Table 5.3.2-4

A Discussion of the Tolerances of the Bivalves, Gastropods and Decapods of Horseshoe Shoal, to Sediment Deposition and Suspended Sediment

Species	Feeding Method	Sediment Deposition	Suspended Sediment	Tolerance to Sediment Deposition (low, medium, high)	Tolerance to Suspended Sediment (low, medium, high)
Bivalves					
Tellins *(Tellina agilis)*	Burrow and then use siphon to deposit feed.[28]	Smothering with 5 cm of sediment would temporarily halt feeding and respiration and require the species to relocate to its preferred depth[1]. Tellins are active burrowers[2] and would be expected to relocate with no mortality, however, growth and reproduction may be compromised.[1]	An increase in suspended sediment is likely to increase the rate of siltation and therefore the food available to Tellins, which are deposit feeders. It is therefore likely that Tellins are insensitive to changes in suspended sediment[1].	High	High
Razor shells (*Ensis sp.*)	Burrow and then use siphon to filter feed, when submerged, they suck in a current of water through their siphons and they sieve out the food particles with their enlarged gills[32]. (suspension feeder)	*Ensis sp*. generally live buried in sand, can extend their siphons and rise in their burrows and so are likely to tolerate smothering by 5 cm of sediment[3]. Note: they can move up and down through sand at a fast rate.[5]	Relatively tolerant of siltation[3] although there is a chance that juveniles could be less tolerant particularly during the time of settling, because they are thought to be susceptible to suffocation[5.]	High	Medium
Soft shell clams (*Mya arenaria*)	Burrow and then use siphon to filter feed (suspension feeder). Feed on microscopic plant and animal matter which is suspended in the water column just above the bottom. Through the beating of small hairlike cilia, a current is created which draws water through the incurrent siphon.[29]	They live in deep permanent burrows of 20-50 cm depth in mixed sediments. Its permanent burrow means that smothering may cause problems[4] Significant mortality (2 -60%) in small and large clams occurred only at burial depths of 50 cm or more in sandy substrates. However, it is suggested that in mud, clams buried under 25cm of sediment would almost certainly die[6]. Note: The level of tolerance depends on the nature of the smothering material.[6]	Studies show that prolonged exposure to suspended sediment concentrations >100mg/l results in reduced body condition and growth, however it has been shown that feeding/filtration continues even where suspended sediment concentration exceeds 300mg/l[4 & 6.] Clams may continue pumping when total suspended solids exceed 300 mg/l, but the production of mucus and the loss of energy during the ejection of pseudofaeces strain the energy budget of the clam[35.]	Medium	Medium

Table 5.3.2-4

A Discussion of the Tolerances of the Bivalves, Gastropods and Decapods of Horseshoe Shoal, to Sediment Deposition and Suspended Sediment

