LOIS RACS(C) Core Programme
Tweed 3
Fieldwork report

Vessel: R.V. Tamaris & semi-rigid inflatable

Dates: October 12-18, 1996

Personnel: Robb Howland-PML Senior scientist
Nick Bloomer-PML
Carolyn Harris-PML
Mike Williams-PML
Peter Rendle-PML

Itinerary:

Saturday 12 October: Departed PML at 0800 for the journey to Berwick-on-Tweed, arriving at 1800.

Sunday 13 October: Arrived at the boat at 0600 in order to load the equipment before the tidal drop made this operation problematical. Completed loading at 0800. Over the low water period, and while the crew were overcoming an injector problem on the boat's starboard engine, we surveyed a number of possible sites for remote EMP 2000 deployments on future surveys. The two sites selected were the abandoned fishery just below the A1 road bridge and the island about 200m downstream from the Union Bridge. The latter site is the same as that used by the 'Tidal reaches' for a water sampler, and will be coordinated with them on the occasions when they are carrying out their surveys.
On completion of this exercise we returned to Tamaris to continue with setting up equipment; all of which had been run and calibrated by the close of work at 1800. At 1500, close to high water, the semi-rigid inflatable was launched through the hole in the sea wall between the old and new road bridges.

Monday 14 October: Commenced work at 0800. Tamaris moved out to Station 5 (the Chandlery) (figure 1), just below the old town bridge, and monitoring of 'standard suite (salinity, temperature, turbidity, pH and dissolved oxygen), nutrients (phosphate, silicate, nitrate, nitrite and ammonia), gravimetrics, C/N and chlorophyll was commenced at 0900. On this occasion freshwater run-off was considerably greater than on previous surveys and it was not possible to anchor the boat until the start of the flood tide.
At 1400 we started repetitive axial profiling of the lower estuary between Stations 4 and 8. Due to a heavy onshore swell it was not possible to work further downestuary. At Station 8 the semi-rigd inflateable was deployed to extend the axial profile up to Station 20 (Chain/Union Bridge). A YSI 6000 was used to monitor 'standard suite' variables on each station and bulk samples were taken for nutrients, gravimetric, C/N and chlorophyll analysis. This run was successfully concluded at 1630 and Tamaris finished the repetitive axial profiling at 1800.

Tuesday 15 October: Commenced work at 0800. Tamaris moved out to Station 5 and monitoring of 'standard suite (salinity, temperature, turbidity, pH and dissolved oxygen), nutrients (phosphate, silicate, nitrate, nitrite and ammonia), gravimetrics, C/N and chlorophyll was commenced at 0915. As on Monday, it was not possible to anchor the boat until the start of the flood tide.
At 1500 we started repetitive axial profiling of the lower estuary between Stations 4 and 8. Due to a heavy onshore swell it was not possible to work further downestuary. At Station 8, on completion of the first run up the estuary, the semi-rigd inflateable was deployed to extend the axial profile up to Station 20 (Chain/Union Bridge). A YSI 6000 was used to monitor 'standard suite' variables on each station and bulk samples were taken for analysis as previously described. This run was successfully concluded at 1720 and Tamaris finished the repetitive axial profiling at 1800.

Wednesday 16 October: Commenced work at 0800. Tamaris moved out to Station 5 and monitoring of 'standard suite (salinity, temperature, turbidity, pH and dissolved oxygen), nutrients (phosphate, silicate, nitrate, nitrite and ammonia), dissolved trace metals, gravimetrics, C/N and chlorophyll was commenced at 0915. As on the two previous days, it was not possible to anchor the boat until the start of the flood tide.
At 1545 we started repetitive axial profiling of the lower estuary between Stations 4 and 8. Due to a heavy onshore swell it was not possible to work further downestuary. At Station 8, on completion of the first run up the estuary, the semi-rigd inflateable was deployed to extend the axial profile up to Station 20 (Chain/Union Bridge). A YSI 6000 was used to monitor 'standard suite' variables on each station and bulk samples were taken for analysis as previously described, with the addition of dissolved trace metals. This run was successfully concluded at 1750 and Tamaris finished the repetitive axial profiling at 1900.

Thursday 17 October: Commenced work at 0600. Tamaris moved out to Station 5 and monitoring of 'standard suite (salinity, temperature, turbidity, pH and dissolved oxygen), nutrients (phosphate, silicate, nitrate, nitrite and ammonia), gravimetrics, C/N and chlorophyll was commenced at 0630. Tamaris maintained position on this station throughout the day, until 1700.
At 1700 the boat moved back into the dock and we unloaded all the scientific equipment. On completion, at high water, we recovered the semi-rigid inflateable onto the road trailer. Work was completed at 1900.

Friday 18 October: Departed Berwick at 0800 for the return journey to Plymouth, arriving at 1900.

General comments:
1. Tamaris. A problem was encountered with a leaking injector on the starboard engine. Peter and Mike carried out a successful short term repair until a spare arrived from Plymouth. This has now been installed.
2. Semi-rigid. By a process of iteration we have arrived at a reasonably good working arrangement of the boat for use on 'core' transects. A plan of the set-up is shown in figure 2.
3. Warnings about working in 'very cold' and 'flood' conditions in the estuary were reiterated by Capt. Jenkinson (harbourmaster) and Peter Blanche (lifeboat skipper and

harbour pilot). We must take every precaution to ensure that safe working practices are adhered to at all times, particularly when using the semi-rigid.

Results:

Figures 2,3,4-a show nutrient (P,Si,NO3 & NO2) distributions against distance downestuary from the Chain Bridge (station 20).

Figures 2,3,4-b show nutrient (as 'a') distributions against salinity.

Figures 2,3,4-c show distributions of salinity, temperature, pH and turbidity against distance downestuary.

Figures 5-a & b show distributions of ammonia against salinity and distance downestuary on 15/10 and 16/10.

Salinity intrusion in the surface waters (see figures 2c, 3c and 4c)to just upestuary of the A1 road bridge, except on 16/10 when, following increased run-off, it only reached Station 8 see figure 4c).

Surface water temperatures in the estuary were decreased by about 1°C on the final day due to the increased, colder freshwater input. The temperature maximum between 1-4km downestuary on 15/10 is probably due to warming by the sun in this very shallow (<1.5m) section.

pH generally covaries with salinity.

Levels of suspended particulate material are generally low, varying between 5-30 ntu. The highest levels are found in the outer estuary where a small turbidity maximum at times of greatest tidal currents is evident.

There is clear evidence of strong nutrient inputs in the area between stations 8 (6.6km downestuary) and station 12 (4.48km downestuary). Station 8 is just downestuary from the sewage outfall and station 12 is just above the confluence with the R. Whiteadder.

The assistance given by Tamaris' crew, Mike Williams and Peter Rendle is gratefully acknowledged.

