The R/V HUGH R. SHARP (Fig. 1) is a 146’ foot, state-of-the art, general-purpose, Regional Class, research vessel built by Dakota Creek Industries in Anacortes, Washington, and officially commissioned into service as part of the University-National Oceanographic Laboratory System (UNOLS) fleet in May 2006. By the end of 2011 the *Sharp* completed 1061 days of science at sea under the operation of the University of Delaware. These cruises served 44 principal investigators for projects funded by the National Science Foundation (492 days), Navy (217 days), National Oceanographic and Atmospheric Administration (182 days), and several other sources (170 days). The ship's regular operating region is the Delaware and Chesapeake Bays and adjacent coastal waters out to 200 nautical miles. However, work has been conducted as far north as the Gulf of Maine, as far south as Florida, and as far offshore as Bermuda. The *Sharp* was designed and outfitted with several innovative features and meets International Council for the Exploration of the Sea (ICES) Report 209 sound emission standards.

Fig. 1. The R/V Hugh R. Sharp at sea.

The Sharp has a shallow draft to facilitate estuarine operations and was designed to be acoustically quiet. A second major design goal was to maximize operational flexibility through modularity and convertibility of the interior spaces. Additionally, the Sharp has several unique design features, including a novel over-the-side handling system with docking head for the CTD (Fig. 2), a retractable centerboard (Fig. 3), a convertible back deck/van space (Fig. 4) with a

covered vestibule to connect the van and lab spaces, and a computer controlled dynamic positioning system that is accomplished using twin rotatable Z-Drives and a tunnel bow thruster.

Fig 2. (upper left) The over the side handling system and CTD docking head

Fig. 3 (above) An overhead view of the retractable centerboard

Fig. 4 (lower left) The interior of the standard UNOLS van that is used to accomodate specialized user needs and lab space configuration

In 2009 the UNOLS Fleet Improvement Committee prepared eight debriefing questions to help determine how the unique features of the Sharp have affected the cruise objectives and to gather experiences of scientists who have experience with the new design features at sea (Table 1). These questions were asked of eight chief scientists after cruises they conducted in either 2010 or 2011.

Table 1. Debrief Questions for R/V Hugh R. Sharp Investigators 2010-2011.

No.	Design Feature, Explanation and Question Posed during Debrief Interviews
1	Size: In order to maintain operational flexibility and reduce overall life-cycle costs the *Sharp* was designed to stay below key regulatory size thresholds. The *Sharp* is less than 300 Domestic Gross Register Tons and 500 International Gross Tons, which are both volume measurements used by the shipping industry. This vessel is essentially as large as can be designed and stay within these limits. **Has the overall size of the vessel either enabled or hindered you in meeting the science objectives of your cruise? Please explain how with specific examples.**
2	Over-the-Side Handling System: The *Sharp* has been outfitted with a system that allows "hands free" launch and recovery of CTD and other systems on the starboard side using a docking head and motion controlled winch systems. **Has this system had a positive impact on your work and if so how? Are there any negative impacts associated with this system?**
3	Retractable Centerboard with mounted acoustic transducers: The *Sharp* is fitted with a retractable centerboard that can be lowered to 2 meters below the keel and on which there are three 24" x 24" transducer bays for ship and science use. Transducers are changeable alongside. **Has this arrangement had any significant positive or negative impacts on your work?**
4	Acoustically Quiet: The *Sharp* was designed, engineered and built to be below ICES 209 noise limits at 8.0 knots. Radiated airborne noise within the ship is also designed to be at low levels. **Have you noticed any difference compared to other vessels, and has this had any positive or negative impacts on your work?**
5	Vans and deck space: The set up of the *Sharp* for any particular cruise is "modular" in that there is a choice between more deck space or more enclosed lab, berthing or storage space. The design of the *Sharp* incorporates the ability to fit two vans on the back deck for lab space or other uses. These vans are essentially integrated into the superstructure when installed. **If you have used the vans, how well did they accommodate your internal space requirements? Did this modularity have a positive or negative impact on your cruise planning and work at sea?**
6	Variable Berthing Capacity: The *Sharp* can accommodate science parties ranging from 14 to 20. By using the conference room as a two-person stateroom, 16 can be carried presently. In the future by using a 4-person berthing van the total can be 18 or 20. **Did your project have need for the full berthing capacity of *Sharp,* and what do you see as the benefits and drawbacks to the approaches available on *Sharp?***
7	Dynamic Positioning: The *Sharp* was designed and outfitted with dynamic positioning (DP) capabilities. This is accomplished by using twin rotatable Z-Drives, a tunnel bow thruster and a commercially available computer controlled dynamic positioning system. All of these components add cost, maintenance requirements and complexity to the operation of the vessel. **How important was the DP system to your work? How well did this system operate during your cruise(s)? Was noise from the DP system disruptive?**
8	Other Features: **Can you describe other design, outfitting or operational features of the *Sharp* that had significant positive or negative impacts on your work at sea? Should these features be requirements of other new Regional Class Research Vessels (RCRVs)? Were there any important design features missing that should be available on RCRVs?**

