

POLYCYCLIC AROMATIC HYDROCARBONS IN DREDGED MATERIAL FROM PORTS AND NAVIGATION CHANNELS IN ENGLAND AND WALES: PRELIMINARY DATA

by Carole Kelly, Robin Law, Kerry Baker, Rachel Waldock and Marie Pendle

Introduction

Maintenance dredging is conducted at ports in order to maintain access for vessels through navigation channels. Around England and Wales, during the period 1998-2001, 100-200 licences for disposal of dredged material were issued annually. The quantity of material disposed to sea varied between 53 and 82 million tonnes per annum over the same period. The dredged materials are disposed of at defined disposal grounds close to shore.



Dredger

Before authorisation is granted the concentrations of selected contaminants are determined. Historically this has included a range of trace elements, organochlorine pesticides, chlorobiphenyls, and butyltin compounds. Dredged material with a high concentration of any of these contaminants may not be disposed of to sea. Since 1998, we have also determined the concentrations of a suite of PAH compounds, including both parent and alkylated PAH. Our aim is to establish the current levels of contamination and, if possible, to derive guideline limit values for use in the licensing process.

Results

Approximately 200 samples of dredged material were analysed, from 17 main locations around England and Wales. The results are shown in Table 1

Table 1: Dredgings PAH summary 1998-2001.

Location	N	C1-N	C2-N	C3-N	Athylene	Athene	Fluorene	P	A	C1-P	Fl	Py	BaA	Chrysene	BFs	BeP	BaP	Perylene	I123cdP	BghiP	DahA	ΣPAH	% oil	% combustion
Heysham	426	904	1060	2160	ND	ND	ND	1720	330	1570	2600	2320	837	1130	2060	823	854	224	799	1030	ND	20,800	38	62
Anglesey	410	697	1080	1790	ND	ND	ND	862	325	956	1291	1430	565	691	1430	606	667	183	570	735	ND	14,300	41	59
Tees	27100	22100	50200	3930	ND	ND	ND	7530	2430	5030	7500	5530	2930	2350	2620	922	1040	271	324	479	ND	142,000	81	19
Great Yarmouth	69	259	287	608	17	24	35	86	89	233	858	683	445	447	1150	362	646	164	308	210	67	7,050	23	77
Great Yarmouth	932	1410	1670	2970	34	112	89	386	131	731	430	500	170	145	215	151	118	32	72	68	26	10,400	80	20
Tilbury	978	2700	8820	9480	15	149	309	1270	329	2330	1450	1150	598	569	2080	748	738	309	399	309	83	34,800	75	25
Sheerness	650	3080	2160	3740	69	116	216	1890	867	2840	4130	3240	1250	2220	2400	963	1370	385	807	632	255	33,300	44	56
Sheerness	92	343	249	402	9.4	33	28	372	158	513	1210	1040	782	1000	1530	607	777	225	519	349	171	10,400	20	80
Mersey	1330	1370	1610	1150	85	148	301	942	469	1070	1830	877	589	534	1380	607	764	186	603	569	168	16,600	48	52
Southampton	135	306	413	459	19	55	36	513	155	521	1360	1630	595	619	1860	735	967	401	505	381	116	11,800	21	79
Cardiff	191	360	463	630	16	67	151	441	129	530	3520	2480	1540	2240	5050	1700	1540	446	1780	1340	461	25,100	11	89
Gosport	40	38	50	150	0.5	20	29	327	39	243	1640	1330	428	511	994	304	429	140	284	159	58	7,210	12	88
Dover	34	82	203	207	< 0.1	13	15	136	35	136	298	262	115	122	339	140	166	61	199	187	43	2,790	30	70
Devonport	185	211	259	457	37	44	91	472	249	882	4940	5220	2660	2600	5790	1800	3380	921	1490	1190	447	33,300	8	92
Shoreham	44	82	91	444	< 0.1	4.8	56	438	79	654	1110	953	499	472	8010	2870	7130	1660	2620	2080	984	30,300	6	94
Milford Haven	93	465	330	312	100	365	209	851	71	292	1030	712	331	422	710	300	305	91	249	236	208	7,680	38	62
Solway	198	1500	1710	2830	55	79	139	585	119	1260	620	562	2470	4770	638	274	268	100	256	221	72	18,700	44	56
Humber	621	1820	2130	2610	28	93	181	1080	271	1460	1580	1340	857	873	1560	662	810	261	552	533	170	19,500	51	49
Tyne	2890	13200	13000	28600	150	559	869	4020	669	6120	3620	2480	1670	1780	3270	1260	1330	260	549	759	190	87,200	79	21