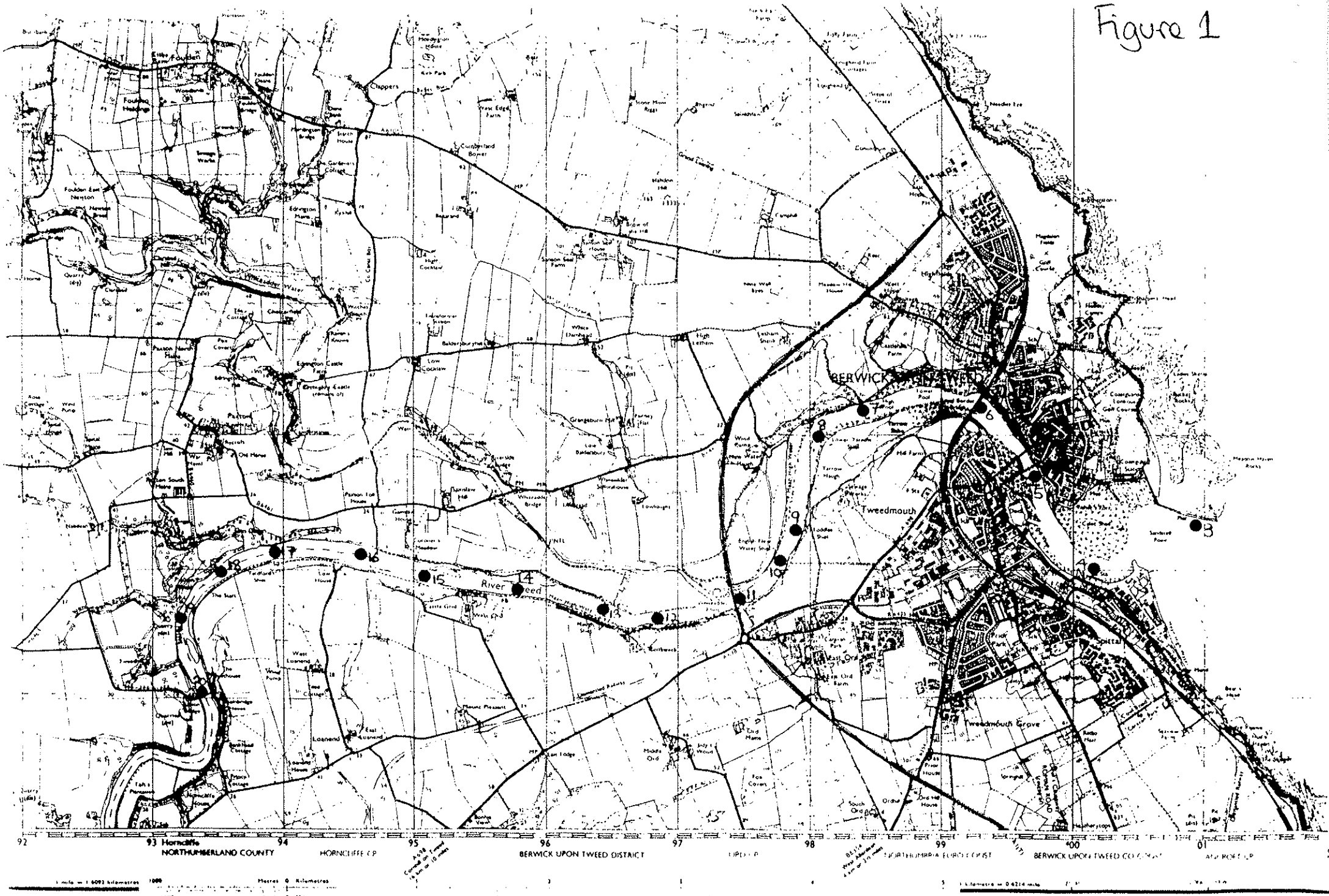
Appendix 1

List of Stations:

Station No.	Dist. downest. (km)	Station description	Map reference *
1		Offshore	
2		Offshore	
3	10.40	Just short of Lighthouse	009524
4	9.37	Lifeboat station	002520
5	8.53	Chandlery	997527
6	7.87	Just before railway viaduct	993532
7	7.00	White house on RHS	984532
8	6.60	Derelict building on corner	981530
9	5.88	Building past outfall on LHS	979523
10	5.58	Prominent trees on either side	978521
11	5.15	A1 road bridge	974517
12	4.48	2nd set of pylons past bridge	968516
13	4.05	Disused fishery on LHS	964517
14	3.38	Disused fishery on LHS	958518
15	2.68	Next fishery. power cables	951519
16	2.17	Next fishery on RHS	946521
17	1.53	End of wall/Fishery with icehouse	930522
18	1.10	Boat house on RHS	935520
19	0.63	End of trees/big house on RHS	932516
20	0	Chain bridge	934510

* - Ordnance survey Pathfinder 438

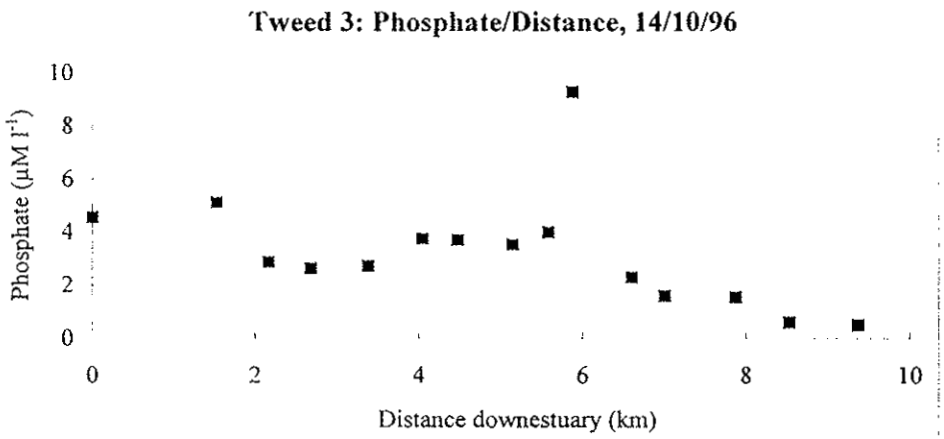
Figure 1

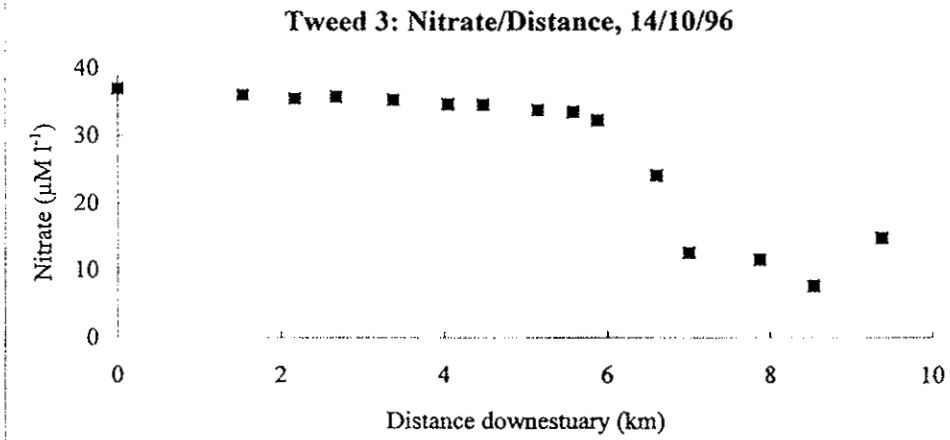


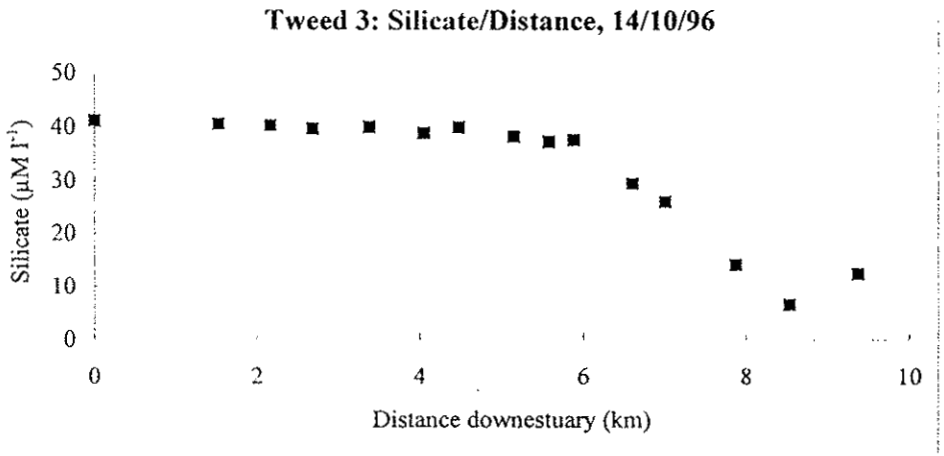
Scale 1:25 000

PATHFINDER 438 (NT 9

fig. 2a


Tweed 3: Phosphate/Distance, 14/10/96
Phosphate (µM l-1)
10
8
6
4
2
0
0
2
4
6
8
10
Distance downestuary (km)