Species	Feeding Method	Sediment Deposition	Suspended Sediment	Tolerance to Sediment Deposition (low, medium, high)	Tolerance to Suspended Sediment (low, medium, high)
Northern Quahog *(Mercenaria mercenaria)*	Burrow and then use siphon to filter feed (suspension feeder).[30]	Quahogs live buried in the top three inches of sandy/stony/clayey bottoms beneath waters reaching up to 45-50 feet in depth. They are sedentary, i.e. they do not change locations once the juvenile clam settles on the bottom[12]. However, studies show that adults bury deeper in sand than in mud and small adults burrow deeper than larger ones. If dug up, the hard clam reburrows, and if covered, can escape upward. Also a clam can apparently escape 10 to 50 cm of overburden if the sediment dumped is the same as surroundings.[34]	The hard shell clam is less well adapted to survival in turbid conditions compared to mussels and oysters and is thus more vulnerable to temporary increases in suspended sediment loads [4]. Larvae are more sensitive to turbidity than are embryos although studies show they tolerated silt of 4 g/l[34]. However, there is the belief that a turbid layer near the bottom can enhance the growth of hard clam, because the layer may contain detrital food utilized by the clams[34].	High	Medium
Common mussel (*Mytilus edulis*)	Attach to rock by byssal thread and filter feed (suspension feeder).[27]	Although apparently sedentary, *Mytilus edulis* is able to move some distance to change its position on the shore or within a bed or to resurface when buried by sand[8]. However, studies show that although some mussels are able to move upwards through accumulated sediment, a proportion will succumb and be smothered.[8]	Studies have reported that *Mytilus edulis is* relatively tolerant of turbidity and siltation, thriving in areas that would be harmful to other suspension feeders. They possess efficient shell cleaning and pseudofaeces expulsion mechanisms to remove silt[4]. Studies indicate that *Mytilus edulis* can survive >25 days at 440 mg/l. However, their feeding rate is reduced by suspended sediment at concentrations >50 mg/l.[8]	Medium	High
Nut clam *(Nucula proxima)*	Deposit feeder[33]	Studies on another bivalve in the genus "Nucula" i.e. *Nucula nitidosa* suggest that these bivalves can tolerate anaerobic conditions for several days and are able to thrive in poorly aerated sediments. In addition, studies have suggested that their ability to tolerant anaerobic conditions and their mobility, allowed them to survive when covered by sediments during stormy weather[15]. This suggests that nut clams would be very tolerant to smothering and would be mobile enough to climb back to the surface.	*Nucula nitidosa* and *nucula proxima* are deposit feeders and therefore is not directly reliant on suspended matter as a food resource. However, an increase in suspended sediment will increase the rate of siltation at the sediment surface which may enhance the food supply for these organisms[15]. Studies have also shown that turbidity does not affect the distribution of these organisms. This suggests that not only would an increase in suspended sediment be tolerated by the nut clam, but it may even be welcomed.	High	High

Table 5.3.2-4

A Discussion of the Tolerances of the Bivalves, Gastropods and Decapods of Horseshoe Shoal, to Sediment Deposition and Suspended Sediment

Species	Feeding Method	Sediment Deposition	Suspended Sediment	Tolerance to Sediment Deposition (low, medium, high)	Tolerance to Suspended Sediment (low, medium, high)
Bay Scallop *(Argopecten irradians)*	Filter feeders, scallops use their gills to siphon diatoms and other planktonic matter from the surrounding water.[16] (suspension feeder)	Scallops are one of only a few Molluscan groups that have the ability to swim actively, especially as a predator avoidance response. They dwell on the bottom as adults, manipulating themselves through "jet propulsion" by forcefully closing their valves[16]. Studies on other scallop species such as the British "*Pecten maximus",* indicate that if scallops were smothered by a 5 cm layer of fine sediment, juveniles and adults could probably lift themselves clear of the new layer since they are capable of jumping and swimming. Newly re-laid scallops are, however, more vulnerable to predators until recessed although it is likely that the predators of the scallop such as starfish and crabs will be occupied in re-establishing their position themselves.[17]	In general, suspended sediment is not likely to have a great deal of impact on Bay scallops, although studies indicate that growth rates of adult *Pecten maximus* are adversely affected by increases in suspended sediments concentrations and excessive particle bombardment may threaten the viability of the feeding apparatus, thereby potentially decreasing ingestion rates. Since scallops have the ability to swim some individuals may be able to escape, although this ability is primarily reserved for escape reactions given the high energy expenditure involved and the distances covered by swimming or jumping are very limited[17].	High	High
Oysters *(Crassostrea virginica)*	Oysters cement themselves onto hard substrates like shells or rocks or other oysters. They do not have discrete siphons, water is simply drawn in and expelled from the body by currents that are created by the beating of the gill cilia.[31]	Studies indicate that oysters buried 1.25 cm or less can usually clear their bills of sediment if the water is warm enough for active pumping. However, burial of oysters with sediment layers exceeding 5 cm has been reported to cause adult mortality[9]. They are cemented to any hard object available, so would not be able to burrow up through deposited material. Although a thin layer (several mm) of sediments may not be fatal to adult oysters, it may affect reproduction. Because larval oysters require hard substrata for settlement, the presence of even a few millimeters of sediment covering an oyster reef may inhibit larval recruitment.[9]	Oysters respond to an increase in suspended sediment by increasing pseudofaeces production and with occasional rapid closure of their valves to expel accumulated silt. Although some studies report that an increase in suspended sediment decreases the filtration rate (studies show that filtration is completely inhibited by 10 mg/l of particulate organic matter and significantly reduced by 5 mg/l) and reduces the growth rate of adults, oyster beds can often naturally be found in relatively turbid estuarine environments. Therefore, a change in suspended sediment levels is likely to result in only sub-lethal effects. Once 'normal' conditions are restored then normal feeding will allow condition to be restored[10]. Note: an increase in suspended sediment may have longer term effects on the population by inhibiting recruitment, especially if the increase coincided with the peak settlement period in summer.	Low	High

