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Summary Memo on an Invasive Species Initial Assessment of the *Endeavour – Spirit of Independence,* Kachemak Bay, September 10-11, 2012, for Buccaneer Alaska, LLC.

Introduction

On September 8, URS was contacted by representatives of Buccaneer Alaska, LLC, to conduct a survey to investigate the potential for non-indigenous (alien) marine invertebrates or algal species to have been carried on the legs of the jack-up drill rig *Endeavour – Spirit of Independence* and possibility of these species being introduced into the marine water of Kachemak Bay and Cook Inlet. URS agreed to conduct an initial visual survey of surfaces in representative areas of the legs to look for encrusted or attached marine biota that might be considered invasive species. Crevices or cavities would also be evaluated for potential to harbor more mobile species.

Presidential Executive Order 13112 defines an "invasive species" as a species: 1) that is non-native to the ecosystem under consideration, and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. A non-indigenous species (NIS) is considered any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem (EO 13112, 1999).

This subject has become a concern in recent years as several non-indigenous species have made their way into Alaskan waters. NIS species are not currently common in Kachemak Bay, especially considering level of marine traffic, but changes in environmental condition such as water temperature may make this area more susceptible to marine species for the more southern latitudes (Ruiz et al 2006, Smithsonian 2011). Most the research effort has focused on ballast water as a mechanism for transport, but hulls of ships and barges are also an important mode of transport that can introduce species to an area (ADF&G 2012).

Background

As conveyed in conversations with representatives of Buccaneer, the *Endeavour* left the Keppel FEL shipyard in Singapore on August 1, 2012 and arrived in Kachemak bay on August 24, 2012 on a heavy-lift vessel semi-submersible float-on, float-off ship "Kang Sheng Kou", which carried the rig out of the water on its deck from the shipyard in Singapore to Alaska (D. Combs, Buccaneer Alaska, personal communication, also MM. Armstrong, Homer News, 2012). The rig remained on the vessel, out of the water, for approximately a week after arrival, when it was moored at the Homer Deep Water Dock (D. Combs, Buccaneer Alaska, personal communication). The rig had been undergoing repairs and upgrades in dry dock at the Singapore shipyard for a period of approximately 6 month. Prior to putting the rig in dry dock repair and upgrading, the rig had been cold-stacked (stored without power) in Malaysia in 40-50 feet of water since 2009 (B. Smith, Archer Drilling, personal communication).

Non-Indigenous species of Concern

A list of non-indigenous species of concern that have been documented in Alaska has been assembled by the Alaska Department of Fish and Game (ADF&G 2012) and the Prince William Sound Regional Citizens Advisory Council (PWSRCAC 2004) include following:

Algae

- Deadman's fingers (*Codium fragile)*
- Rock Weed (Fucus cottonii)

Sponges

- Boring sponge (*Cliona thoosina*)

Polychaetes

- Capitellid worm (Heteromastus filiformis)

Bryozoan

- Single-horned Bryozoan (*Schizoporella unicornis*)

Tunicates

- *Botrylloides violaceus* (orange or pink morph)
- *Botryllus schlosseri* (orange or white morph)
- Didemnum tunicate (*Didemnum vexillum*)

Shellfish

- Manila clam (Venerupis philippinarum)
- Eastern softshell clam (*Mya arenaria*)
- Pacific oyster (*Crassostrea gigas*) (not reproductive in Kachemak Bay)

Crustaceans

- European Green crab (*Carcinus maenas*)
- Chinese mitten crab (*Eriochier sinensis*)
- Tube-dwelling amphipod (*Jassa marmorat*)

Most of these species are moving up the western coast of the U.S. and Canada as opposed to coming in from the Asian Pacific (Ruiz et al 2006). Additional species are suspected of being introduced but the origin and time and method of introduction is not understood. These are referred to as "cryptogenic" species (Hines and Ruiz 2000).

Survey Schedule

The visual invasive species survey was conducted on the *Endeavour* on September 10 and 11, 2012 while it was moored at the Homer Deep Water Dock. The survey was conducted by David Erikson, Senior Biologist with URS Corporation. Mr. Erikson is based out Homer and has over 40 years of professional experience in Alaska, including marine studies of Kachemak Bay and Lower Cook Inlet with Dames & Moore, a legacy company. Mr. Erikson was assisted by Don Combs, Buccaneer Alaska's QSE Coordinator, and Billy Smith, Offshore Installation Manager with Archer Drilling.

Methods

The focus of the first day of the survey was on the three legs (bow, port and starboard legs) of the rig, particularly the lower portions of the just about the waterline and the portions that were in the water during the cold-stack period. The survey was primarily a visual inspection with photographs and collection of some representative specimens. The bow leg of the rig and its support structures were initially evaluated for any marine life. The survey then focused on the jacking guides in each corner of the legs (chords), and guide slots, which seems to have the most marine growth (old oyster shell and barnacles). These attached shells near the guides extended up the legs from the main deck about 20 feet to the next level, but the survey focused on the lower extent of the legs that could be accessed and sampled safely. Photographs were taken of the shell or shell material and any other areas that showed signs of marine growth. Samples of shells were collected from the guide slot of loose shells on the deck or walkways, which had previously become detached.

Based on what was seen on the first day's survey, the survey on the following day focused on the spud cans (the bottoms of the legs) and their support members. These areas had not been recently scraped and painted like the rest of the legs and marine growth was evident. Collecting samples from this structure required additional assistance of a trained climber as it required accessing the spud can from the main deck by ladder and the use of a climbing harness. The target of this effort was a film of encrusted marine life on a structural component of the spud can. Close up photos of the crust were taken and a sample from two areas was collected for microscope examination.