Tweed 3: Nitrate/Distance, 14/10/96
Nitrate (µM l-1)
40
30
20
10
0
0
2
4
6
8
10
Distance downestuary (km)


Tweed 3: Silicate/Distance, 14/10/96
Silicate (µM l-1)
50
40
30
20
10
0
0
2
4
6
8
10
Distance downestuary (km)

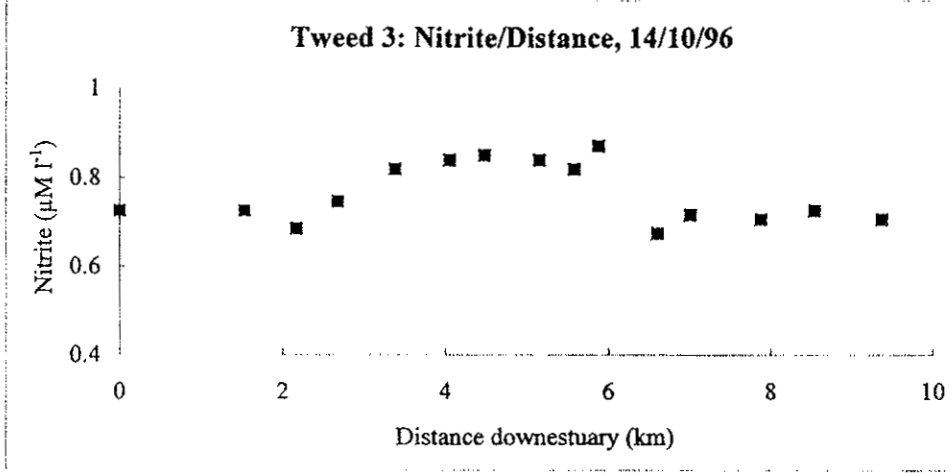
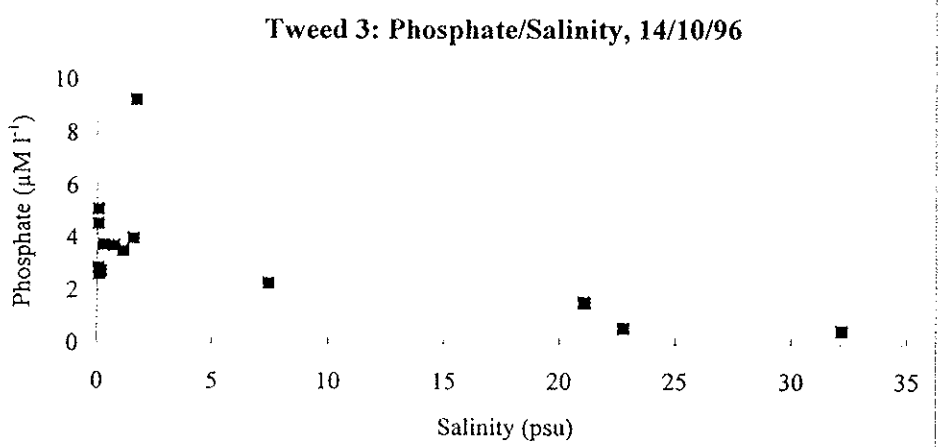
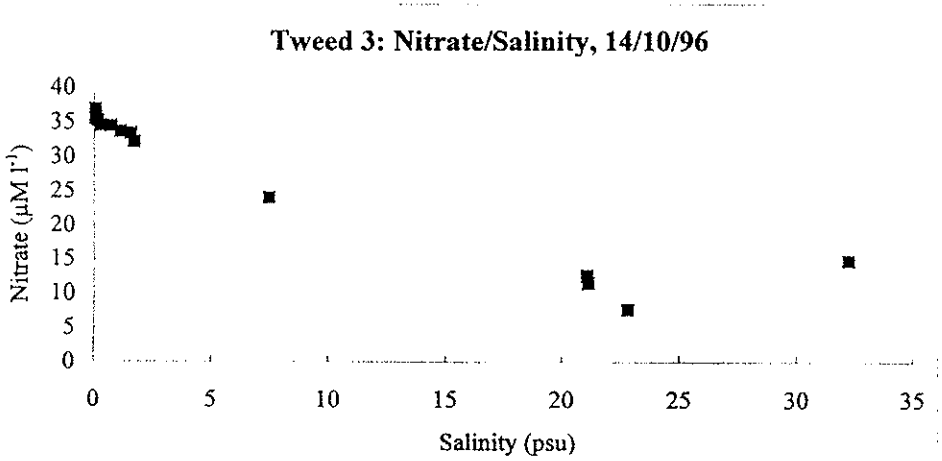
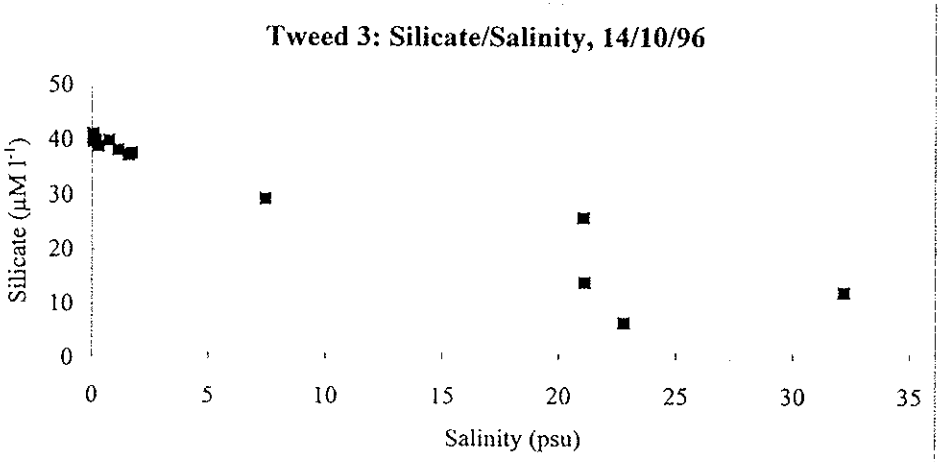

Tweed 3: Nitrite/Distance, 14/10/96
Nitrite (µM l-1)
1
0.8
0.6
0.4
0
2
4
6
8
10
Distance downestuary (km)

Fig. 26


Tweed 3: Phosphate/Salinity, 14/10/96
Phosphate (µM l-1)
Salinity (psu)


Tweed 3: Nitrate/Salinity, 14/10/96
Nitrate (µM l-1)
Salinity (psu)


Tweed 3: Silicate/Salinity, 14/10/96
Silicate (µM l-1)
Salinity (psu)

