Reconnaissance Survey of Benthic Communities of a Potential Borrow Site off Tangier Island, Virginia

Report to

Virginia Airports Authority

from

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by

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Introduction

The Virginia Institute of Marine Science was called on to render advice and services to the Virginia Airports Authority concerning the environmental impact and design of an extension of the runway of the airport on Tangier Island, Virginia. The southern end of the present runway is now being threatened by the erosion due to the rapid retreat of the western shore of Tangier Island (Fig. 1). Extending the runway would require the stabilization of the shoreline in the vicinity of the runway and filling a tract of subaqueous bottom.

VIMS geologists have provided information regarding coastal engineering options and fill material acquisition (Boon, 1975). VIMS wetlands scientists were consulted and concluded that the proposed action would not detrimentally impact the intertidal zone and wetlands, which are being lost to erosion at a rapid rate. VIMS advised the Virginia Airports Authority that the only potentially significant impact would be the alteration of the habitat of benthic (bottom-dwelling) organisms in the vicinity of the fill borrow area.

An assessment of the extent of impact must be contingent on knowing (1) the location and dimensions of the borrow area and (2) the nature of the benthic biota in the area. VIMS geologists have located fill material suitable in quantity and quality in the broad shallow area just offshore to the west of the runway and have recommended location, configuration, and dimensions of the borrow site. However, the biology of the area was little known and it was decided that a reconnaissance survey of the benthic macrofauna should be conducted in order to allow a confident assessment of the long term impact of the sand acquisition on the benthos. From this information we could evaluate the recoverability of the system, based on knowledge of life history and reproductive modes of the constituent species and experience elsewhere in the Chesapeake Bay on recolonization of dredged bottoms.

This report presents the results of the reconnaissance survey of benthic macrofauna and an assessment of the long term impact of the fill acquisition on benthic communities. It represents the final report for the contractual agreement for the execution of this work between the Virginia Airports Authority and the Virginia Institute of Marine Science.

Results

Sedimentary Habitats

The nature of bottom sediments have a profound effect on the distribution and abundance of benthic organisms and knowledge of sediment granulometry is essential in interpretation of results of surveys of the benthos. Sediments throughout the area off the western shore of Tangier Island are fine to medium sands and the sorting index (a measure of the standard deviation of particle sizes about the mean) indicates that they are moderately sorted to very well sorted (Table 1). The sediments generally become coarser offshore. The results of our sediment analyses agree very closely with those of Boon (1975). They conclude that the sediments in the area are dynamic and are being actively wave-sorted and transported. Boon and Byrne hypothesize that well sorted coarser sands are being moved toward shore and to the south, and covering nearshore are the finer sands and muds remaining from the eroding island. In some places close to shore, peat, stumps and other relict features are exposed.

Benthic Communities

Table 2 presents the results of the faunal analyses. A total of 15,731 individuals representing 60 species was taken from the 13 sampling sites. Polychaetous annelids were the most numerous and diverse forms, comprising 36.5% of the animals collected and represented by 25 species. Bivalve molluscs comprised about the same proportion (39.2%) of the individuals collected but only 9 species were taken. 16.2% of the animals were amphipod crustaceans which were represented by 6 species and 5.7% were isopod crustaceans

Table 1. Percent weight in grain size classes, median sediment diameter (phi units and mm) and sorting index (S_ϕ) of sediment samples from each station.