Results

Remnant shell material and whole shells on the legs are primarily confined to a narrow 4-inch space between the leg chord and the jacking guide for the leg (Photo 1-3). The jacking movement doesn't appear to scrape these shells off in the process of raising and lowers the legs. The shell or shell crusts were found in the narrow, 4-inch gap on most of the chords (corner structures) of each of the three legs. Most of the shells in the narrow gap were covered with a thin coat of gray paint, which likely happened during the painting of the legs and their supports while it was in dry dock this past year. Remnants of oyster shell were also noted on the spud can support members and catwalks to the spud can manhole and on the lower portion of the jacking guide (seen though an inspection port) (Photo 4-7).

Shells in this 4-inch gap were primarily oyster (several species) with barnacles the second most common shell (Photo 8-12). Barnacle shells were both attached to metal surfaces and other shells. The starboard leg had more barnacles and less oyster shells. None of the shells examined supported any live animals,

nor was there any remnant of tissue associated with the shells. Some of the shells had been dead for some time, based on the deterioration of the shell material.

No living organisms were found in the encrusted marine film that was sampled from the spud can support member (Photos 14-17). Examination under a microscope found the mat to consist mostly of a dried calcareous tube worm cases, juvenile mussels, and a few juvenile clams (Photos 18-19). The mat was held together by the byssal threads of the mussels. Some of the juvenile mussels had some desiccated tissue still in the shell, suggesting they were likely alive when the rig went into dry dock. There were also dead fly larvae (maggots) entangled in the mat, which likely feed on the mussels and worms after they died.

Loose shell debris was found in several areas around the leg such as decks, stairways, cracks and crevices and catwalks. Much of this scattered shell debris appears to have come from the scraping and cleaning of the legs and supports prior to being painted this past year.

Discussion

Jack-up rigs with their large leg structures provide an excellent hard substrate for encrusting marine invertebrates and algae to attach to, and a certain amount of marine growth on any structure below the water is to be expected. Since the hull of a jack-up rig is regularly elevated out of the waters, it does not provide as suitable a substrate for attached marine life. Because of this, the legs do require periodic maintenance and cleaning to get rid of this growth and the potential for introducing invasive or non-indigenous species into areas when changing locations.

It would be difficult to accurately predict where and when the oysters attached to the Endeavour's legs, how long they have been there or when they died. However, the period of time the rig was cold-stacked in Malaysia would be a likely time period for attachment and grow of these oysters. Oysters are common in Malaysian region with six species documented, including the Pacific oyster, a locally farmed species in Kachemak Bay (Lam and Morton 2009). The time the rig spent in dry dock in Singapore would likely have killed any remaining oysters along with any other attached marine biota.

From the size of the shells, the attached oyster shells appeared to be from mature specimens at least a couple of years old. The number of species of oysters or barnacles present on the rig and their age was not determined. Some of the older shells had calcareous worm tubes attached to the inside valves of the shells, suggesting they have been dead for some time, but still attached to the legs. Some of the shells may have been from an earlier period in the rig's 30 year history of operation.

During this survey, we looked at the most likely place on the rig for living marine life: the spud can and supporting structure (encrusting mat) at the bottom of the legs. We found only dry, empty mussel shells and tube worm cases, which indicated these structures had not been in the water for some time. We also looked at the oyster shells and barnacles that had attached the metal surfaces in the gap near the jacking guides on the legs and support structures on the spud can and no live organisms were found. Some appear to have been dead for a very long time.

The extended period of time the rig was in dry dock (approximately 6 months) appears to have been long enough to kill whatever invertebrates and algae had become attached during or before the time it was cold-stacked. In addition, after spending months in dry dock, the rig underwent it's 30-day journey to Alaska on the deck of the heavy lift vessel (out of the waters) allowing very little opportunity for new biota to become attached. With the rig and its legs out of the water for this extended period of time, survival of any attached marine biota on structures would be highly unlikely, especially soft-bodied organisms.

Based on the results of this survey, it appears that the period of time the rig spent out of the water during the last 6 months was the dominant factor in killing the attach marine biota and substantially reducing the potential for any non-indigenous or invasive species to be introduced to Kachemak Bay or Lower Cook Inlet.

Recommendations:

- Loose shell debris should be removed for all areas near the legs.
- The spud cans, supporting structures and catwalks should be scraped and painted at the same time as the other parts of the legs to minimize the risk of introducing non-indigenous species.
- The 4-inch gap near the jacking guides should be cleaned of old shell material and monitored for any build up after the drilling season.
- Leg structure should be cleaned of attached marine biota after the rig has completed its drilling season each year to minimize potential for transport of non-indigenous species.

References

Alaska Department of Fish and Game. 2012 Invasive species overview. Online: http://www.adfg.alaska.gov/index.cfm?adfg=invasive.main.

ADRF&G 2012. Invasive species methods of introduction. Online: http://www.adfg.alaska.gov/index.cfm?adfg=invasive.pathways.

Armstrong, M. 2012. Jackup rig Endeavour arrives in Kachemak Bay. Homer News, August 24, 2012.

Combs, D. Buccaneer Alaska LLC. Personal communication with David Erikson, URS Corporation.

Executive Order (EO) 13112. Presidential Documents Executive Order 13112 of February 3, 1999. Invasive Species.

Lam, K. and B. Morton. 2009. Oysters (Bivalvia: Ostreidae and Gryphaeidae) recorded from Malaysia and Singapore. The Raffles Bulletin of Zoology 2009 57 (2): 481-494.

Prince William Sound Regional Citizens Advisory Council. 2004. Non-indigenous aquatic species of concern for Alaska. Fact Sheets 1-15.

Ruiz, G.M., T. Huber, K. Larson, L. McCann, B. Steves, P. Fofonoff and A. H. Hines. 2006. Biological Invasions in Alaska's Coastal Marine Ecosystems: Establishing a Baseline. Final Report Submitted to Prince William Sound Regional Citizens' Advisory Council & U.S. Fish & Wildlife Service. Submitted by Smithsonian Environmental Research Center, Edgewater, Maryland USA.