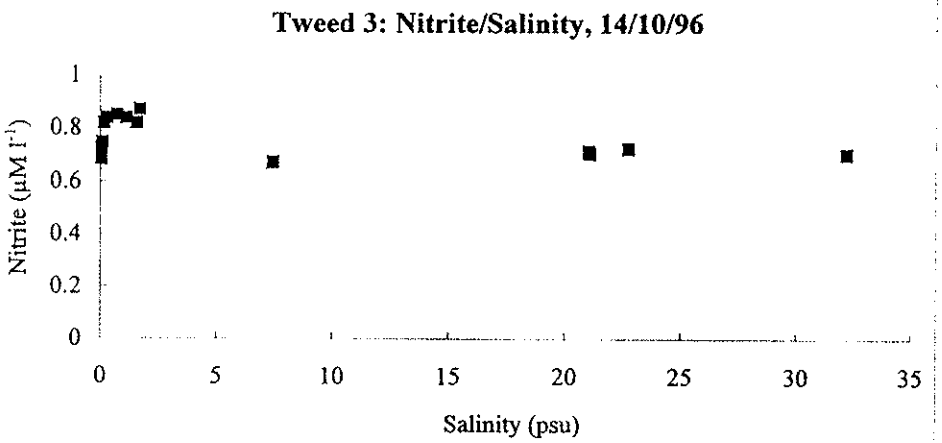
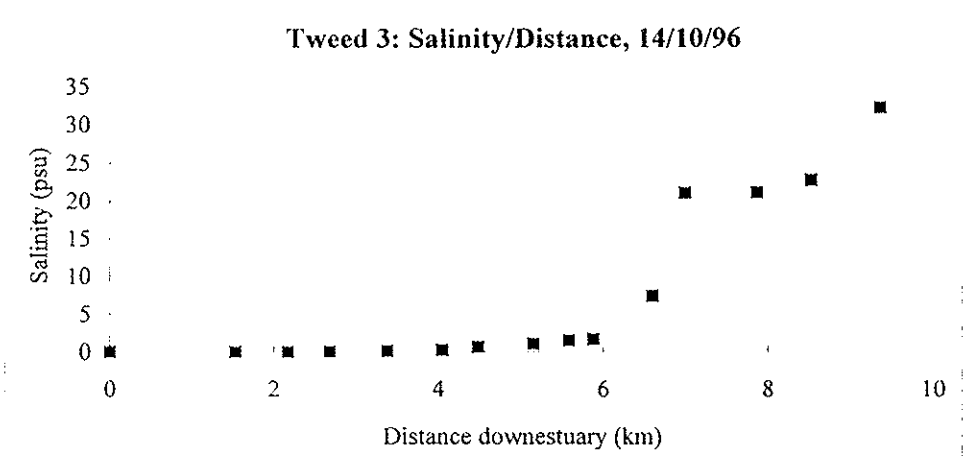
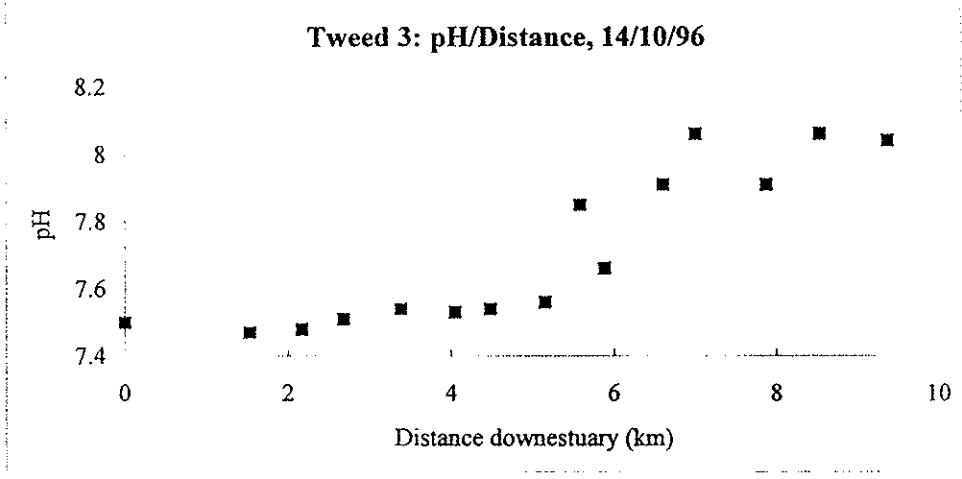
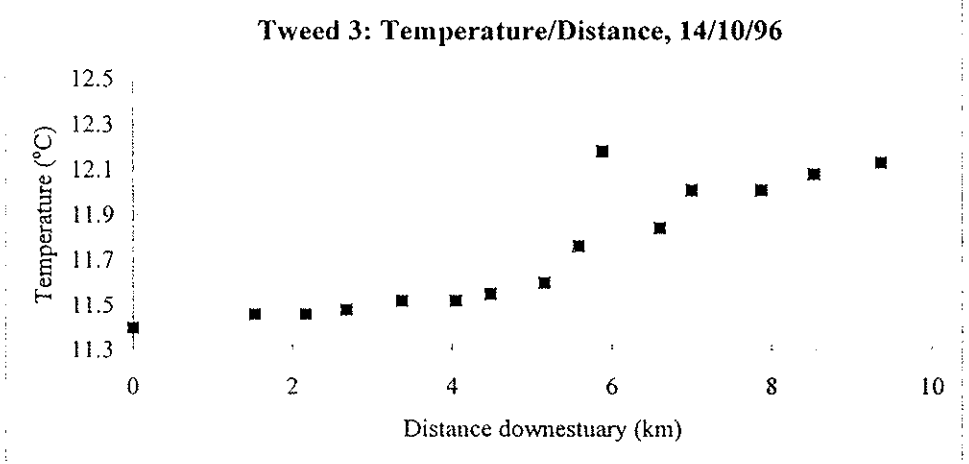

Tweed 3: Nitrite/Salinity, 14/10/96
Nitrite (µM l-1)
Salinity (psu)

Fig 2c


Tweed 3: Salinity/Distance, 14/10/96
Salinity (psu)
35
30
25
20
15
10
5
0
0
2
4
6
8
10
Distance downestuary (km)


Tweed 3: pH/Distance, 14/10/96
pH
8.2
8
7.8
7.6
7.4
0
2
4
6
8
10
Distance downestuary (km)


Tweed 3: Temperature/Distance, 14/10/96
Temperature (°C)
12.5
12.3
12.1
11.9
11.7
11.5
11.3
0
2
4
6
8
10
Distance downestuary (km)

