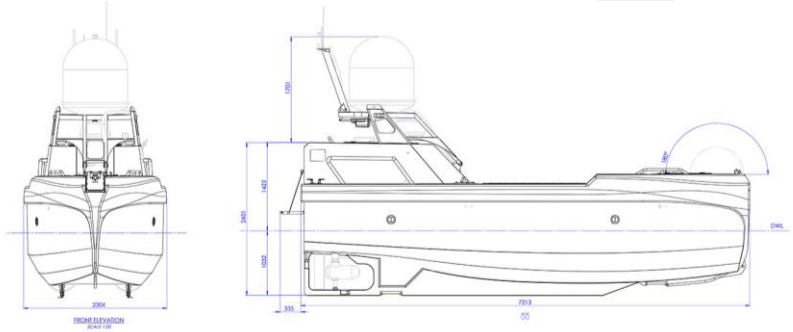
Primary Advantages: **Endurance up to 25 days, Potential for Over the Horizon Capabilities (monitored over VSAT), 1m x 1.5m Payload Moonpool, 1 kw Payload Power, Dual Redundancy, Diesel Electric Propulsion, Ships in 20' Container, Trailerable. Optional Retractable Rams, Sensor Winch, & Anchor.**

Base Specs	C-Worker 6
Length:	5.8m
Beam:	2.2m
Height:	4.75m or 2.2m with mast folded
Draft*	0.9m
Weight	3200kg lightship
Propulsion:	2 diesel generator sets driving 2 electrical pods via battery bank
Speed:	Up to 5 knots
Approximate endurance and range:	25 days @ 3 knots = 1800 NM 15 days @ 4 knots = 1440 NM
Fuel capacity:	1000 liters
Payload capacity (weight, power):	1kW, 350 kg; Moonpool 1.5x1.0x1.1m (LxWxD)

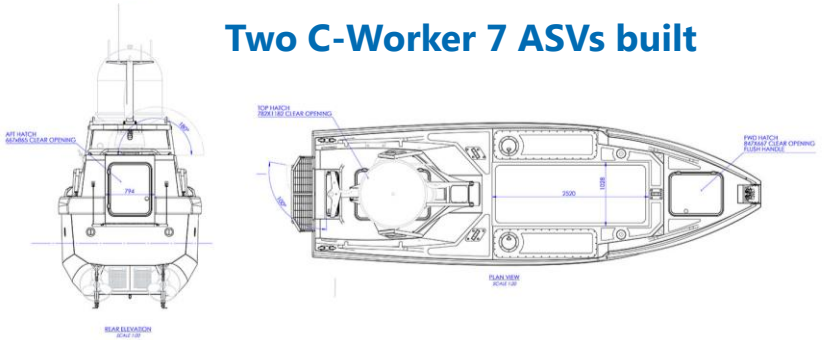
C-Worker 7 (7.2m / 24')

<u>Primary Advantages:</u> Over the Horizon Capabilities (monitored over VSAT), Endurance up to 30 days, 1m x 2.5m Payload Moonpool, 2kw Payload Power, Dual Redundancy, Diesel Electric Propulsion, Trailerable. Optional Retractable Rams, Sensor Winch, & Anchor.

Base Specs	C-Worker 7
Length:	7.2m
Beam:	2.3m
Height:	4.2m
Draft*	0.9m
Weight	3750kg lightship
Propulsion:	2 x20 kW diesel generator driving 2 electrical pods via battery bank
Speed:	Up to 6knots
Approximate endurance and range:	30 days @ 3 knots = 1800 NM 18 days @ 4 knots = 1440 NM
Fuel capacity:	1200 liters
Payload capacity (weight, power):	Up to 2 kW, 500kg; Moonpool 2.5x1.0x1.1m (LxWxD)