Ruiz GM, Hines AH. (2000) Biological invasions at cold-water coastal ecosystems: ballast mediated introductions in Port Valdez/Prince William Sound, Final Report to Regional Citizens Advisory Council of Prince William Sound.

Smith, B. Archer Drilling. Personal Communication with David Erikson, URS Corporation.

Smithsonian Institute. 2011. Alaska cold water no barrier to invasive species, scientist say. August edition. Online: http://smithsonianscience.org/2011/08/alaskas-cold-waters-no-barrier-to-invasive-marine-species-scientists-say/.

Photos

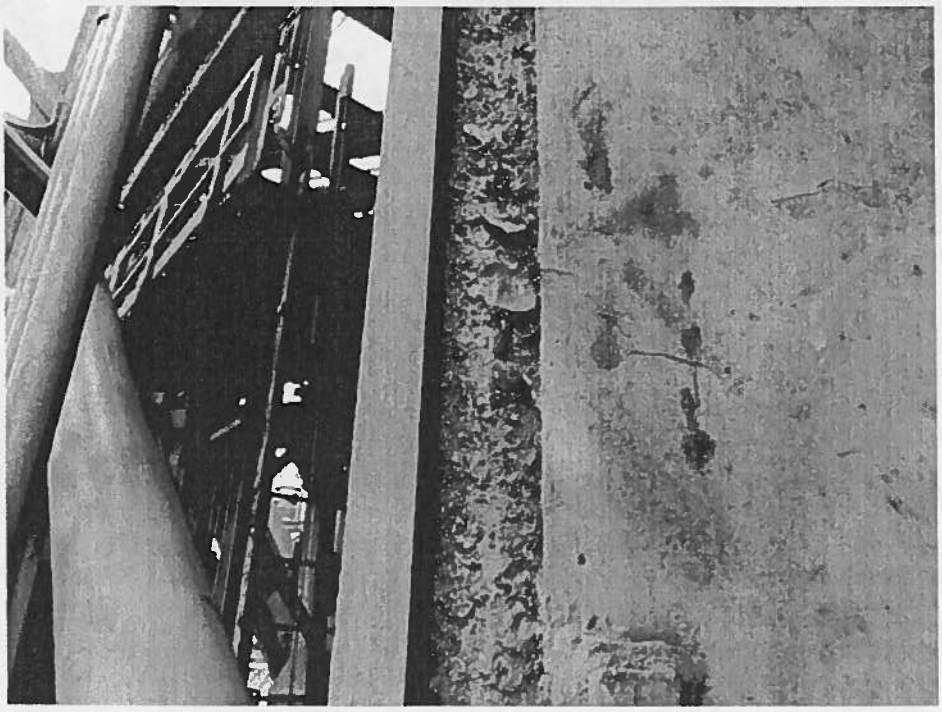

Photo 1. Old oyster shell on the bow leg (right) at the jacking guide slot (under gray paint). Operation of the jacking mechanism doesn't remove the old shells.

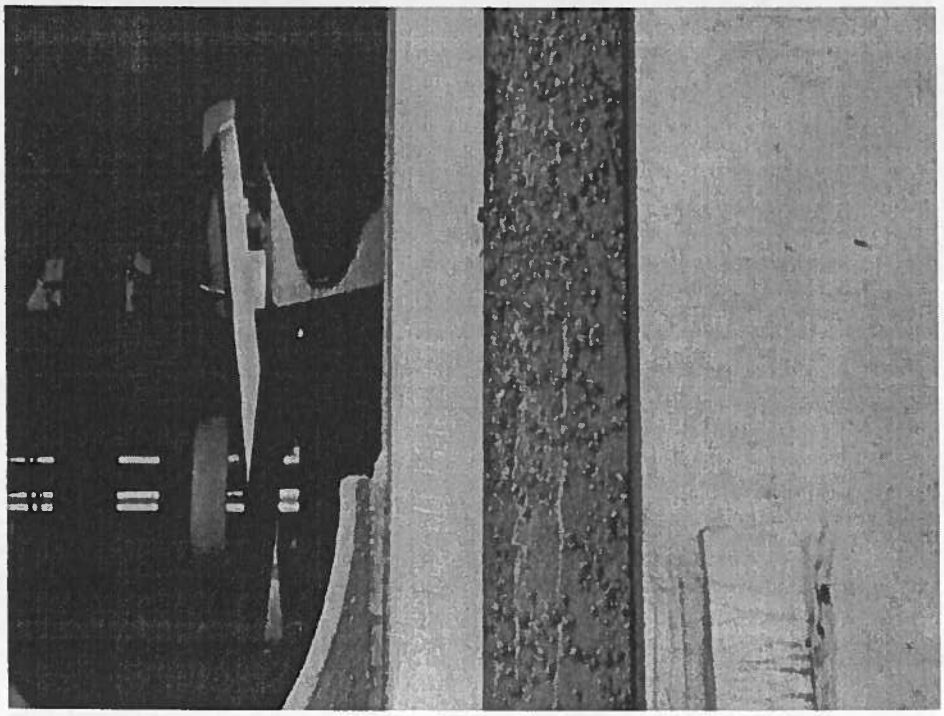

Photo 2. Dead barnacles shell on Starboard Leg (left) at the jacking guide slot on the right. Most of the barnacles have been painted over during the latest painting of the legs (gray paint).