Table 5.3.2-4

A Discussion of the Tolerances of the Bivalves, Gastropods and Decapods of Horseshoe Shoal, to Sediment Deposition and Suspended Sediment

Species	Feeding Method	Sediment Deposition	Suspended Sediment	Tolerance to Sediment Deposition (low, medium, high)	Tolerance to Suspended Sediment (low, medium, high)
Transverse ark *(Anadara transversa)*	Filter feeder. They use their gills to siphon diatoms and other planktonic matter from the surrounding water. (suspension feeder)	There were no studies found that address the tolerances/sensitivities of this species, but they are known to often burrow or nestle in mud and sand, under stones[2], however due to the fact that they have chunky/bulbous shells, it is likely they will not be fast burrowers and in fact some ark shells are known to attach themselves to rocks. Therefore, if these shells were smothered it might be more likely they would die before they could pull themselves out of the sediment.	In general, suspended sediment is not likely to have a great deal of impact on this organism, although it is possible that excessive particle bombardment may threaten the viability of the feeding apparatus, thereby potentially decreasing ingestion rates. However as is seen in other bivalves these species will likely possess efficient shell cleaning and pseudofaeces expulsion mechanisms to remove silt. Therefore, as was stated for many of the other bivalves present on Horseshoe shoals, a change in suspended sediment levels is likely to result in only sub-lethal effects and once 'normal' conditions are restored then it is likely that normal feeding will allow condition to be restored.	Medium	High
Round pandora/ Gould pandora (*Pandora gouldiana*) Spoon clam/shell (*Periploma sp.*)	Burrow and then use siphon to filter feed Burrow and then use siphon to filter feed	In general, these two bivalves active burrowers (Pandora are probably fast burrowers too) and they require their inhalant siphon to be above the sediment surface for feeding and respiration (Spoon shells only make shallow burrows). There were no studies found that address the tolerances/sensitivities of each of these species, however based on what has been written about other similar bivalve species sudden smothering with sediment would be likely to only temporarily halt feeding and respiration and require these bivalves to relocate to their preferred depth. As active burrowers they would be expected to relocate with no mortality, however, growth and reproduction may be compromised owing to energetic expenditure. Growth and reproduction would be expected to return to normal following relocation.	In general, suspended sediment is not likely to have a great deal of impact on these two organisms, although it is possible that excessive particle bombardment may threaten the viability of the feeding apparatus, thereby potentially decreasing ingestion rates. However as is seen in other bivalves these species will likely possess efficient shell cleaning and pseudofaeces expulsion mechanisms to remove silt. Therefore, as was stated for many of the other bivalves present on Horseshoe shoals, a change in suspended sediment levels is likely to result in only sub-lethal effects and once 'normal' conditions are restored then it is likely that normal feeding will allow condition to be restored	Medium - High	High

Table 5.3.2-4

A Discussion of the Tolerances of the Bivalves, Gastropods and Decapods of Horseshoe Shoal, to Sediment Deposition and Suspended Sediment