ND: not determined

Key to PAH compounds : N, naphthalene; Athylene, acenaphthylene; Athene, acenaphthene; P, phenanthrene; A, anthracene; Fl, fluoranthene; Py, pyrene; BaA, benz[a]anthracene; BFs, benzo[fluoranthene]; BeP, benzo[e]pyrene; BaP, benzo[a]pyrene; I123cd, indeno[1,2,3-cd]pyrene; BghiP, benzo[ghi]perylene; DahA, dibenz[a,h]anthracene. C1 to C3 denote degrees of alkylation in substituted PAH.

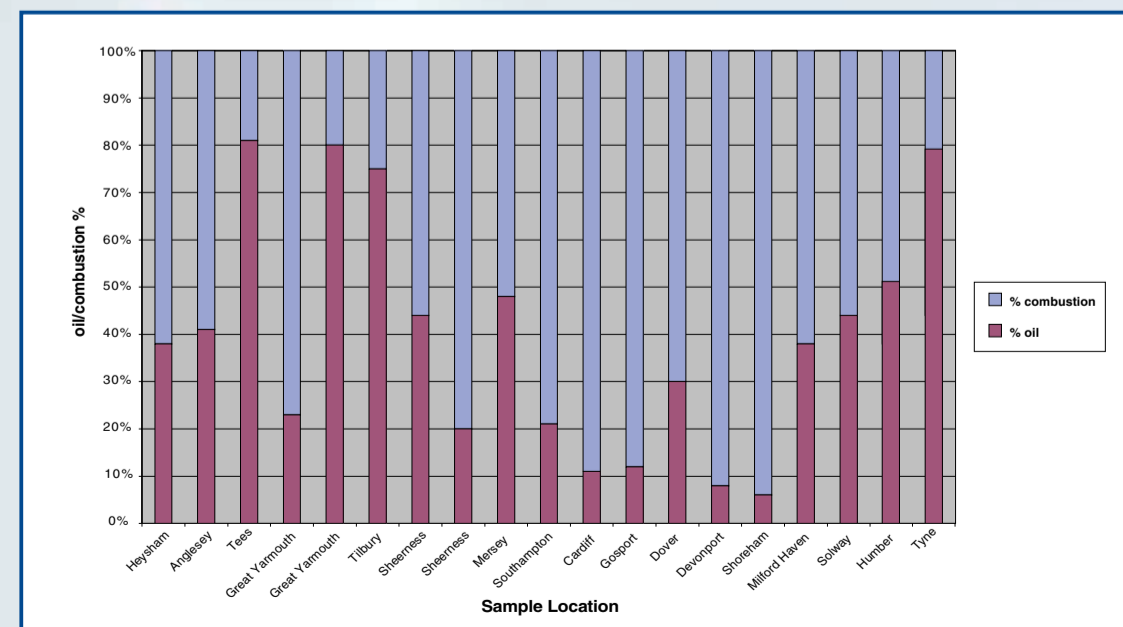


Figure 1: Shows a plot of the sample location against the percentage of oil and combustion derived PAH

Examples of the two source types are Devonport (predominantly combustion-derived) and the Tyne (predominantly oil-derived). These differences in sources are also apparent in the total ion chromatograms obtained for the two samples during GC/MS analysis.