The feedback received from debriefings is summarized in Table 2 according to design feature in this report to inform design recommendations for future Regional Class Research Vessels.

Most users found that the size of the Sharp was about right for their needs. All users greatly appreciated the ship's flexibility to accomodate more or fewer scientists due to its variable berthing arrangement. Some did comment that the ship space and ship crewing were at operational limits at maximum berthing, and that this number of scientists was not practical for longer cruises. Most of the scientists in our survey did not have scientific needs that required an acoustically quiet ship, but all users commented on how quiet the Sharp is to other ships and how this really had a positive impact on ship habitability.

Responses were overwhelming favorable on the novel features of the R/V Sharp. The over-the-side (OTS) handling system was well received. Several scientists commented on its ease of use and safety, and also mentioned that the system allowed them to sample in higher sea states than would be possible for other ships of this size. (One negative comment outside of this survey was received from a potential Sharp user who had concerns that the OTS design and proximity of the docking head to the rosette could increase low level contamination of samples collected using the rosette bottles.) Most users did not need the retractable centerboard feature but appreciated its value. The one scientist that did use the retractable centerboard really liked the design, and commented on how the ease and speed in which equipment could be mounted or removed was a great benefit to their science needs. The shallow draft was felt to be very valuable for estuarine operations although it does increase ship roll even with trim tabs. The stairs and ship design was ideal for a user who did alot of diving operations. One user praised the load control system on the A-frame.

Users liked the flexibility of the van arrangements and deck space. Most users felt that the deck space was adequate for their needs even with two vans. The unique vestibule walkway design to connect the van and labs worked very well and accommodated science need. The vestibule arrangment was especially valuable to users who worked in both specialized vans and lab spaces and needed the protection and safety moving between these spaces. One user praised the modular hoods and the flexibility of hood placement in the labs. Users indicated some improvements could be made in the design of connectivity between the van and lab spaces for running cables, transfer lines etc., in the freshwater supply to van and/or deck spaces.

Users who needed dynamic positioning were pleased with its operation. Users who had not used DP before commented on how this improved station keeping and was especially beneficial as the Sharp often does operations in confined areas or areas of high tidal currents. One comment was received indicating that the DP was not capable of holding the ship in position during rough weather.

Suggestions were made on other improvements to better accommodate current and future needs. A Seabeam capability for bottom mapping would be useful. One user commented that the 9/16" trawl wire was undersized for some operations and expressed a future need to have a capability for dual cable operations (fiber optic and wire rope). Users mentioned that there was some room for improvement is a few specific areas: the underway data acquistion system and logging of data streams (e.g. winch data), internet capability, the ship's crane and the underway clean seawater system.

In summary, all users greatly appreciated the R/V Sharp's flexible and novel design features and felt that these features were valuable and helped them to better meet their science objectives. Without exception, all users thought that the Sharp was a great ship and one of the most capable, if not the most capable, regional ship currently in the UNOLS fleet.