Species	Feeding Method	Sediment Deposition	Suspended Sediment	Tolerance to Sediment Deposition (low, medium, high)	Tolerance to Suspended Sediment (low, medium, high)
Gastropods					
Slipper limpets *(Crepidula fornicata, Crepidula convexa and Crepidula plana)*	Attach to rock by foot and filter feed, strains microorganisms and organic debris from the water.[27]	Smothering with a 5cm layer of sediment would be expected to clog the feeding and respiration structures. However, it has been demonstrated that *Crepidula fornicata* is capable of clearing its feeding structures at some energetic cost. So, although there may be some energetic cost as a result of smothering, probably resulting in decreased growth and reproductive output, there is unlikely to be mortality[7]. Note: the fact that they live in chains of up to 12 individuals means that at least some of the chain would avoid the effects of smothering[7]. *Crepidula plana* is even less likely to suffer impact from smothering as it generally is attached to larger and more mobile organisms such as the underside of horseshoe crabs and inside large snails shells occupied by hermit crabs[46]	Crepidula are all active suspension feeders, an increase in suspended sediment is therefore likely to interfere with the feeding and respiration structures. Growth rate and filtration rate tend to decrease as turbidity increases with the greatest reduction in filtration occurring between 140-200 mg/L. When suspended sediment returns to normal levels, feeding and respiration return to normal. However, it will take a period of time to replenish food reserves, during which reproductive output will not be at maximum levels[7].	High	High
Atlantic Oyster drill *(Urosalpinx cinera)*	Predator, feeds on barnacles, mussels & oysters and other bivalves.[26]	Studies on other similar snails (such as Atlantic dog whelk "*Nucella lapillus*") indicate that dog whelks and thus the oyster drill is probably not adversely affected by temporary smothering. If smothering occurs, there will be an energetic expenditure involved in freeing itself from the smothering material.[11]	Not likely to have a great deal of impact, although the accumulation of silt or mud may restrict their ability to distribute themselves. In addition, the abundance of their prey (e.g., barnacles and mussels) may be restricted by increased suspended sediment, thus reducing their food supply.[11]	High	High

Table 5.3.2-4

A Discussion of the Tolerances of the Bivalves, Gastropods and Decapods of Horseshoe Shoal, to Sediment Deposition and Suspended Sediment

Species	Feeding Method	Sediment Deposition	Suspended Sediment	Tolerance to Sediment Deposition (low, medium, high)	Tolerance to Suspended Sediment (low, medium, high)
Knobbed Whelk *(Busycon carica)* & Channeled Whelk *(Busycotypus canaliculatus)*	Predators, feed on bivalves such as hard clams (*Mercenaria mercenaria*), oysters (*Crassostrea virginica*), and arks (*Anadara sp*).[18]	Studies have shown that whelks will burrow into the bottom substrate and remain dormant for extended periods during winter storms[18]. In addition, studies involving the collection & release of whelks has found that whelks can be naturally buried from depths of 1 to 14.4 cm (i.e. choose to bury themselves to such depths)[19]. Based on this information it is likely that Whelks would have no problem being buried with up to 20mm of sediment from the plows. In addition, they are both very active snails, using their large foot to glide across the bottom or to plow through the sand underground[20], so even if they were buried in sediment deeper than they would like, they should be able to dig themselves out very quickly.	Not likely to have a great deal of impact, although the abundance of their prey (i.e. hard clams & oysters) may be restricted by increased suspended sediment, thus reducing their food supply.	High	High
Minute hydrobia (*Hydrobia totteni*)	Deposit feeder, feeding on planktonic and minute detrital food items. [25]	Studies on other similar snails (such as *Hydrobia ulvae*) indicates that these snails are quite tolerant of smothering. However, the snails can only burrow up through certain sorts of sediment. If the silt content of the smothering sediment is high and the water content low then it is unlikely that the surface will be regained from 5 cm down. Looser sediment with high water and low silt content can be negotiated quite rapidly. The surface is generally regained within a day. If the surface cannot be regained then Hydrobia ulvae can survive burial for quite extended periods although this is highly temperature dependent. Temperatures of 20 degrees Centigrade result in all individuals dying after 10 days. Survival is much better at lower temperatures. It is thought that oxygen stress is the cause of mortality.[13]	Detritus forms one of the main food sources for Hydrobidae snails so increased siltation may be beneficial. As the snails lives in and on sediment, increases in sediment deposition will probably not affect locomotion.[13]	High	High