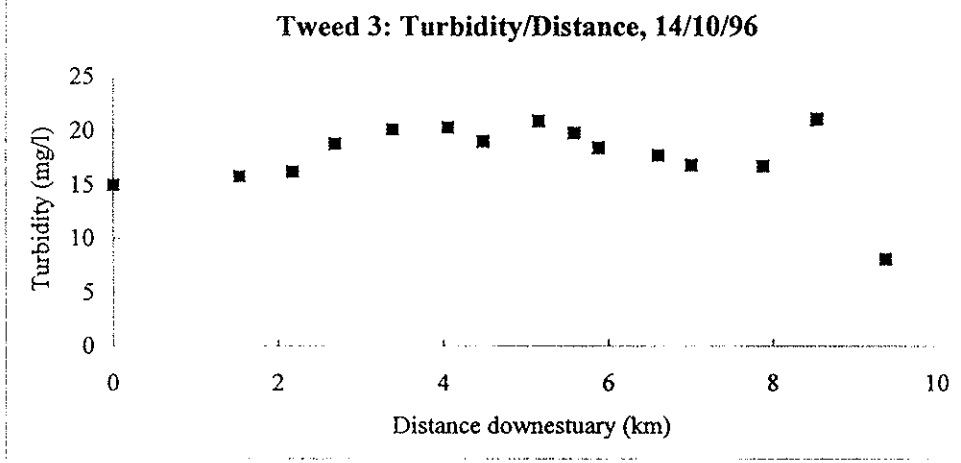
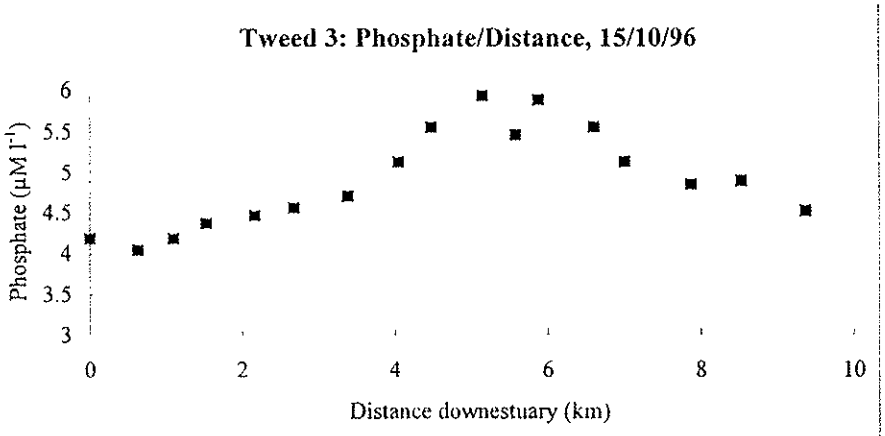
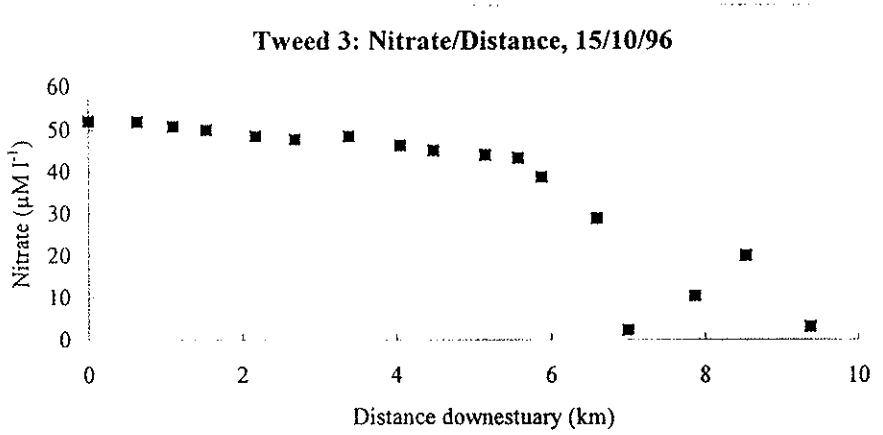
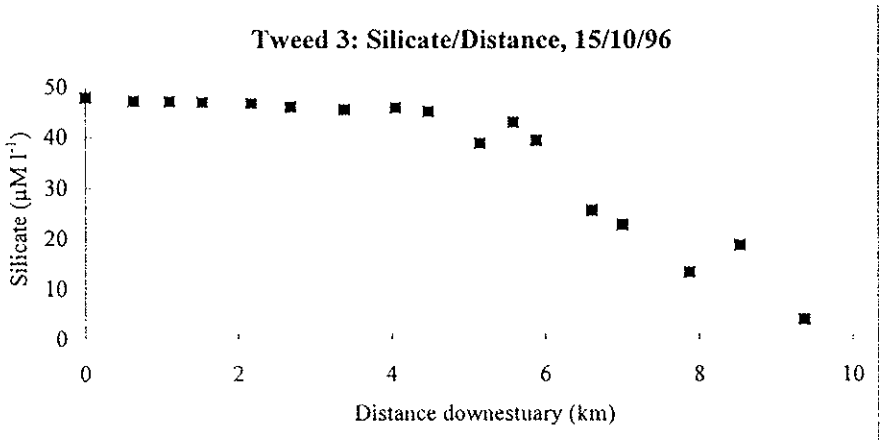

Tweed 3: Turbidity/Distance, 14/10/96
Turbidity (mg/l)
25
20
15
10
5
0
0
2
4
6
8
10
Distance downestuary (km)

Fig 3a


Tweed 3: Phosphate/Distance, 15/10/96
Phosphate (µM l⁻¹)
6
5.5
5
4.5
4
3.5
3
0
2
4
6
8
10
Distance downestuary (km)


Tweed 3: Nitrate/Distance, 15/10/96
Nitrate (µM l⁻¹)
60
50
40
30
20
10
0
0
2
4
6
8
10
Distance downestuary (km)


Tweed 3: Silicate/Distance, 15/10/96
Silicate (µM l⁻¹)
50
40
30
20
10
0
0
2
4
6
8
10
Distance downestuary (km)