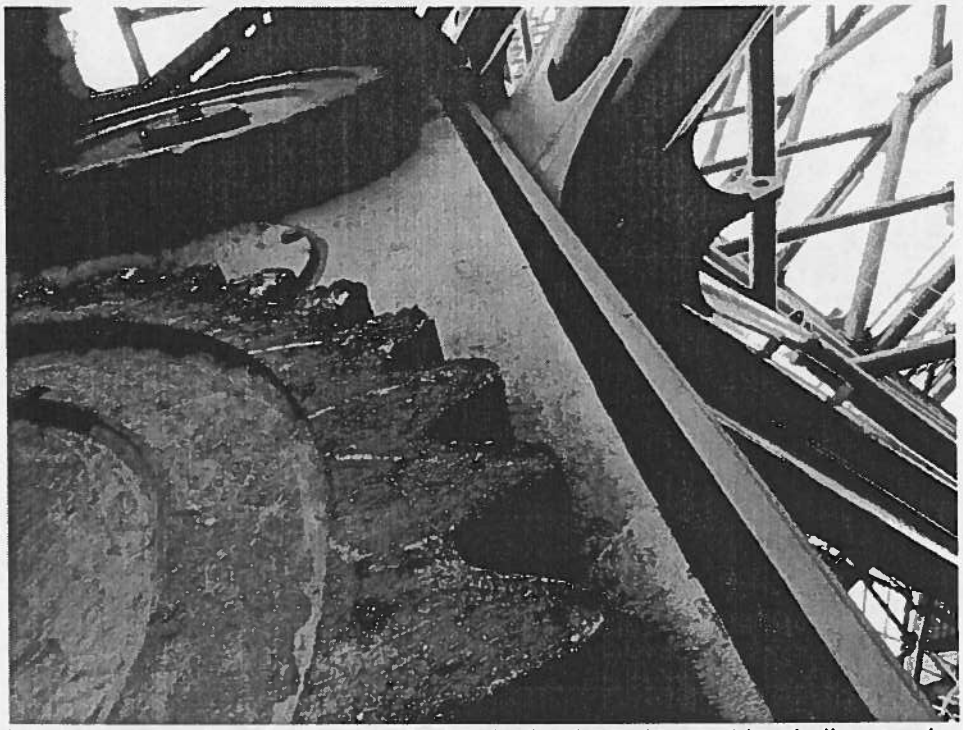

Photo 3. Old shells encrusted on the Bow Leg in the slot by the jacking guide. Shells extend up to the next deck level.

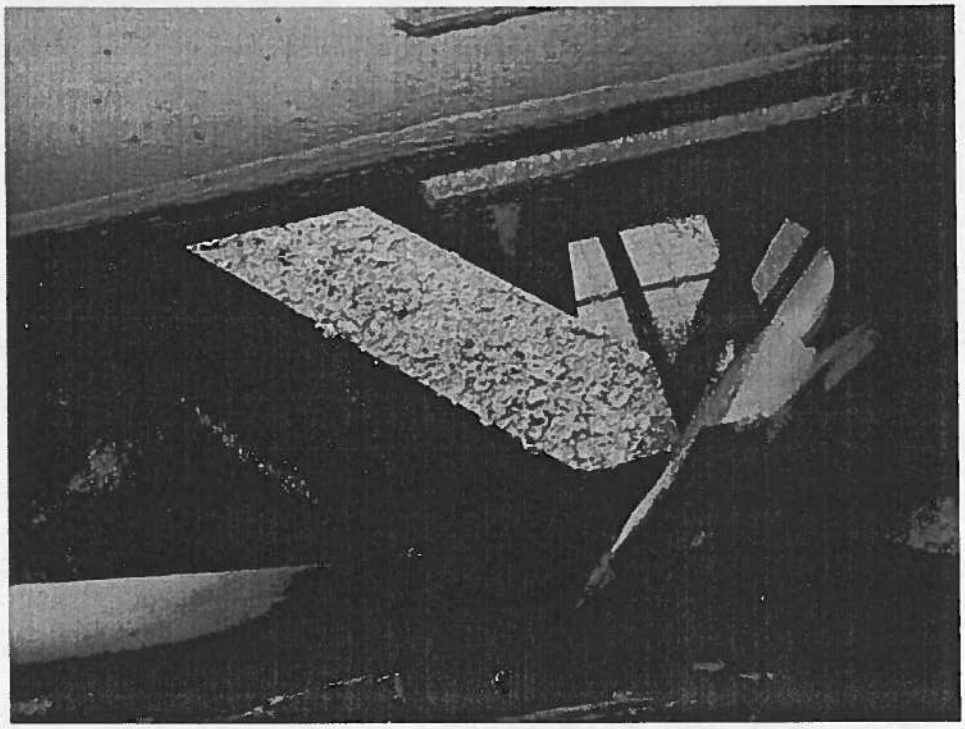

Photo 4. Old oyster attachments on the top of a support member on the spud can. No live oysters