Table 5.3.2-4

A Discussion of the Tolerances of the Bivalves, Gastropods and Decapods of Horseshoe Shoal, to Sediment Deposition and Suspended Sediment

Species	Feeding Method	Sediment Deposition	Suspended Sediment	Tolerance to Sediment Deposition (low, medium, high)	Tolerance to Suspended Sediment (low, medium, high)
Other Gastropods					
Miniature moonsnail (*Natica pusilla*) Mud dog whelk (*Ilyanassa trivittata*) Luna dovesnail (*Mitrella lunata*) Miniature cerith (*Seila adamsi*) Pyramid shell (*Odostomia seminuda*)	Predator, feeds on bivalves[24] Scavenger, eats dead/dying organisms[27] Predator on sea squirts among other things[23] A grazing snail, eats algae and organic material[21] Ectoparasite on bay scallops[22]	In general, snails are mobile so have a good chance of finding the surface again following a smothering event. However, the type of sediment (how loose it is) will dictate how quickly the snails will be able to make their way through to the surface. For example, if the sediment is well oxygenated and fluid (as with high water, high silt content), it will be relatively easy for snails to reach the surface. In addition, the locomotive abilities of each snail will also dictate how quick they will move up. How tolerant each snail is to lack of oxygen will also dictate how long they may survive once/if they are buried for an extended period. There were no studies found that address these characteristics for each of the snail species. It is likely the snails of Horseshoe Shoals will display a range of tolerances to smothering such as *Hydrobia* surviving burial for extended periods[13] compared to the common periwinkle (*Littorina littorea*) which typically only survives for up to 24 hours once buried[14]. In addition,	In general, suspended sediment is not likely to have a great deal of impact to the snails of Horseshoe Shoals although the accumulation of silt or mud may have an impact on the distribution of larval stages. For the pyramid shell and miniature moonshell, which depend on other organisms for prey, an increase in suspended sediment may have an impact on the abundance of their prey thus reducing their food supply. However, for the scavenger snails detritus is a main food source so increased siltation may be beneficial. In addition, studies have shown that increases in siltation over an extended period may have some influence in changing substratum type and removing available habitat such as nooks and crevices. For the snail species that use nooks and crevices, if habitat type is no longer optimal then the snail populations may decrease.	Medium - High	Medium - High
Decapods					
American Lobster (*Homarous americanus*)	Predator, feeds on crabs, bivalves, shrimp and small fish. Will also scavenge dead and dying organisms.[36]	Due to their mobility, sediment deposition events would not seriously affect adult lobsters, but may temporarily affect juveniles. After a sedimentation event, adults may have to expend energy to clear the entrance to burrows, and/or temporarily leave a particular area to look for shelter. Juveniles may be affected more than adults, as they may have to spend additional time moving to a new shelter, which results in an increase in time exposed to predation.[37]	In general, suspended sediment is not likely to have a great deal of impact to the American lobster, although the accumulation of silts may affect the distribution of larval stages. The lobsters mobility would allow it to continue searching for food sources during times of high suspended sediments [36].	High	High

Table 5.3.2-4

A Discussion of the Tolerances of the Bivalves, Gastropods and Decapods of Horseshoe Shoal, to Sediment Deposition and Suspended Sediment