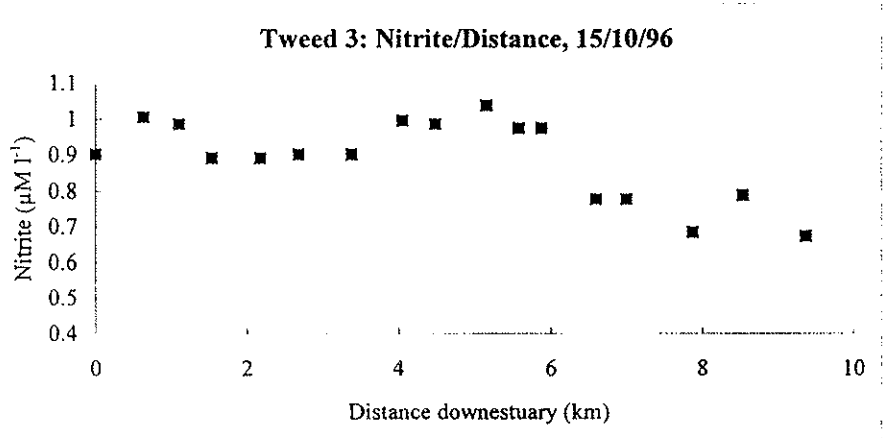
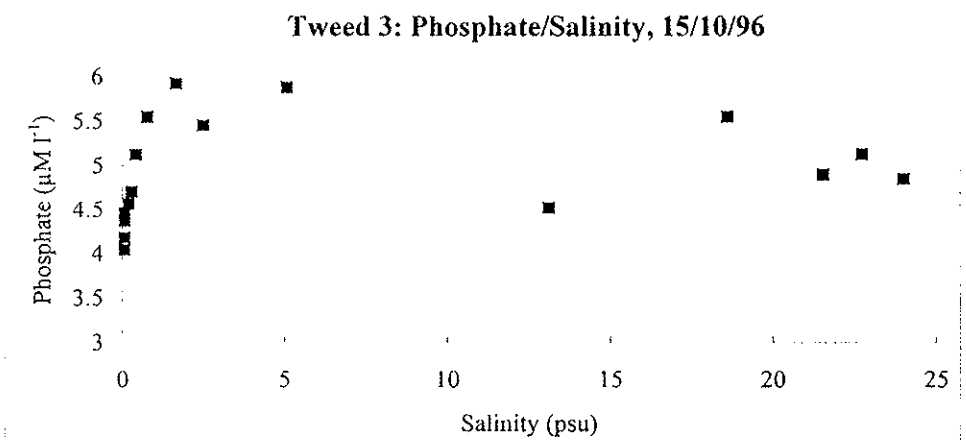
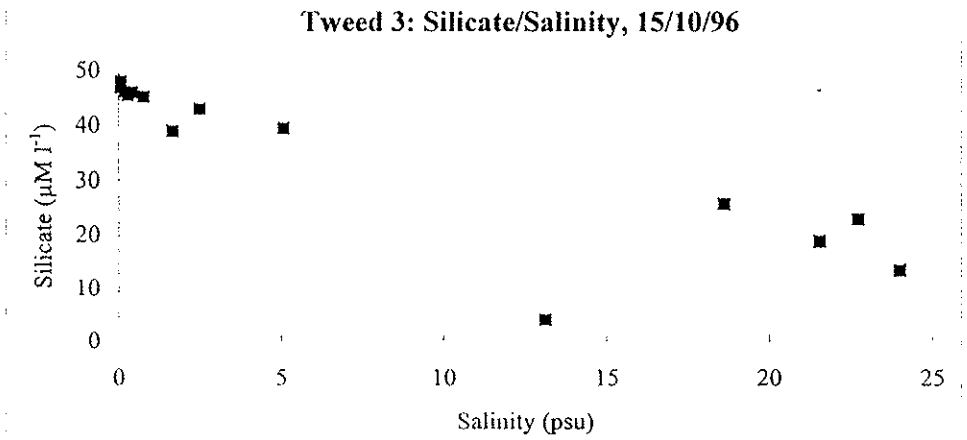
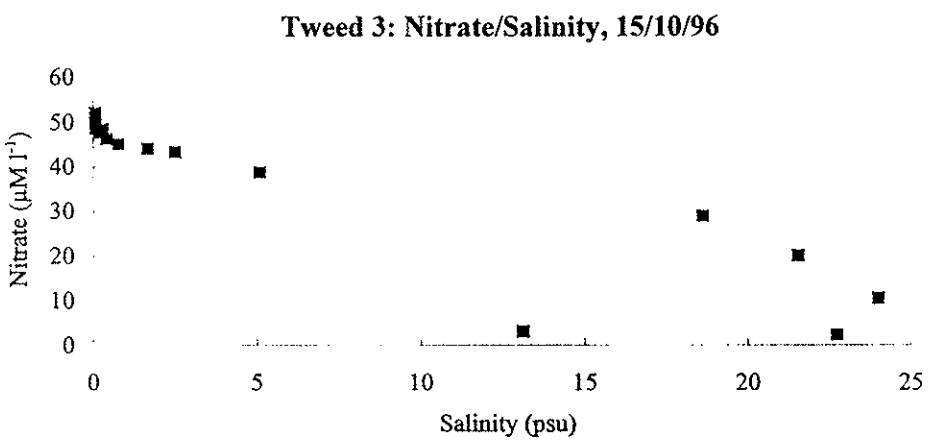

Tweed 3: Nitrite/Distance, 15/10/96
Nitrite (µM l⁻¹)
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0
2
4
6
8
10
Distance downestuary (km)

Fig 36


Tweed 3: Phosphate/Salinity, 15/10/96
Phosphate (µM l-1)
6
5.5
5
4.5
4
3.5
3
0
5
10
15
20
25
Salinity (psu)


Tweed 3: Silicate/Salinity, 15/10/96
Silicate (µM l-1)
50
40
30
20
10
0
0
5
10
15
20
25
Salinity (psu)


Tweed 3: Nitrate/Salinity, 15/10/96
Nitrate (µM l-1)
60
50
40
30
20
10
0
0
5
10
15
20
25
Salinity (psu)

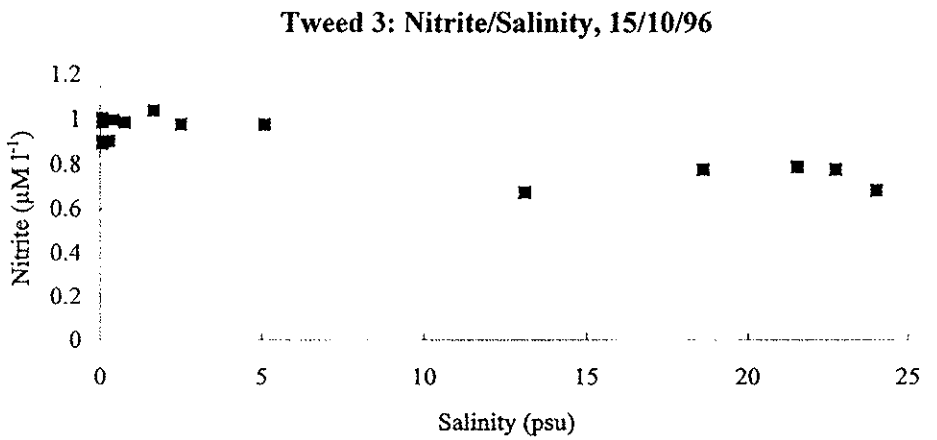
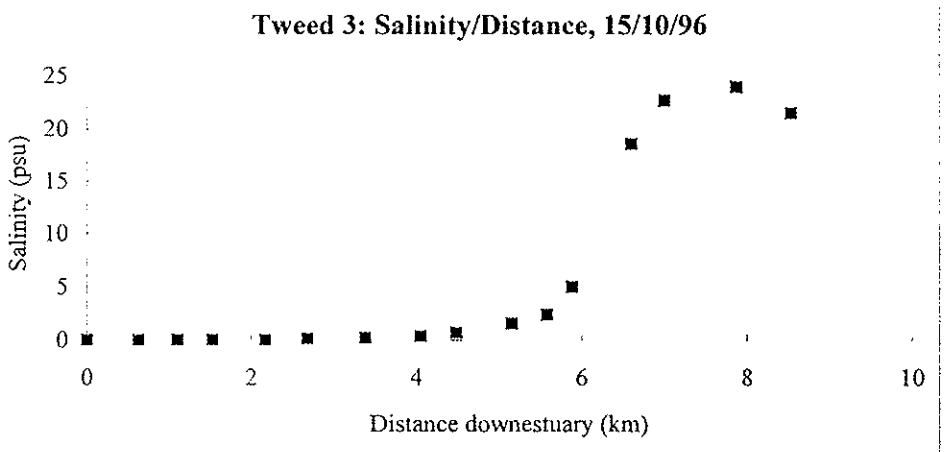
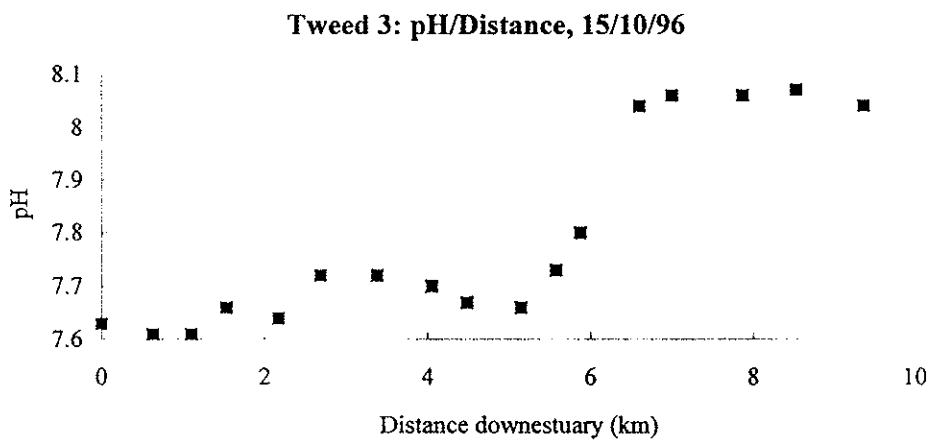
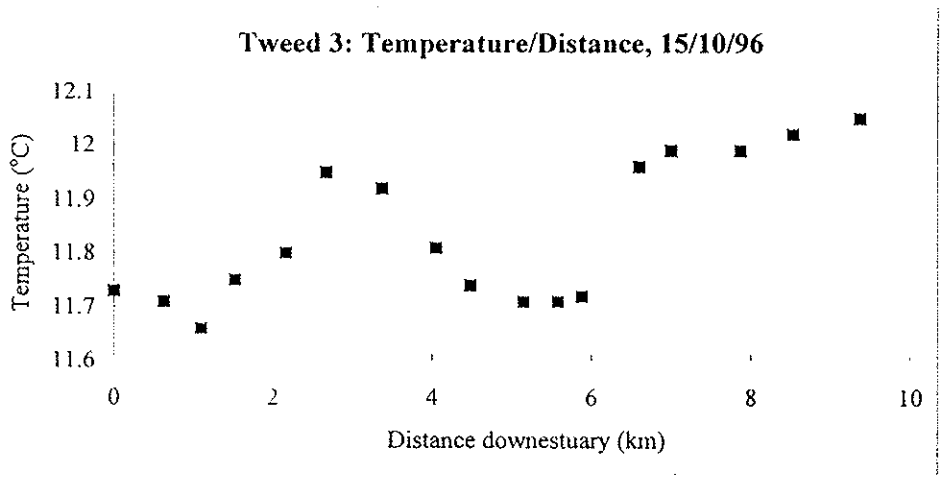