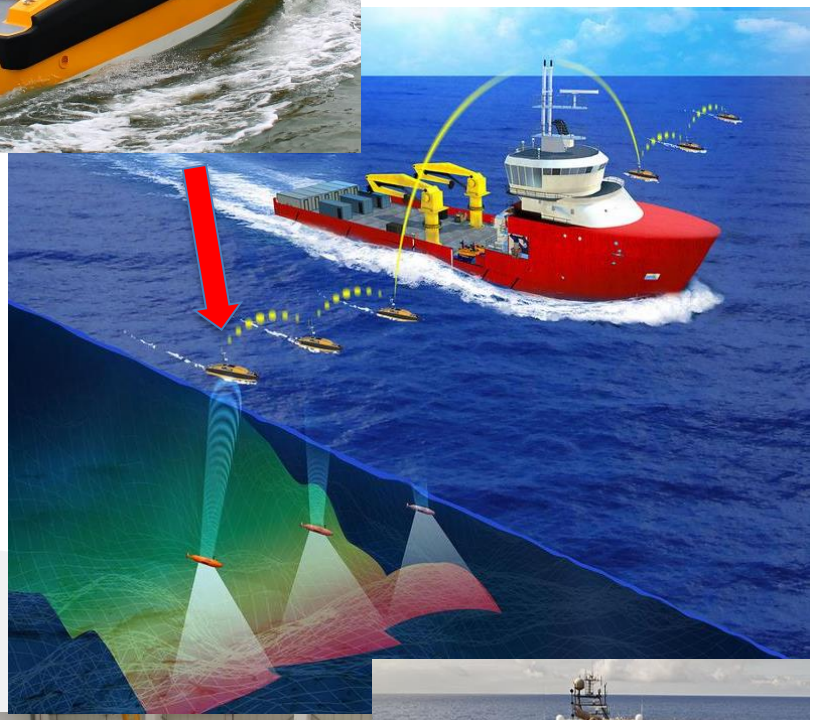
Two C-Worker 7 ASVs built



C-Worker 8 (7.6m / 25’)

Primary Advantages: Force multiplier for AUV & multibeam operations, dual direct drive diesel propulsion, dual cone & bullet latching system for dual davit launch and recovery from host surface vessel, trailerable.

Base Specs	C-Worker 8
Length:	7.7m
Beam:	2.15m
Height:	4.3m
Draft*	1.0m
Weight	4900kg
Propulsion:	Twin Yanmar 4JH45 (45 hp) Diesel Twin Fixed Propellers
Speed:	Up to 8 knots
Approximate endurance and range:	8 days @ 4 knots = 768 NM 4 days @ 6 knots = 576 NM
Fuel capacity:	1260 liters
Payload capacity (weight, power):	1kW, 200kg