Table 2. Chief Scientist's responses to debriefing questions

Cruise P. I.	Bryne & Nordahl	Sommerfield	(Kirchman/Cotttrel	Luther
Question	Debrief #1	Debrief #2	Debiref #3	Biogeochemistry Debiref #4
Vessel Size:	The Sharp meets their needs, the overall size is good and the cost reasonable. Did 24/7 ops, 13 scientists onboard. A negative is the smaller crew for ops, e.g. gear handling. The low freeboard makes for wet deck in rough seas. The shallow draft leads to significant roll- the trim tabs help somewhat.	Sharp is the right size for his work that is mostly at the interface of rivers and the coastal ocean he also said the ship is fairly comfortable offshore. The Ship is headed to the shipyard for some work to stabilize it so not everyone thinks the ride is fairly comfortable	Sharp is just about right for what we do. It is comfortable and safer than Cape Henlopen. Van space used heavily	The size has allowed us to do what we normally have done, but I have found deployment of moorings and other equipment much easier than the R/V Cape Henlopen and some other vessels as the deck size are wonderful for a range of work
Over the side Handling System:	CTDs made every third station, hence ~ 150/cruise. Handling system viewed positively. Better than without the system. Do not have severe weather in May and June so no comment on system performance in poor conditions. No negative impacts.	He really likes the CTD crane besides allowing deployment of the CTD in rougher weather; it makes the whole operation safer. He says almost everyone he talks to is very happy with the CTD handling system.	The handling system is great. At first it took a little while for the crew to get used to using it. This is past now. The system is reliable but a little overkill in terms of roll compensation	The major positive impact for the CTD launch and recovery is that it is all automatic and we don't have to bring it aboard and possible injuring ourselves in the process. Sampling is much easier and safer as the CTD can be brought within the garage doors on the ship for sampling from the bottles.
Retractable Centerboard with mounted acoustic transducers:	Ddin't use but like the shallow draft ,esp. as new NOAA Fisheries vessels draw 20' and have 'halo effect' with inaccessible areas. Can imagine how acoustics would be of value. Future plans to use HABCAM system to video bottom and transmit to ship via fiber optic, Seabeam capability for bottom mapping would be beneficial. If feasible would use the retractable centerboard.	He does not use this feature so he has no comment	Do not use	This is a good arrangement and has not impacted our science.
Acoustically Quiet	Not needed for scallop surveys. Sharp in much quieter than other ships, 'fishing capable'. Noted this is an expensive feature with significant maintenance costs. Other ship noise not normally heard is heard (eg stabilizer arms have noisy hydraulic lines, as used 90 deg elbows rather than smooth, tapered curves (now corrected?).	He says the ship really is quiet. He doesn't require the quiet but he really appreciates it.	It is noticeable that Sharp is quieter. This has a positive impact when working long hours.	This ship is VERY quiet and I know of no other ship that give such noise reduction comfort
Vans and deck space:	Likes the van arrangement. Has sink and measuring stations, with electronic equipment (e.g., scales) that transmit to main lab. A real plus over commercial boats formerly used. A second van would interfere with deck space now used for spare dredge. Freshwater supply could be better (currently limited to either deck or van use) and needs more flow. Semi-permanent connections for computer cables, etc between van and main lab would be very desirable to preclude stringing wires each time.	He also doesn't use vans in his work but he did say that there is adequate (lots of) deck space and it is clear deck space even when there are 2-25 foot vans on board. He fills 25-55 gallon drums as part of his work and there is still lots of deck space. The multi beam system is housed in a van so when that is used it goes on quickly and everything just plugs in. He also says the wet lab and the dry lab are good sized. He compares the deck space with the Wecoma.	We have used two configurations- one radioisotope van or two vans (isotope and general use). Deck space was not limiting and was used for incubators. Stern operations were not conducted. Breezeway is a good feature. It is nice for changing shoes when entering the isotope van. It is well lit when deck lights are off	We have used the trace metal clean van and normal van on one cruise and we were still able to have ample room to deploy a mooring. The vans provide much more space and allow for more science to be accomplished while at sea
Variable Berthing Capacity	They had 22 persons aboard. Didn't use conference room for extra berthing but for office area. Crowded at mealtime, but tolerable. Lauded the lone cook that accomodated this many people – excellent food.	They use 13 of the 14 standard bunks. Useful to have capability to get extra berthing by converting other space or adding a bunk van. Ship works well with 13 or 14 scientists but the galley only seats 10 so mealtimes are conjested.	Never maxed out berthing. 14 is plenty	We have used all the berths without needing the conference room. I don't see a reason to use the conference room or a berthing van.