Tweed 3: Nitrite/Salinity, 15/10/96
Nitrite (µM l-1)
1.2
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
Salinity (psu)

Fig 3c


Tweed 3: Salinity/Distance, 15/10/96
Salinity (psu)
25
20
15
10
5
0
0
2
4
6
8
10
Distance downestuary (km)


Tweed 3: pH/Distance, 15/10/96
pH
8.1
8
7.9
7.8
7.7
7.6
0
2
4
6
8
10
Distance downestuary (km)


Tweed 3: Temperature/Distance, 15/10/96
Temperature (°C)
12.1
12
11.9
11.8
11.7
11.6
0
2
4
6
8
10
Distance downestuary (km)

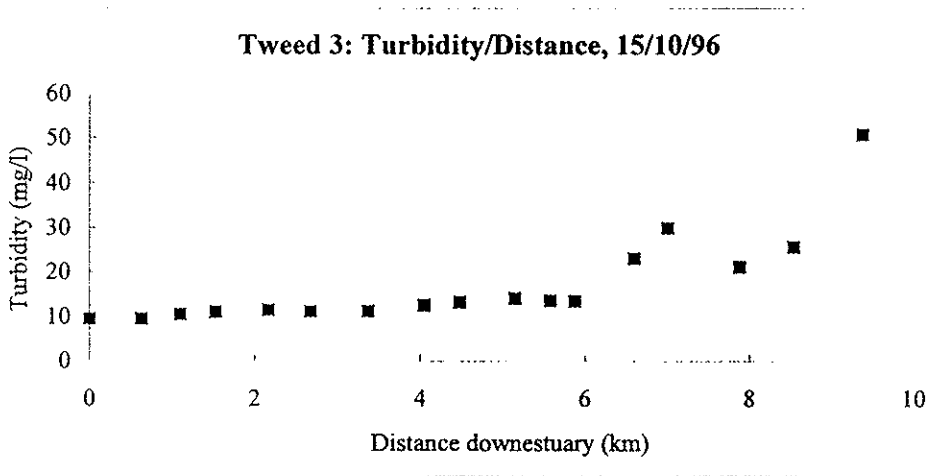
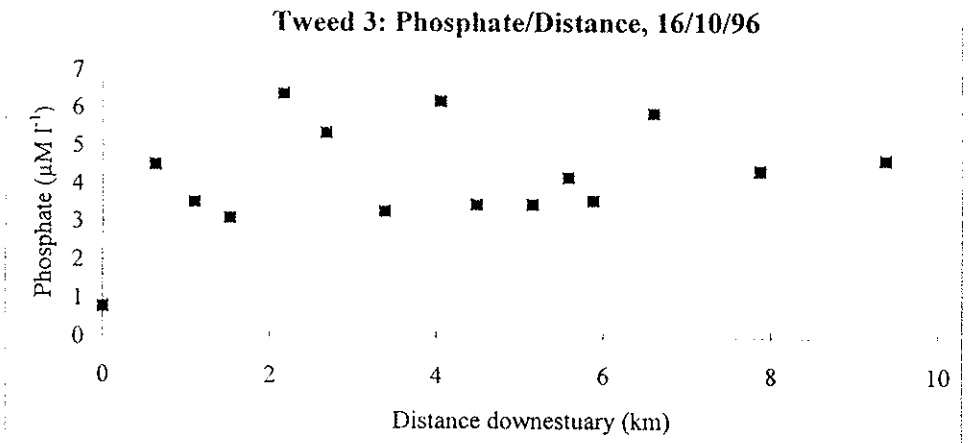
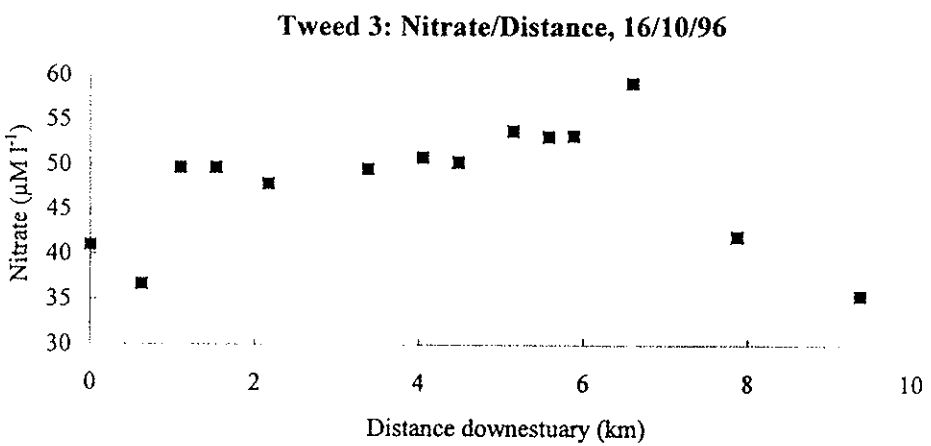
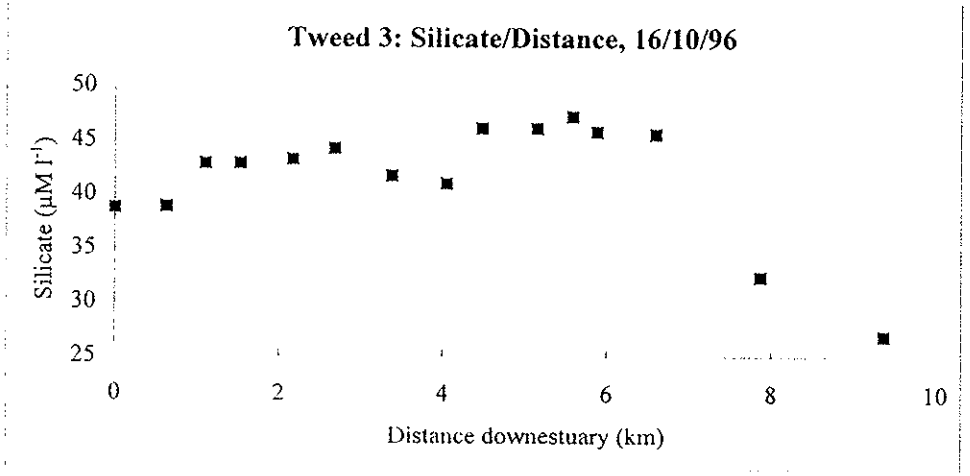