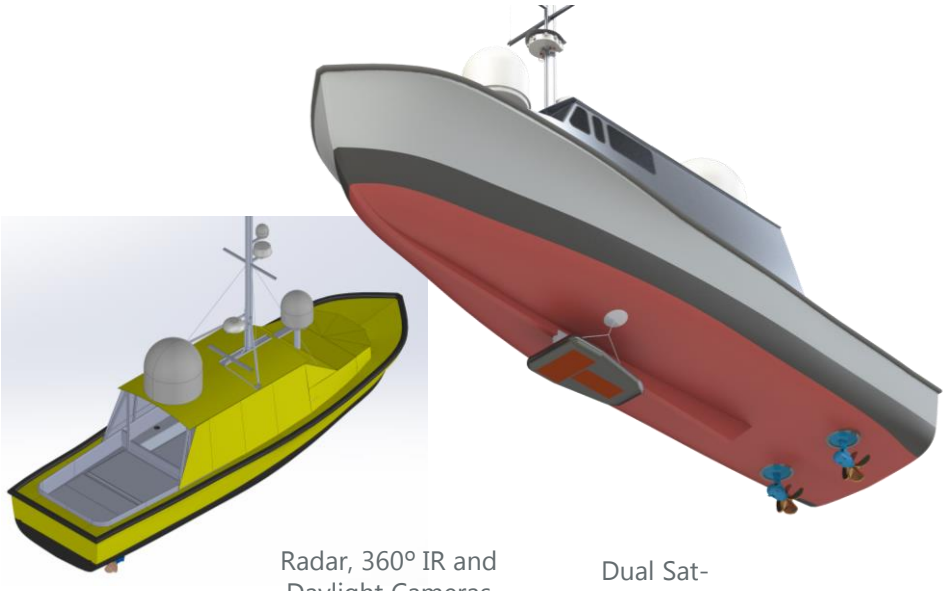


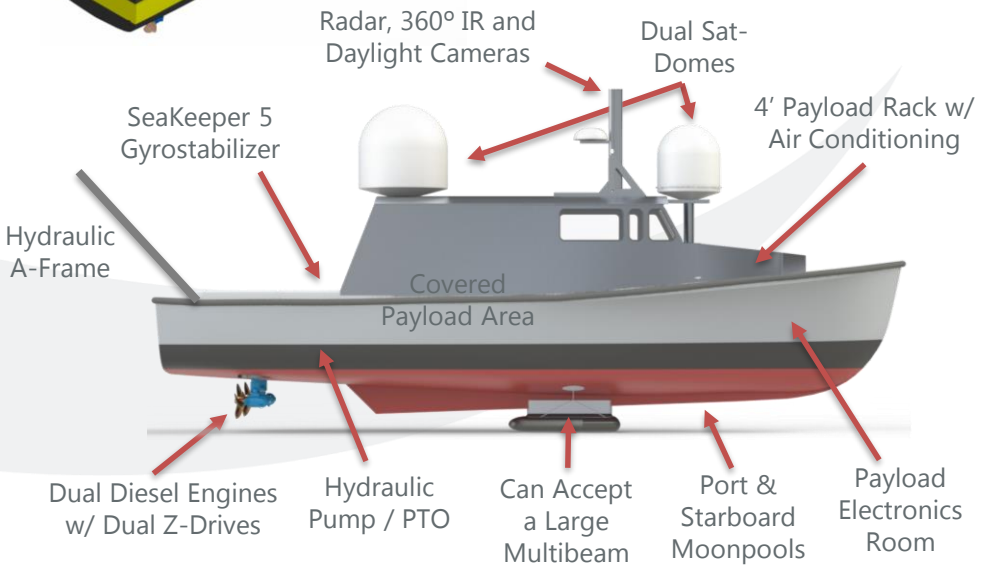
Eight delivered in 2017

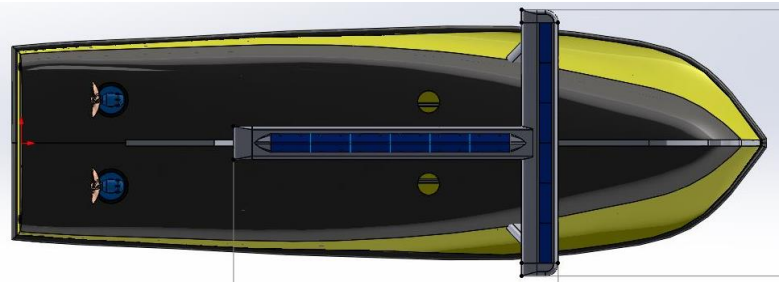
C-Worker 12 (12m / 40')

<u>Primary Advantages:</u> Over the Horizon Capabilities (monitored over VSAT), Endurance up to 30 days, Dual 14" Payload Moonpools, 8 kw Payload Power, Dual Redundancy, Road Trailerable in the USA. Optional Retractable Rams, Sensor Winch, & Anchor.