	Size Fractions (Ø size classes)							Median Particle Diameter		Sorting Index
Station	-1 (>2 mm)	0 (2-1 mm)	1 (1-0.5 mm)	2 (500-250 µ)	3 (250-125 µ)	4 (125-63 µ)	>4 (<63 µ)	Md_ϕ	Md_{mm}	S_ϕ
1	1.1	1.6	9.0	19.8	43.2	16.8	8.3	2.42	0.187	1.08
2	1.3	1.3	10.0	37.3	45.9	3.3	0.8	2.00	0.250	0.72
3	3.1	6.8	27.4	48.6	13.0	0.7	0.2	1.22	0.429	0.83
4	0.2	1.4	18.8	65.0	12.9	1.0	0.7	1.43	0.371	0.55
5	0.0	0.0	17.0	72.4	9.8	0.7	0.1	1.43	0.371	0.45
6	0.4	2.4	15.3	56.7	22.9	2.1	0.2	1.58	0.334	0.66
7	0.0	1.0	3.4	10.8	74.4	9.5	0.8	2.43	0.186	0.44
8	0.0	0.4	11.4	52.0	30.7	4.5	1.0	1.76	0.295	0.69
9	0.0	0.8	6.8	48.3	41.4	2.3	0.3	1.90	0.268	0.60
10	0.8	1.4	10.3	56.4	27.4	3.2	0.5	1.70	0.308	0.63
11	0.0	0.7	18.9	65.7	13.5	1.1	0.2	1.44	0.369	0.53
12	0.6	1.2	15.1	51.5	26.9	4.3	0.4	1.69	0.310	0.72
13	0.0	0.3	6.0	64.1	28.3	1.0	0.2	1.70	0.308	0.49

representing 5 species. The remaining 902 individuals were distributed among 15 species in 13 higher taxa.

Three species, the polychaete Ophelia bicornis, the bivalve Gemma gemma and amphipod Monoculodes edwardsi, dominated at all collection sites. These three species comprised 74% of the total individuals with Gemma alone comprising 37.1% of the individuals.

Other species well represented at all stations were the polychaetes Scolecolepides viridis, Scoloplos robustus, Paraonis fulgens, the gastropod Acteocina canaliculata, the bivalve Mulinia lateralis and the isopods Chirodotea caeca and Sphaeroma quadridentatum. The echinoderm Leptosynapta tenuis, a large deposit feeding holothurian, was present at all but the most inshore pair of sites.

Station 2 had the greatest abundance of both species and individuals. This was in part due to the fact that the collections contained the remains of old tree stumps which undoubtedly increased the heterogeneity of the bottom, allowing for more species to coexist.

No obvious trends are apparent in the species diversity measures. Informational diversity (H') was fairly uniform throughout the study area and falls within the range typical for that salinity regime in the Chesapeake Bay (Roberts et al. 1975). The influence of the rather high species richness on H' was moderated by low evenness caused by the dominance of Gemma, Ophelia and Monoculodes.

The density of macrofauna (mean ca. 4,000/m^2) off Tangier Island is relatively high considering the dynamic stress of the shifting sand habitat. Although no directly comparable habitats have been studied in the Bay, Boesch and Rackley (1974) found much lower densities on dynamic sand bars in the lower Bay, although some of the same species were found there (e.g. Gemma gemma). Hamilton and La Plante (1972) found high macrofaunal densities in the nearshore sand habitat off Cove Point, Maryland, attributable to an high abundance of Gemma gemma. Very high densities of the small bivalve Gemma have been reported elsewhere (Sanders et al. 1962). Several species abundant off Tangier were also abundant in the Cove Point sand habitat, e.g. Scoloplos robustus, Chiridotea caeca, Mulinia lateralis and Glycera dibranchiata, but two of the dominant species, Ophelia bicornis and Monoculodes edwardsi are not known to occur in similar abundance elsewhere in the Bay.

Life Histories and Recruitment of Dominant Species

The bivalve Gemma gemma broods its young and releases them as tiny bottom clams, thus there is no wide ranging dispersive life stage as in most bivalves. Gemma is, however, quite capable of small scale dispersion because of its high degree of mobility and its great reproductive potential. Gemma should be able to recover well from local (in the order of hundreds of meters) extinction.

The polychaete _Ophelia_ _bicornis_ is a small, actively burrowing grub-like worm adapted to life in dynamic sediments. It is probably not very mobile in the horizontal direction but its larvae develop in the plankton and can disperse widely. _Ophelia_ larvae are known to be able to "select" a suitable sediment habitat by testing its chemical characteristics before undergoing metamorphosis (Wilson 1952). Recovery from local extinction would depend on successful larval recruitment. Other polychaetes, _Scoloplos robustus_, and _Paraonis_ _fulgens_ are similar to _Ophelia_ in active burrowing habits and life history. They too depends on planktonic larval recruitment. The spionid polychaete _Scolecolepides_ _viridis_ maintains its purchase by building vertical tubes in the sediment and it feeds on surface deposits by means of long palps. _Scolecolepides_ is a commonly abundant form in mesohaline and oligohaline salinities (ca. 0-15‰ salinity) and it is recuited via planktonic larvae. The abundance and fecundity of _Scolecolepides_ suggests recuitment following local extinction should occur within a year of extinction.