Species	Feeding Method	Sediment Deposition	Suspended Sediment	Tolerance to Sediment Deposition (low, medium, high)	Tolerance to Suspended Sediment (low, medium, high)
Rock Crab *(Cancer irruratus)*	Opportunistic, will feed on live bivalves, crustaceans and carion. [38]	Due to their mobility, sediment deposition events generally would not affect rock crabs, they would most likely burrow out from under the silt and move to a new unaffected area[38]. Increased mortality would not be expected due to increased sedimentation.	Increased suspended sediment may result in a temporary avoidance of the disturbance site, however, a rise in mortality due to increased suspended sediment loads is not expected [38].	High	High
European Green Crab (*Carcinus maenas*)	Omnivore, feeds mainly on mollusks, arthropods, plants and algae. [39]	Adult European Green Crabs would not be affected by increased sediment deposition due to their mobility, however, post settlement mortality of juveniles, may increase if large areas of diverse habitat are impacted.[39]	Due to the wide range of habitats that the European Green Crab is known to inhabit, including turbid estuaries, it is unlikely that an increase in suspended sediment would have any negative effects[39].	High	High
Say Mud Crab *(Dyspanopeus sayi)*	Carnivore, feeds mainly bivalves [40]	Due to their mobility, increased sediment deposition would not be expected to negatively affect Say Mud Crab populations on Horseshoe shoal. Say Mud Crabs would be expected to burrow out from under any smothering event, and/or temporarily leave the area until the disturbance is complete.	Due to their mobility[41], increased suspended sediment would not be expected to negatively affect Say Mud Crab populations on Horseshoe shoal.	High	High
Lady Crab *(Ovalipes ocellatus)*	Predator, feeds mostly on bivalves and some crustaceans. [41]	Due to their mobility, increased sediment deposition would not be expected to negatively affect Lady Crab populations on Horseshoe shoal. Lady Crabs would be expected to burrow out from under any smothering event, and/or temporarily leave the area until the disturbance is complete.	Due to their mobility[41], increased suspended sediment would not be expected to negatively affect Lady Crab populations on Horseshoe shoal, crabs would be expected to migrate away from the disturbance until complete.	High	High
Hermit Crab (*Pagurus spp.*)	Scavenger, eats dead/dying organisms [42]	Due to their mobility, increased sediment deposition would not be expected to negatively affect hermit crab populations on Horseshoe shoal[42]. Hermit crabs may have to expend energy burrowing out from under a smothering event, however, increased mortality would not be expected.	Due to their mobility[42], increased suspended sediment would not be expected to negatively affect hermit crab populations on Horseshoe shoal. Hermit crabs would be expected to migrate away from the disturbance until complete.	High	High

Table 5.3.2-4

A Discussion of the Tolerances of the Bivalves, Gastropods and Decapods of Horseshoe Shoal, to Sediment Deposition and Suspended Sediment

Species	Feeding Method	Sediment Deposition	Suspended Sediment	Tolerance to Sediment Deposition (low, medium, high)	Tolerance to Suspended Sediment (low, medium, high)
Pea Crab (*Pinnixa sp.*)	Commensal/parasytic on bivalves [43]	Pea Crabs, most often are found living inside bivalve shells [43]. If the commensal bivalve is affected by increased sediment deposition, then so will the Pea Crab. Since most bivalves are tolerant of sedimentation, no adverse affects are expected for the Pea Crab.	Pea Crabs, most often are found living as commensals, inside bivalve shells[43]. If the commensal bivalve is affected by an increase in suspended sediment, then so will the Pea Crab. Since most bivalves are tolerant of suspended sedimentation, limited adverse affects are expected for the Pea Crab.	High	Medium - High
Spider Crab (*Libinia dubia*)	Primarily scavenger, but can prey on small fish, and invertebrates. [44]	Due to their mobility and tolerance for pollution, increased sediment deposition would not be expected to negatively affect spider crab populations on Horseshoe shoal [44]. Jet Plow activities may actually benefit these crabs by unearthing decaying organic matter, an important food source, from deeper sediments.	Due to their mobility and tolerance for pollution [44], increased suspended sediment would not be expected to negatively affect spider crab populations on Horseshoe shoal.	High	High
Horseshoe Crab (*Limulus limulus*)	Predator, primarily preys on bivalves and polychaetes. [45]	Horseshoe crabs are not likely to be affected by an increase in sediment deposition. Horseshoe crabs are known burrowers, they locate their prey using their tactile senses as opposed to site, and their mobility would allow them to temporarily leave an area if necessary.[45]	Horseshoe crabs are not likely to be affected by an increase in suspended sediment. Horseshoe crabs locate their prey out of the sediment by tactile senses as opposed to site, and their mobility would allow them to temporarily leave an area if necessary[45].	High	High