Base Specs	C-Worker 12P
Length:	12.1m
Beam:	3.6m
Height:	3.5m Hydraulic A-Frame
Draft*	1.16m max
Weight	8850 kg
Propulsion:	Dual Yanmar 4JH110 Diesel Engines with dual Olympic Z-Drives
Speed:	Up to 9 knots
Approximate endurance and range:	35 days @ 4 knots = 3360 NM 14 days @ 7 knots = 2352 NM 7 days @ 9 knots = 1512 NM
Fuel capacity:	5,550 liters
Payload capacity (weight, power):	4000 Pounds, 8 kw







C-Enduro (4.2m / 14')

Primary Advantages: **Diesel, Solar, and Wind Powered, Endurance 30+days, Over the Horizon Capabilities (monitored over Iridium), Large Payload Capacity**

Base Specs	C-Enduro
Length:	4.2m
Beam:	2.4m
Height:	2.8m (including antennae), 1.5m (mast off)
Draft*	0.4m
Weight	350kg lightship
Propulsion:	2 x DC Electric brushless motors, solar, wind, diesel
Speed:	Up to 6 knots
Approximate endurance and range:	30+ days @ 2 knots = 1440 NM 3 days @ 6 knots = 432 NM
Fuel capacity:	90 liters
Payload capacity (weight, power):	35kg, 300w peak, 50w continuous

Payloads Operated to Date

- Single Beam Echo Sounder (Odom CV100, numerous others)
- Multi-beam Echo Sounder (Kongsberg 2040, Reson, R2sonic, Teledyne MB1, Edgetech 6205)
- Ultra Short Baseline Positioning System (Sonardyne Lodestar GyroUSBL)
- Sidescan (Edgetech 4200, Edgetech 4125, Tritech Starfish)
- Acoustic Doppler Current Profiler (Teledyne RDI and Nortek)
- Passive Acoustic Monitor arrays (various)
- Conductivity, Temperature, & Depth (various)
- Acoustic Fish Tracking (Vemco)
- Wetlabs Triplet Puck (Chlorophyll, Dissolved Oxygen, Fluro.)
- Inspection ROV (Saab Seaeye Falcon)
- Acoustic Modem (various)
- Helikite w/ Camera
- Meteorological (wind speed, pressure, temperature, humidity)
- Laser (Renishaw Dynascan, Velodyne)
- Oil Spill Boom Towing
- Oil Spill Dispersant Application

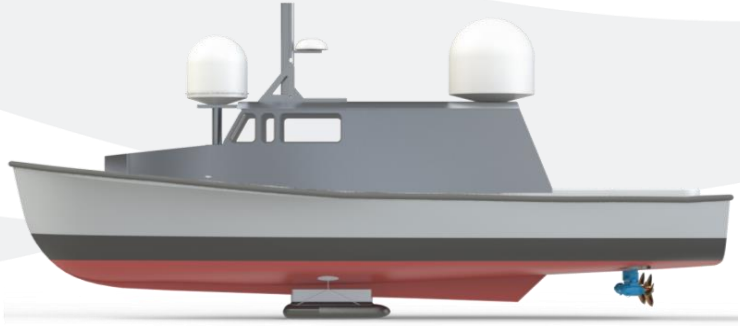
Interest in…

- Small Seismic Compressor
- Hull Mounted & Towed Subbottom Profiler
- Magnetometer & Gradiometer Surveys
- UAV Deployment & Recharge
- Buoyancy Glider Deployment & Recovery
- Mid-Frequency Multibeam to 1000m
- Remote Tide Modelling
- UUV Deployment & Recovery
- Drifter Buoy Deployment
- ROV Operations
- Sonardyne Blue-comm LED Modem
- Fire Suppression Foam Application

Summary

- ASVs have repeatedly demonstrated benefits in hydrography
  - Substantial production increases
  - Safety
- Until autonomy is perfected, ASVs must be supervised
- Will require some training / on board training
- Cannot eliminate ships and personnel
- Must account for LARS, spares, upgrades, CTD casting, etc.

CW5 – Great Hydrographic Force Multiplier



CW12 – Great Over-the-Horizon Survey Vessel

Makes Sense to Upgrade to Optionally Unmanned

ASV unmanned marine systems

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