Table 2. Chief Scientist's responses to debriefing questions

Cruise P. I. Question	Bryne & Nordahl Debrief #1	Sommerfield Debrief #2	(Kirchman/Cotttrel Debiref #3	Luther Biogeochemistry Debiref #4
Dynamic Positioning:	Don't use it, save perhaps for CTDs (uncertain).	They put pumps overboard and they need to stay on station for 20 min or so. Usually the boat driver can hold station, but when the get in the high tidal current areas they use the DP. This feature is very nice when they need to be perpendicular to the currents. He thinks the DP works well.	Not important for our work. Not used	We have used the DP to make sure that our mooring is placed at the same position each year in the Delaware Bay. It met our expectations.
Other Features:	Wire (9/16th) light for dredging, ¾" better. A net reel would be nice. Endurance is good, adequate deck and lab space, and good support at sea and ashore. 24/7 internet with real-time data transfer ashore would be useful for communication/decision-making. Internet access poor (one shared computer on bridge). FIC should see what NOAA does re connectivity. The underway data acquisition system could be better and is difficult to access- may be a fleet-wide issue? Trawl winch data should be logged. Future plans for habitat mapping using HABCAM and scallop trawl sequentially will need capability for both fiber optic (large bending radius) and wire rope (smaller bending radius) thus two different sheaves on A-frame (Sharp currently has both wires on below-deck winches?)	He says the sharp is a very capable ship and everyone feels that way. However they are comparing to their previous ship the Cape Henlopen. He thinks this ship comparable to some of the other Intermediate Class UNOLS ships. He feels this is the ideal size for a coastal/inland waters ship. Some people have complained about stability but he doesn't think this is an issue. He thinks that 85% of the users do water column work and all think the hands free CTD is great. Overall he really likes this ship.	Features of Sharp that standout are its relative proportions of wet and dry labs, berthing space is right, galley is a little small, nice lounge/conference room. Technicians shack is easily accessible and centrally located. Short distance and direct connections between labs.	I believe that the R/V Sharp has wonderful capabilities for a RCRV and exceeds many other, if not all other, vessels in that class. The deck and lab (both wet and dry) space are laid out well and two vans can be accommodated easily with plenty of deck space still available. The berthing quarters are also as good if not better than most vessels that I have sailed on.

Table 2. Ch Table 2. Chief Scientist's responses to debriefing questions

Cruise P. I.	M_Johnson	Katz	Tang	Canuel
Question	**Debrief #5**	**Debrief #6**	**Debrief #7**	**Debrief #8**
Vessel Size:	The size of the Sharp was ideal for my research objectives. We had a science crew of 11, and did not feel like we were in each other's way. We were able to access far up tributaries as well as sample the coastal ocean and open Bay. The Sharp has adequate space for dry and wet lab research, as well as on-deck incubations and vans	Prof. Katz found the size of the vessel an improvement over previous vessels used (e.g., R/V Cape Henlopen and R/V Cape Hatteras). His main comments on this related to the deck space and ability to fit vans on back deck.	For their cruise the ship was full. They felt that it would be good if the Sharp were a little bigger, but they realized that they had previously done basically the same kind of thing on the Seward Johnson. Overall the size was adequate.	Ship size is perfect for my science needs. We don't have major deck space needs.
Over the side Handling System:	The hands free CTD system worked smoothly for us and was convenient for accessing samples when it was raining. No negative impacts.	The CTD system was used in an ancillary capacity. Near bottom measurements were adequately conducted with the ship's CTD system although the marine techs were hesitant to deploy to < 2 m from bottom. Since this was not a critical element of the science Prof. Katz did not critically evaluate the docking head and motion control winch system.	They really loved this feature. They said all they had to do was ask the tech to do a CTD and the tech was able to do it all by himself. The science party was free to do other things while the CTD was being done.	Doesn't use specialized winches or wires, collect water column and sediment samples, and do filtration/ ultrafiltrations of large volumes and low volume incubations. The OTS system has worked well. A drawback is that it's large and so difficult to work close to the bottom. Can't get interface samples as the CTD is at top of the cage. A second small CTD sensor unit that can get closer to the bottom would be very useful. (Not collecting rosette samples so can't comment on potential contamination from OTS system).
Retractable Centerboard with mounted acoustic transducers:	This arrangement did not affect our research	This was not specifically commented on. Prof. Katz did comment on the utility of the ship's mapping system for target selection and obstacle avoidance.	They also loved this feature. The mounted equipment on this and it was no big deal. It saved a lot of time over having to deploy their acoustic toys without the feature.	Doesn't impact my work. Ship is stable and very comfortable to work on. The roll seems less than other similar coastal vessels I've worked on.
Acoustically Quiet	The Sharp is very quiet and does hardly created vibrations at all. This was very helpful for doing microscopy while underway	Did not comment on this feature.	They really appreciated this feature also. They said relative native oceanic noise (waves, wind, rain, etc.), the Sharp was quite quiet even with the generators, fans and pumps running. They were impressed.	A great thing, very quiet interior spaces (except when dynamic positioning is on). We don't use any acoustic equipment.
Vans and deck space:	The vans were very helpful. It would be nice to have a second general purpose van available. It would also be nice if they had better ventilation inside.	Prof. Katz found this one of the most improved features of the *Sharp* relative to previous vessels used. He found that it greatly aided his work to have a protected environment on deck for instrument prep and ability to also have an instrument supply van on hand.	Although they did not use the vans they appreciated the flexibility they offered. One thing they said was that by the time they got all their stuff set-up in the lab it was quite crowded. Next time they will use one of the vans for equipment.	My focus is natural abundance 14C so the capability to bring a 14C free van to accomodate my equipment is extremely valuable. The walkway overhang gives good protection and security for personnel moving between lab and vans. Back deck space was adequate for large incubation troughs with flow-through seawater. We don't need a second van but the modularity and capability is desirable to accomodate several scientists needing specialized or isolated spaces.
Variable Berthing Capacity	We did not need to use the full berthing capacity of the Sharp. I think 20 might be a too many, but if meals were in shifts and work space well organized, I guess it could work	This was not utilized on this cruise as the science party was only 8 persons.	They did not use the berthing but what they did say is something like "if you put 20 scientists on the Sharp for any length of time it might get pretty close".	We have not utilize the high berthing capability (max 10 in science party)