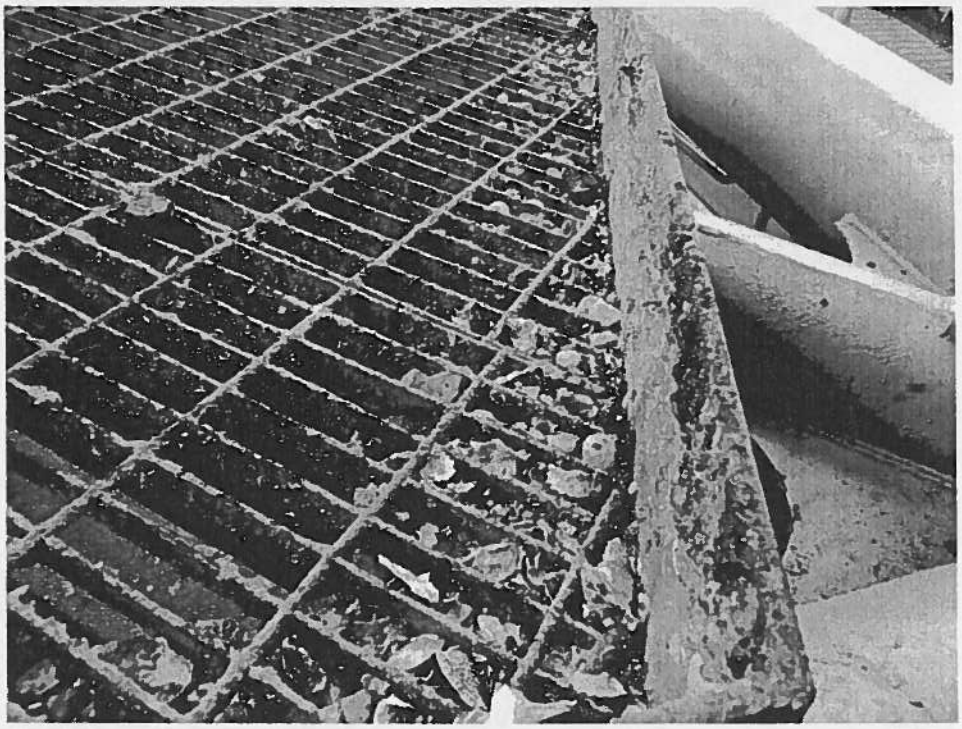

Photo 5. Shell debris on the catwalk out to the manhole on top of the spud can. Debris likely collected from cleaning the legs of encrusting marine biota prior to painting the legs.

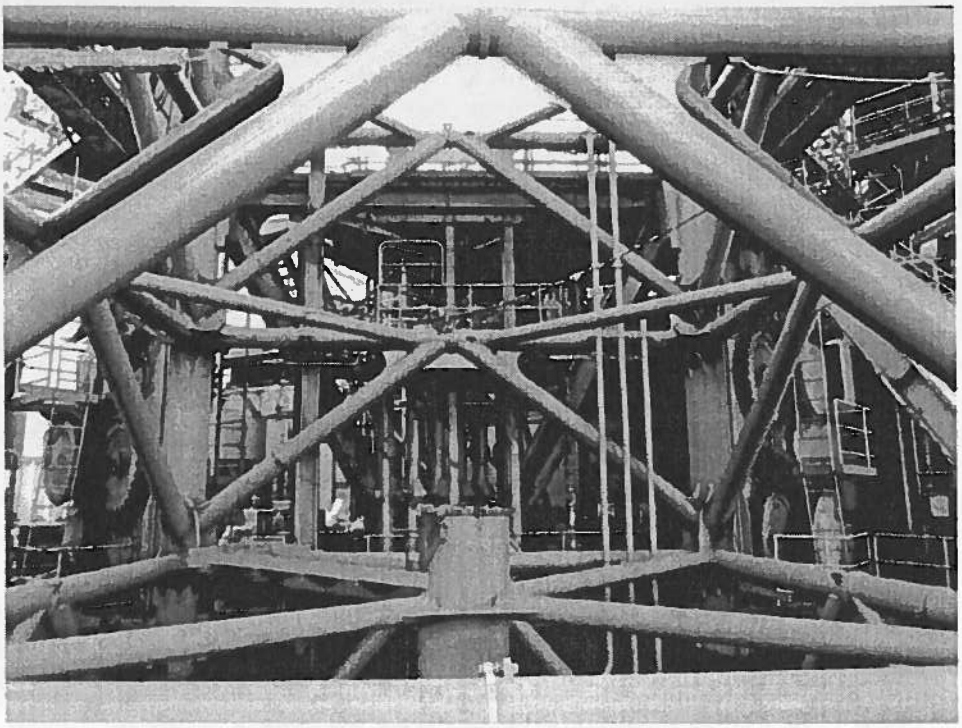

Photo 6. Cable stretched across bow leg (center of photo) with encrusting marine organisms. This cable was likely underwater when the rig was cold-stacked.

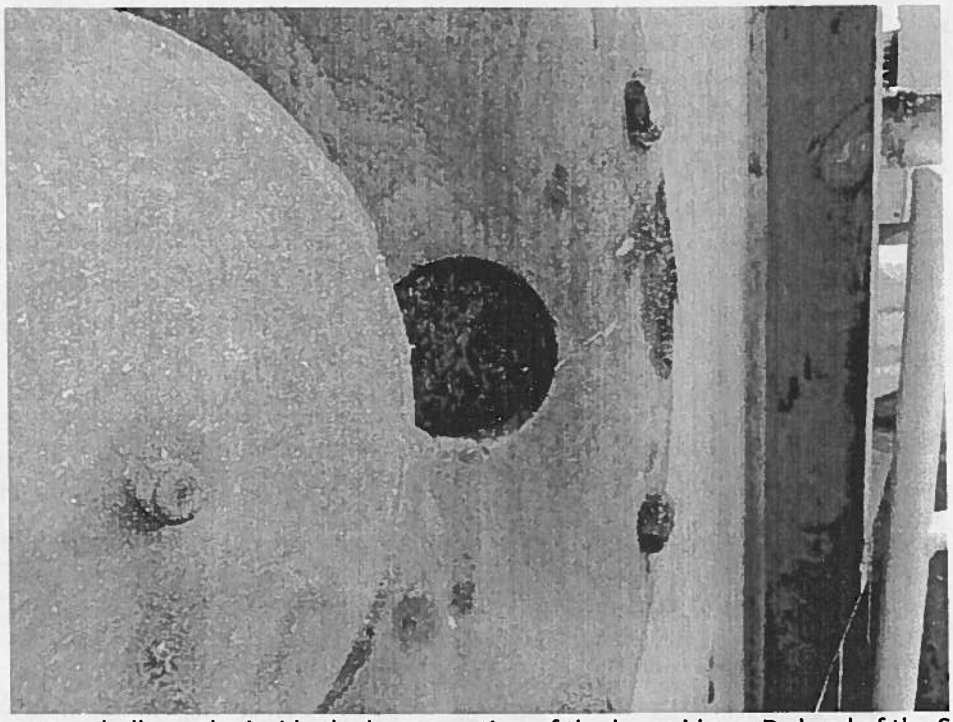

Photo 7. Old oyster shells on the inside the lower portion of the leg guide on D chord of the Starboard leg. Shells attached to this structure can only be seen through this opening when the legs are raised.