References

1 Rayment, W.J., 2004. Fabulina fabula. Bean-like tellin. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 25/08/2005]. Available from: <http://www.marlin.ac.uk/species/Fabulinafabula.htm>
2 Gosner (1978)
3 Hill, J.M., 2000. Ensis spp.. Razor shell. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 25/08/2005]. Available from: <http://www.marlin.ac.uk/species/Ensisspp..htm>
4 Poole Harbour Approach Channel Deepening and Beneficial Use Schemes EIA. Borough of Poole and Poole Harbour Commissioners http://www.phc.co.uk/eia1.htm (http://www.phc.co.uk/9%20Fish%20and%20Shellfish%20resource%20223%20kb.pdf)
5 Benthic Infauna at the Mouth of the Columbia River. Gary M. Braun (Tetra Tech, Inc.) May 2005. Prepared for: Institute for Natural Resources at Oregon State University. http://inr.oregonstate.edu/download/benthic_infauna_final_braun.pdf
6 Tyler-Walters, H., 2003. Mya arenaria. Sand gaper. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 25/08/2005]. Available from: http://www.marlin.ac.uk/species/Myaarenaria.htm
7 Rayment, W.J., 2003. Crepidula fornicata. Slipper limpet. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 04/05/2005]. Available from: http://www.marlin.ac.uk/species/Crepidulafornicata.htm
8 Tyler-Walters, H., 2002. Mytilus edulis. Common mussel. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 25/08/2005]. Available from: <http://www.marlin.ac.uk/species/Mytilusedulis.htm>

Table 5.3.2-4

A Discussion of the Tolerances of the Bivalves, Gastropods and Decapods of Horseshoe Shoal, to Sediment Deposition and Suspended Sediment

Species	Feeding Method	Sediment Deposition	Suspended Sediment	Tolerance to Sediment Deposition	Tolerance to Suspended Sediment
				(low, medium, high)	