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Cruise P. I.	M_Johnson	Katz	Tang	Canuel
Question	Debrief #5	Debrief #6	Debrief #7	Debrief #8
Dynamic Positioning:	The DP system was not important for our work on this cruise, but I could see how it would be useful for future needs (i.e. maintaining position along a front)	Was used only coming onto site and not during experiments, as it would have disturbed the current measurements. The ship used a three-point mooring arrangement to stabilize it during the experiments. This was not adequate during rough weather, however. Is there an alternate stable mooring arrangement?	They used this when they ran lines and they thought it was really helpful. This is probably in relation to the Seward Johnson cruise. They thought all future ships should have DP.	DP was valuable and very useful as we routinely work up in narrow estuary with shipping traffic where the ship can't anchor but we need to remain stationary for long periods. (I'm not familiar with how this measures up with using a bow thruster) One drawback is the DP is really loud in berthing area (thrusters?) when on.
Other Features:	The Sharp could benefit from a second or larger wet lab (although this did not cause issues for us). The on-line layout for the Sharp needs to be updated for planning cruises. I cannot think of missing design features for RCRVs.	Katz found the ship's ADCP system very useful in his work to profile the mean current velocity. The main limitations discussed were the difficulties in over-the side deployment and particularly retrieval of instruments in rough weather using the stern A-frame. Ship's crane did not have sufficient reach to help with this with his payloads. The main improvement he suggested is some method to stabilize instrument packages during such over-the-side deployments and retrievals.	They did a lot of diving (to imbed acoustic targets into the sandy bottom) and really appreciated the stairs on the starboard side that is cut notched into the ship and normally is covered by plate on the fantail when not in use. Liked the load control system on the A-frame that is composed of a couple of small winches that are mounted on either side of the A-frame that control the height above the deck of the A-frame load. Finally, they had these couple of comments about R/V's in general that they wanted to make: 1) Most ships are not at all well set-up for diving opps, 2) DP is a wonderful thing, and 3) There is no ship in the U.S. that is equipped to run on batteries for a limited amount of time (6-8h) in order to accommodate acoustic studies that need really quiet operations. Evidently the British and Canadians each have one.	Modular hoods and the flexibility of hood placement in different labs has been very, very useful to me and very helpful to my science as well as adding to the ease of working on the Sharp. A clean underway seawater system would have been useful for collecting samples in some situations as the estuary is a dynamic system and also we could sample when steaming, I think the underway system is not currently functional? We deploy tubing by connecting it to the wire and pump at an assigned depth for a long period of time-the electronics control for the winch used is a small hand held box, it seems flimsy to me.. but we have never had a failure.