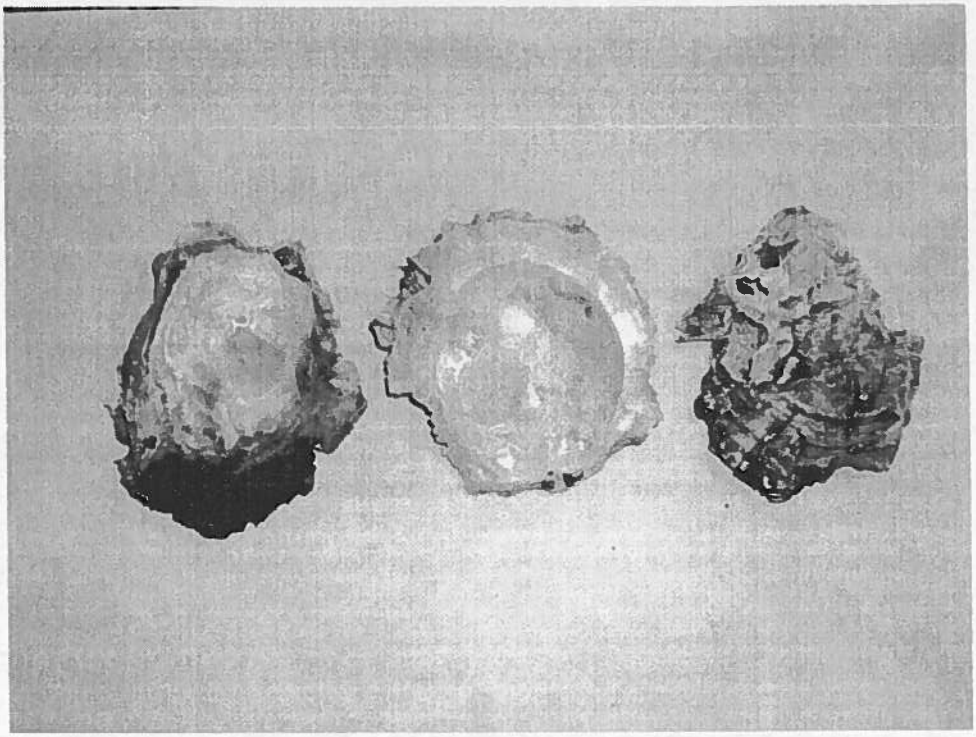

Photo 8. Old oyster shells (unidentified) from the Bow Leg guide slots.

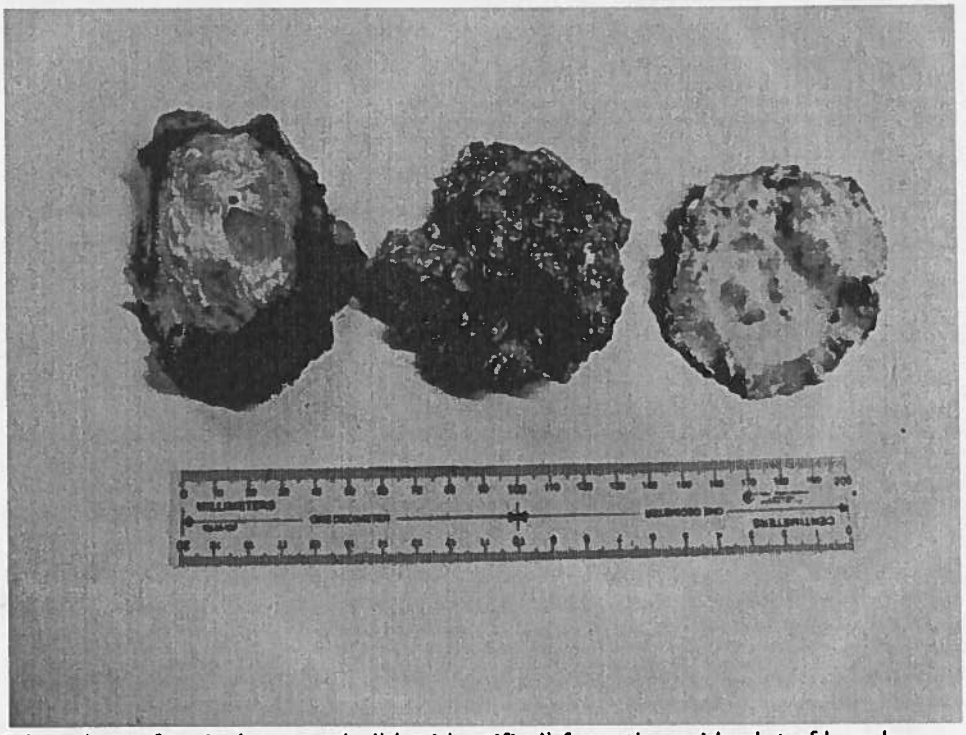

Photo 11. Right valves of typical oyster shell (unidentified) from the guide slot of bow leg.