The amphipod _Monoculodes_ _edwardsi_ is an actively burrowing animal which lives in mobile surface sediments. It, like all peracarid crustaceans (amphipods, isopods, etc.), broods its young and thus produces relatively few offspring. However, _Monoculodes_ is quite an active swimmer and is frequently found in plankton samples (Feeley and Wass, 1971). Recovery from local extinction, assuming no change in the habitat, should be very rapid. The isopod *Chiridotea caeca* and *Sphaeroma quadridentatum* are also quite active as adults, both crawling and swimming, and should also recover quickly from local extinction.

With the possible exception of the holothurian *Leptosynapta tenuis* and the phoronid *Phoronis psammophila* there seem to be no large, long-lived members of the community. Recovery of the community from local extinction should depend almost totally on recruitment either of adults from surrounding bottom (e.g. *Gemma*, *Monoculodes*, *Chiridotea* and *Sphaeroma*) or of larvae from the plankton (e.g. *Ophelia*, *Paraonis*, *Scoloplos* and *Scolecolepides*) and not on the additional, longer term process of growth and maturation of long-lived inhabitants. Most of the members of the community are probably annuals.

Conclusions

Long-term Impact of Fill Acquisition

The philosophy of the preliminary recommendations of VIMS concerning borrow site location and dimensions was to attempt to assure minimum alteration of bottom topography and rapid physical recovery of the bottom. Thus it was proposed that dredging be limited to 6 feet below the natural bottom. Although it is estimated that it would take many years for the filling in and leveling off of the resulting pit, even in this regime of active sediment transport, the bottom of the depression should be covered with a veneer of surface sediment transported from adjacent bottoms within a short period of time (certainly within a year). We would then expect relatively little qualitative difference in the surface sediments from those now characteristic of the area. The sediments could be slightly finer due to selective transport of fine sands into the area and reduced wave winnowing of silts and clays, but should still consist predominantly of fine to medium sands. This should allow relatively complete recovery of the benthic community within two years, allowing one year for reconstitution of surface sediments and another for recolonization of the biota.

If the design depth of no more than 6 feet is adhered to, we see no chance of stagnation or oxygen depletion in the borrow pit.

Fill acquisition off Tangier Island will cause local extinction of benthic organisms and short term loss in productivity in a limited area. Thus, it still remains desirable to utilize spoil generated from channel maintenance dredging in Tangier Harbor as fill for the runway extension should it prove suitable and available in a timely manner.

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Table 2. Summary table for all species identified from triplicate grab samples taken at 13 station sites off Tangier Island. For each station the total number of each species for the three 0.1 m^2 grabs, total number of species, total number of individuals, species diversity, evenness and richness are given.

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
PLATYHELMINTHES														
Stylochus ellipticus											1			1
RHYNCHOCOELA														
Nemertean Unid.	4	8	4	5	5	5	3	7	3	3	6	5	8	66
OLIGOCHAETA														
Peloscolex gabriellae	2	161	2	40	22	45	1	23	12	24	21	18	6	377
POLYCHAETA														
Asabellides oculata		1												1
Drilonereis longa								1						1
Eteone heteropoda	1	6	1	3	1		2	4		1	1			20
Eteone lactea		2			2		2	3	2				3	14
Exogone dispar						1						1		2
Glycera dibranchiata		5	2	1	1	1	1	1	1	2	1	3	2	21
Glycinde solitaria		1		1										2
Gyptis vittata				1	1	2						1		5
Heteromastus filiformis	7	35		4				2						48
Nereis succinea	1	2		2			1	1			1	1		9
Ophelia bicornis	1	5	474	263	280	238	31	268	515	516	257	308	426	3582
Parahesione luteola			1											1
Paraonis fulgens	15	25	21	3	22	5	170	15	41	10	18	6	26	377
Polydora ligni	4	14		5		2				1	2	2		30
Pseudeurythoe paucibranchiata										1		1		2
Sabellaria vulgaris				1										1