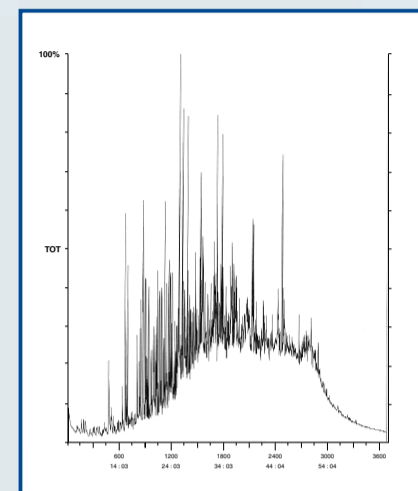


Figure 2: Total Ion Chromatogram of Tyne sample

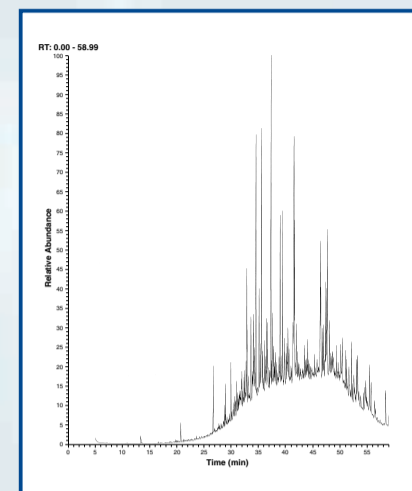


Figure 3: Total Ion Chromatogram of Devonport sample

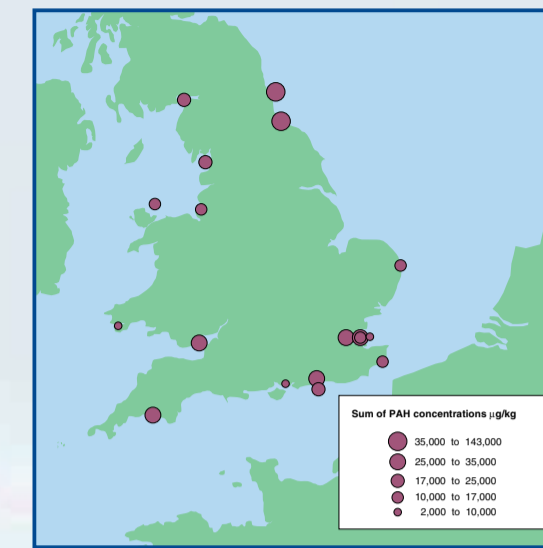


Figure 4: Map showing sites and sum of PAH in dredged material

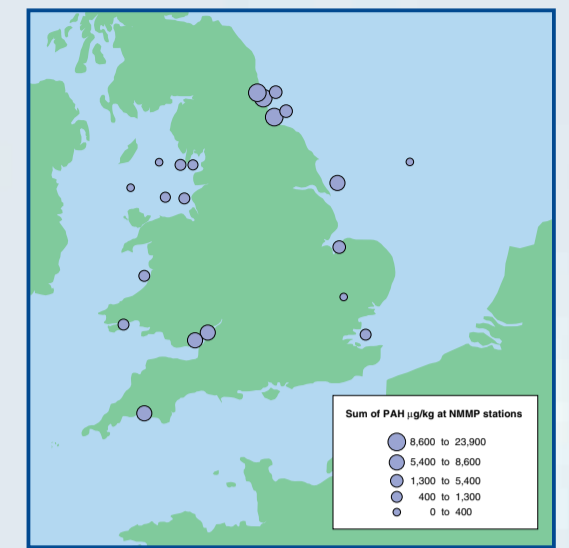


Figure 5: Map showing sites and sum of PAH in marine sediments

The results obtained from this study have also been compared with PAH concentrations drawn from samples collected during 1993-96 and analysed within the UK National Monitoring Programme. For this earlier study only parent PAH were determined, and so source allocation was not possible. Figure 5 shows selected data from this study for comparison with Figure 4.

Discussion

An earlier survey of PAH in UK sediments showed a range of ΣPAH concentrations (for 15 parent PAH) from not detected to 43,500 µg kg⁻¹ dry weight³. The lowest concentrations occurred in sandy sediments and those at offshore sites, and the highest in estuarine muds. Assessing the ecotoxicological significance of these data, the authors concluded that:

- the sediments of the estuaries of the English north-east coast (Tyne, Wear and Tees) and Milford Haven contained PAH-contaminated sediments at some sites which were likely to be acutely toxic to sediment dwelling organisms.
- a wider range of industrial estuaries had PAH levels in sediments likely to cause chronic effects, including the induction of neoplastic liver disease in fish.

The removal of these contaminated sediments and their disposal to cleaner offshore sites is therefore a matter of concern.



Dredging

Conclusions

These preliminary data have demonstrated high PAH concentrations in sediments from areas that are dredged to maintain access for vessels. Based on earlier studies, these concentrations are, in many cases, sufficient to cause toxicity. It is important, therefore, to gather additional data, both to fill in gaps in coverage and so as to develop guideline limit values for approval purposes. Alongside these studies CEFAS are also developing a toxicity screening procedure using sediment bioassays which will be deployed routinely. Finally, in order to assess the significance of the disposal of contaminated sediments it is essential to conduct studies at dredging disposal sites, and this began in 2001.

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