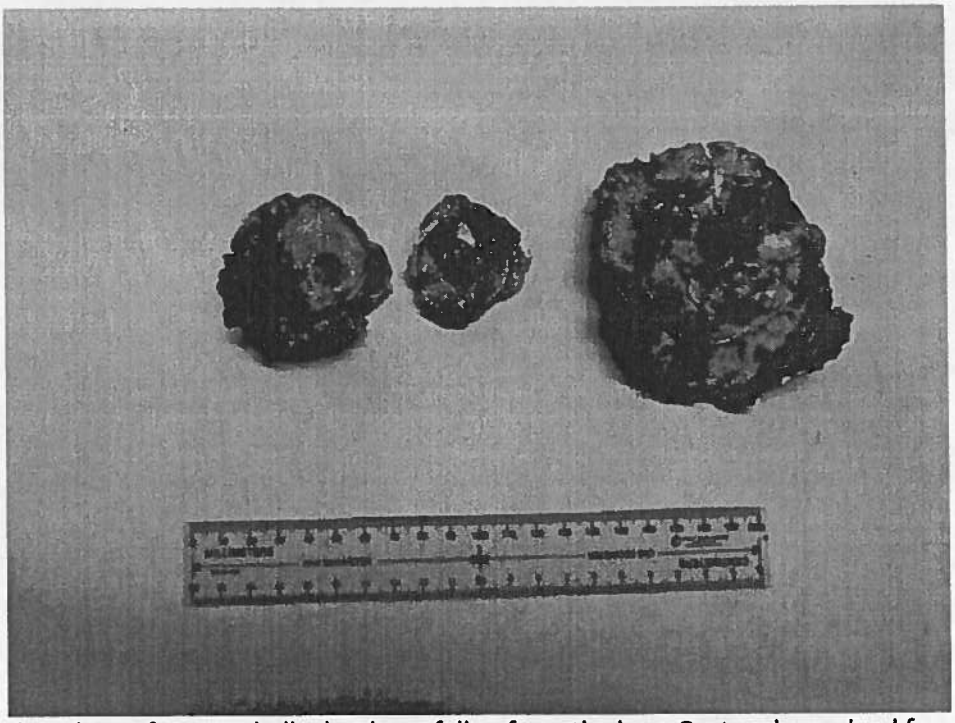

Photo 12. Right values of oyster shells that have fallen from the legs. Oysters been dead for an extended period and shells are deteriorating.

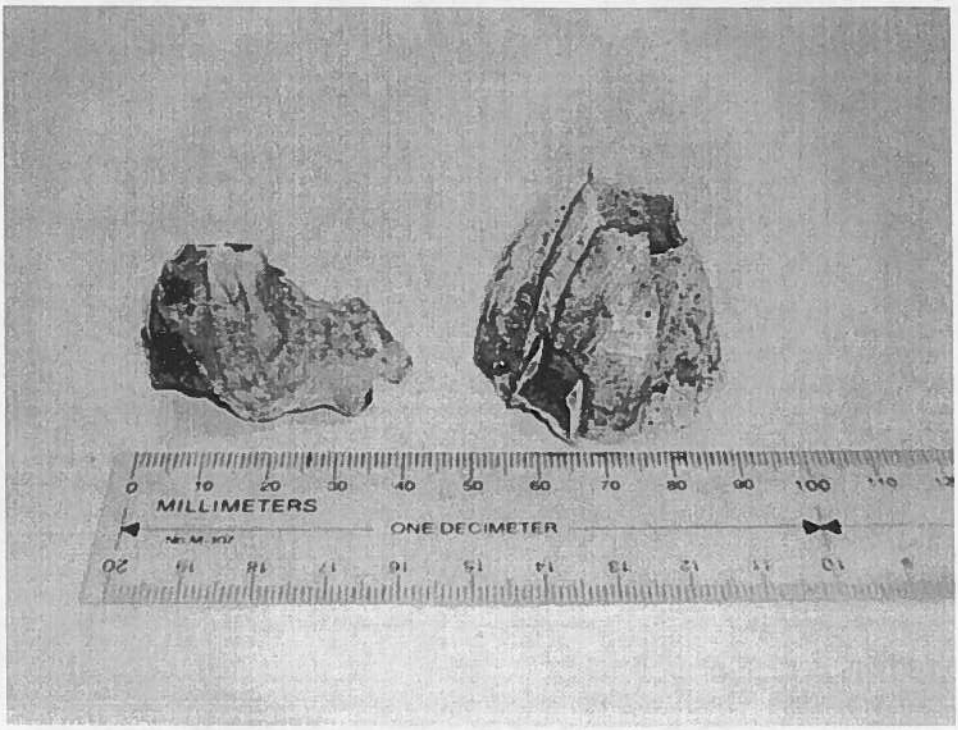

Photo 13. Old barnacle shells that had become detached from the legs.