Table 2 (Continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
POLYCHAETA (cont.)														
Scolecolepides viridis	58	53	38	40	42	76	74	31	48	42	49	80	65	696
Scolelepis squamata		6				9						2	1	18
Scoloplos robustus	61	62	30	57	93	39	107	110	60	80	55	31	48	833
Scoloplos rubra		1		2	1	11		1			1	3		20
Spiochaetopterus oculatus											1			1
Spiophanes bombyx		3		1		9						2	5	20
Streblospio benedicti	1	6						1				1		9
Syllidae	2	6				1	1	10	2	4	2	2		30
Tharyx setigera				1										1
GASTROPODA														
Acteocina canaliculata		34	5	11	11	49		8	6	16	28	32	4	204
Doridella obscura										1			1	2
BIVALVIA														
Gemma gemma	81	1352	148	475	308	878	293	303	429	255	479	445	401	5847
Lyonsia hyalina		1	1		4	14			1	3	4	13		41
Macoma balthica	5	3	1	3		4		1		1	2	4		24
Macoma mitchelli							1							1
Mulinia lateralis		4	1	4	6	83		1		8	16	48	2	173
Mya arenaria	5	9	3	10	4	15	1	2	2	1	6	8	3	69
Petricola pholadiformis		9	2	1			1		2	2		1	1	19
Tagelus sp.		1						1						2
Tellina agilis	2	1					1	1		1				6
CIRRIPEDIA														
Balanus improvisus	5			2						1				8
MYSIDACEA														
Neomysis americana		1	2	3	4	6		13	5	4	4			42

Table 2 (Continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
CUMACEA														
Cyclaspis varians			4	1		2	1	6	5	8	8	1	7	43
Oxyurostylis smithii				2	5							3		10
OSTRACODA														
Cytheridae				1			1							2
ISOPODA														
Chirodotea caeca	1	4	23	2	33	17	26	10	11	15	46	21	40	249
Cyathura burbancki						6					1	7		14
Cyathura polita	1	2												3
Edotea triloba	1	1		5				1						8
Sphaeroma quadridentatum	1		19	2	23	4	3	6	7	2	9	6	3	85
AMPHIPODA														
Acanthohaustorius millsi		5		8	1		247		1	1			6	269
Corophium sp.				1	4				1	2	2			10
Gammarus mucronatus	1				1	3				2	2	15	1	25
Monoculodes edwardsi	81	116	148	164	184	125	200	250	228	239	167	225	112	2233
Paracaprella tenuis				1										1
Stenothoe sp.			1		3					1	1			6
DECAPODA														
Crangon septemspinosa	1	3			2			1		2	1			10
INSECTA														
Clunio sp.												1		1
PHORONIDA														
Phoronis psammophila	1	1		4	11	3		1	2	4	10	50	2	89

Table 2 (Continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
ECHINODERMATA														
Leptosynapta tenuis		4	1	3	3	13		2	2	3	6	5	4	46
PISCES														
Paralichthys dentatus					1									1
Total Number of Species	25	37	23	37	29	29	22	31	23	33	32	34	24	60
Total Number of Individuals	343	1953	932	1133	1078	1666	1168	1085	1380	1256	1208	1352	1177	15731
Diversity (H')	2.98	1.99	2.34	2.65	2.96	2.61	2.80	2.78	2.37	2.59	2.84	3.01	2.49	2.94
Evenness (J')	0.64	0.38	0.51	0.50	0.60	0.53	0.62	0.56	0.52	0.51	0.56	0.59	0.54	0.49
Species Richness (S-1/lnN)	4.11	4.75	3.22	5.12	4.01	3.77	2.97	4.29	3.04	4.48	4.37	4.58	3.25	6.11