9 Sedimentation: Potential Biological Effects of Dredging Operations in Estuarine and Marine Environments http://el.erdc.usace.army.mil/elpubs/pdf/doere20.pdf
10 Jackson, A., 2003. Ostrea edulis. Native oyster. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 25/08/2005]. Available from: <http://www.marlin.ac.uk/species/Ostreaedulis.htm>
11 Tyler-Walters, H., 2003. Nucella lapillus. Dog whelk. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 25/08/2005]. Available from: http://www.marlin.ac.uk/species/Nucellalapillus.htm
12 http://www.oceanviewfoundation.org/critterofmonth_quahog.html
13 Jackson, A., 2000. *Hydrobia ulvae*. Laver spire shell. *Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme* [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 25/08/2005]. Available from: <http://www.marlin.ac.uk/species/Hydrobiaulvae.htm>
14 Jackson, A., 2005. Littorina littorea. Common periwinkle. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 25/08/2005]. Available from: http://www.marlin.ac.uk/species/Littorinalittorea.htm
15 Sabatini, M. & Ballerstedt, S., 2004. Nucula nitidosa. A bivalve mollusc. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 25/08/2005]. Available from: <http://www.marlin.ac.uk/species/Nuculanitidosa.htm>
16 http://www.mass.gov/czm/wpshell.htm
17 Marshall, C.E. & Wilson, E., 2005. Pecten maximus. Great scallop. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 25/08/2005]. Available from: <http://www.marlin.ac.uk/species/Pectenmaximus.htm>
18 http://www.dnr.state.sc.us/wcp/pdf/Knobbedwhelk.pdf
19 http://www.marsci.uga.edu/gaseagrant/pdf/whelk2.pdf
20 http://www.biomescenter.com/channeledwhelk_learn.htm
21 http://www.reefkeeping.com/issues/2004-07/rs/index.php
22 http://fwie.fw.vt.edu/WWW/macsis/lists/M060150.htm
23 http://www.serc.si.edu/labs/benthic_ecology/recruitment_dispersal.jsp
24 http://www.santafe.edu/files/gems/paleofoodwebs/ChrisLucz1999EcolModel.pdf
25 http://gmbis.marinebiodiversity.ca/BayOfFundy/taxListInfo.jsp?taxListInfo=Hydrobia%20totteni
26 http://www.biomescenter.com/oysterdrill_learn.htm
27 http://www.amscopub.com/%5Cimages%5Cfile%5CFile_146.pdf
28 Smith 1964. Keys to Marine Invertebrates of the Woods Hole Region
29 http://www.mi.mun.ca/mi-net/fishdeve/clam.htm
30 http://www.chesapeakebay.net/hard_clam.htm
31 http://www.patsclams.com/Shellfish_101/Shellfish_Biology/shellfish_biology.html
32 http://www.wildsingapore.com/chekjawa/text/g411.htm
33 http://www.nan.usace.army.mil/business/prjlinks/dmmp/benefic/pdf/sitemmp.pdf
34 Stanley, J. G., and R. Dewitt. 1983. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) -- hard clam. U.S. Fish Wildl. Serv. FWS/OBS-82/11.18. U.S. Army Corps of Engineers, TR EL-82-4. 19 p?. http://www.nwrc.usgs.gov/wdb/pub/0200.pdf
35 Newell, C.R., and H. Hidu. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) -- softshell clam. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.53). U.S. Army Corps of Engineers, TR EL-82-4. 17 pp. http://www.nwrc.usgs.gov/wdb/pub/0168.pdf
36 Ely, E. 1988. Rhode Island Seagrang Fact Sheet: The American Lobster. [cited 09/06/06]. Available from :<http://seagrant.gso.uri.edu/factsheet/fslobster.html>
37 Wilber, D. H., Brostoff, W., Clarke, D. G., and Ray, G. L. (2005). Sedimentation: Potential biological effects from dredging operations in estuarine and marine environments. DOER Technical Notes Collection (ERDC TN-DOER-E20), U.S. Army Engineer Research and Development Center, Vicksburg, MS. [cited 09/06/06] available from: <http://el.erdc.usace.army.mil/dots/doer/doer.html>
38 Neal, K.J. & Wilson, E., 2005. *Cancer pagurus*. Edible crab. *Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme* [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 19/07/2006]. Available from: <http://www.marlin.ac.uk/species/Cancerpagurus.htm>
39 Neal, K.J. & Pizzolla, P.F, 2006. Carcinus maenas. Common shore crab. Marine Life Information Network: Biology and Sensitivity Key Information Sub-programme [on-line].

Table 5.3.2-4

A Discussion of the Tolerances of the Bivalves, Gastropods and Decapods of Horseshoe Shoal, to Sediment Deposition and Suspended Sediment

Species	Feeding Method	Sediment Deposition	Suspended Sediment	Tolerance to Sediment Deposition	Tolerance to Suspended Sediment
				(low, medium, high)	

Plymouth: Marine Biological Association of the United Kingdom. [cited 06/09/2006]. Available from: <http://www.marlin.ac.uk/species/Carcinusmaenas.htm>
40 http://www.mi.mun.ca/mi-net/fishdeve/atlantic.htm
41 http://www.biomescenter.com/ladycrab_learn.htm
42 http://www.glaucus.org.uk/crustace.htm
43 http://www.mbl.edu/marine_org/marine_org.php?func=detail&myID=BX136&source_myID=D1
44 http://www.biomescenter.com/commonspidercrab_learn.htm
45 http://www.sms.si.edu/IRLSpec/Limulu_polyph.htm
46 Weiss, H. M. 1995. Marine Animals of Southern New England and New York: Identification Keys to Common Nearshore and Shallow Water Macrofauna. Connecticut Department of Environmental Protection, Natural Resources Center, Hartford, CT. 344 pp.