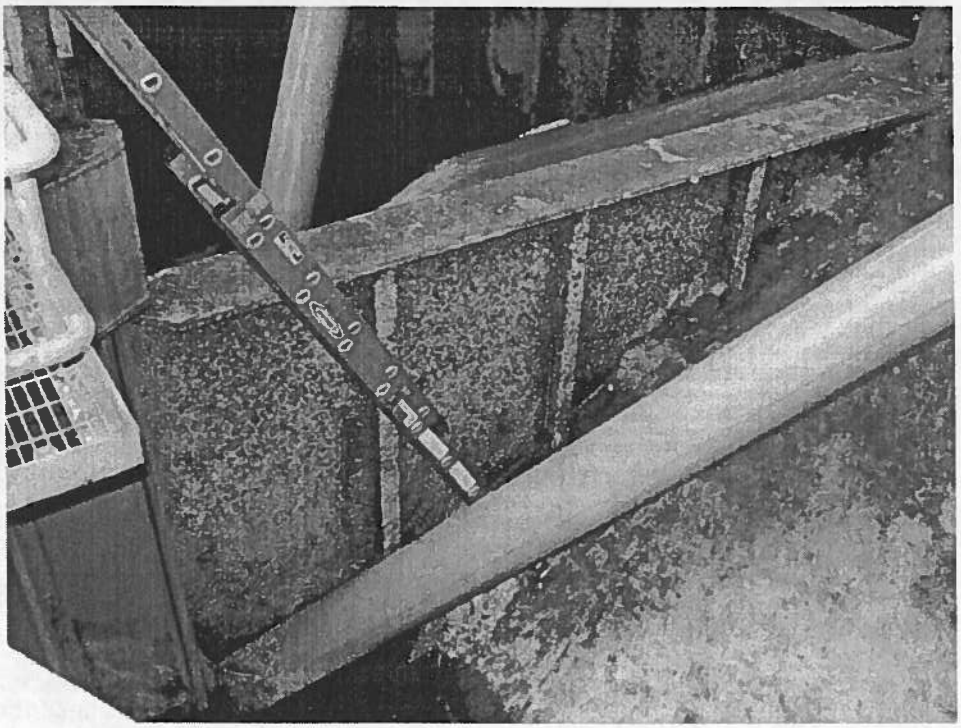

Photo 14. Encrusted marine organisms (grayish film) on spud can support member just above the water level on the Bow Leg.

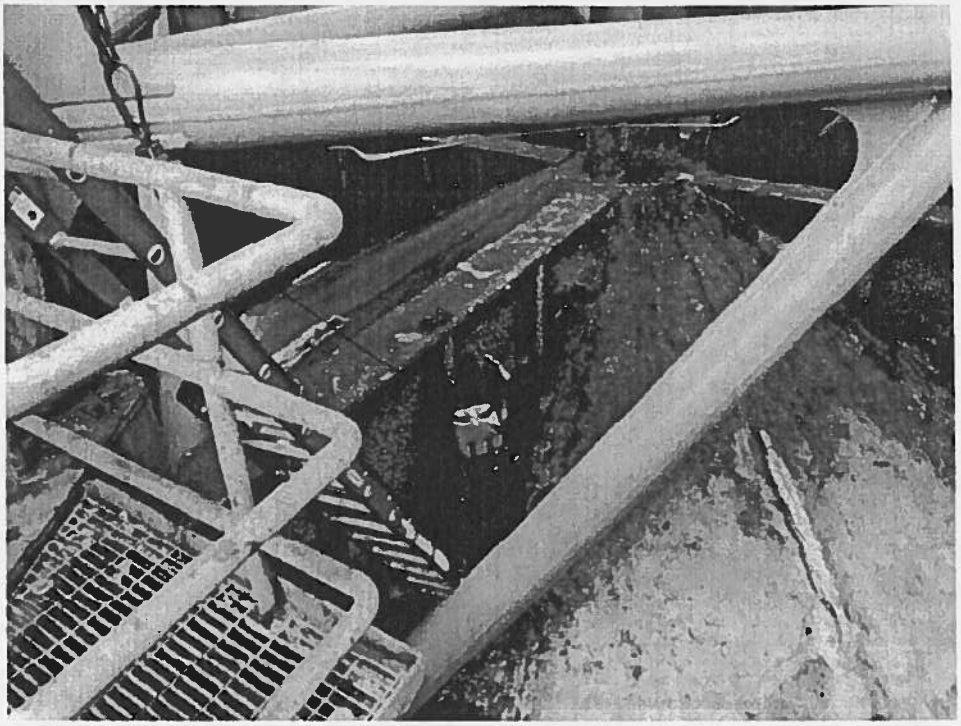

Photo 15. Worker preparing to take sample from vertical surface. Shell debris on the grate in the lower left.

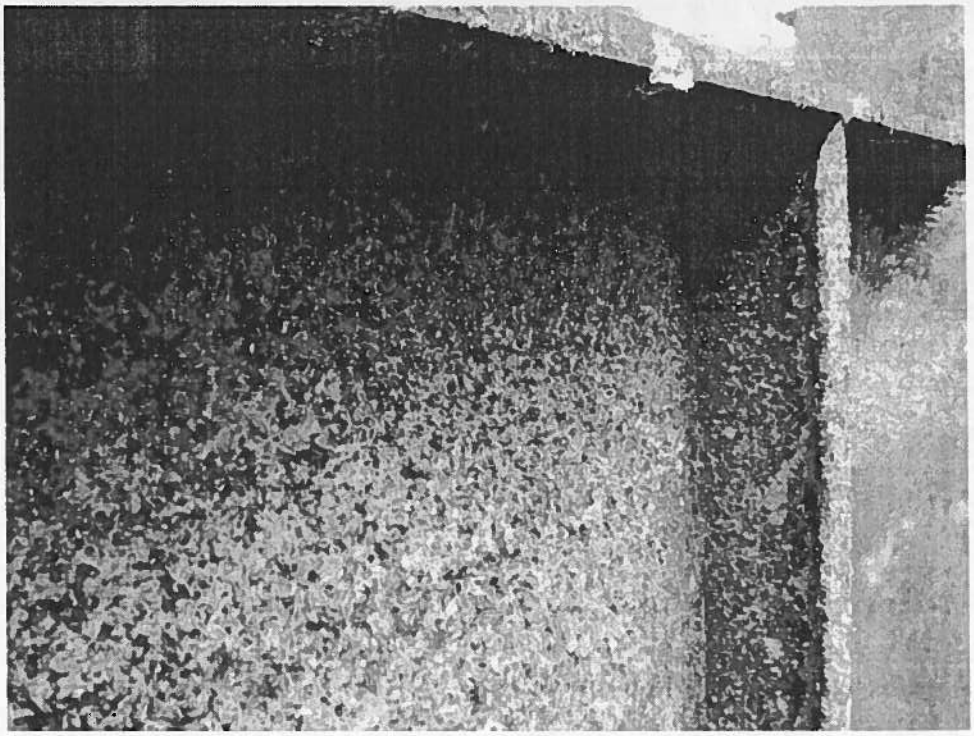

Photo 16. Close up of encrusted juvenile mussels and calcareous worm tubes on the spud can structural support member.