Tweed 3: Turbidity/Distance, 15/10/96
Turbidity (mg/l)
60
50
40
30
20
10
0
0
2
4
6
8
10
Distance downestuary (km)

Fig 4a


Tweed 3: Phosphate/Distance, 16/10/96
Phosphate (µM l-1)
0
1
2
3
4
5
6
7
0
2
4
6
8
10
Distance downestuary (km)


Tweed 3: Nitrate/Distance, 16/10/96
Nitrate (µM l-1)
30
35
40
45
50
55
60
0
2
4
6
8
10
Distance downestuary (km)


Tweed 3: Silicate/Distance, 16/10/96
Silicate (µM l-1)
25
30
35
40
45
50
0
2
4
6
8
10
Distance downestuary (km)

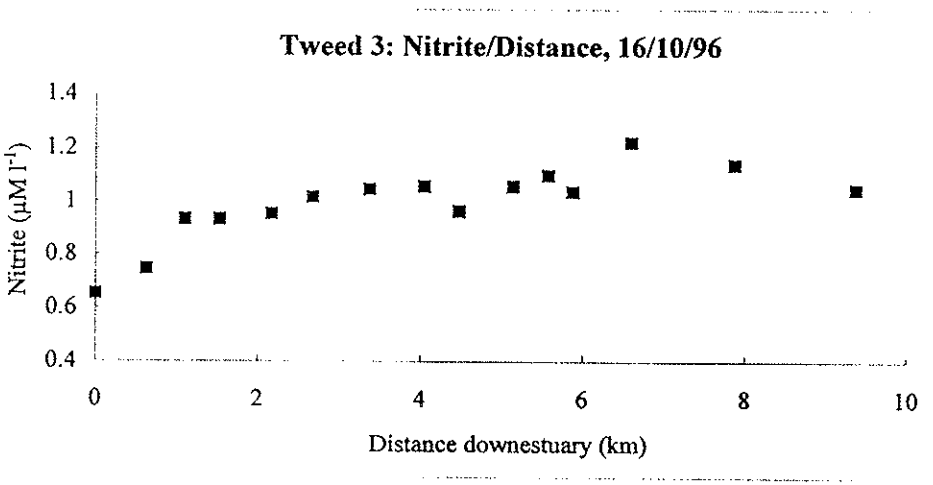
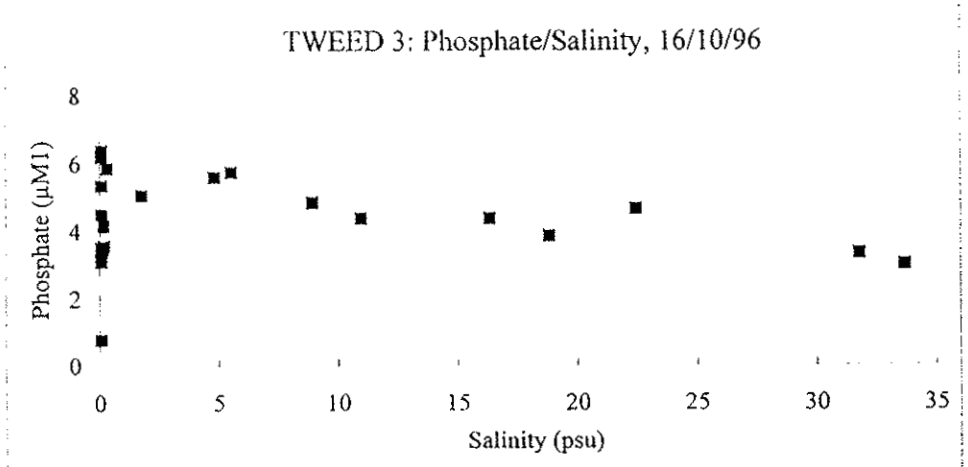
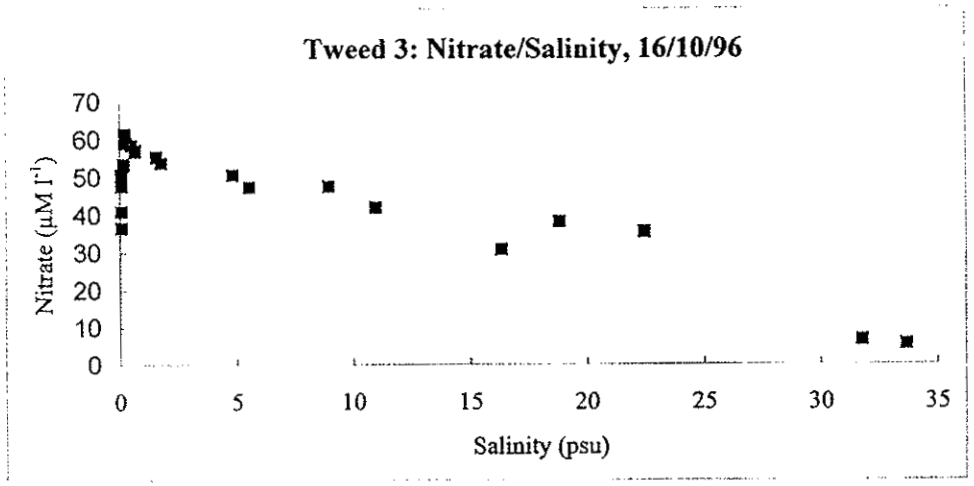
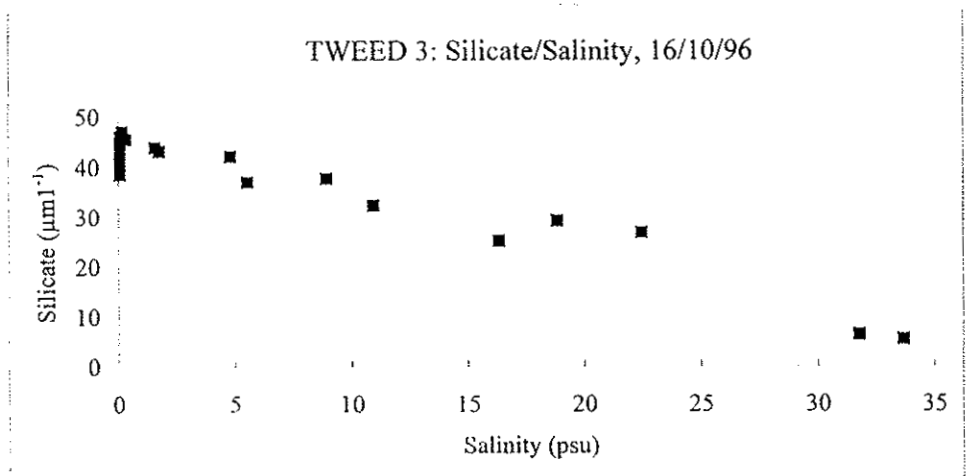

Tweed 3: Nitrite/Distance, 16/10/96
Nitrite (µM l-1)
0.4
0.6
0.8
1
1.2
1.4
0
2
4
6
8
10
Distance downestuary (km)

Fig 4b


TWEED 3: Phosphate/Salinity, 16/10/96
Phosphate (µM1)
0
2
4
6
8
0
5
10
15
20
25
30
35
Salinity (psu)


Tweed 3: Nitrate/Salinity, 16/10/96
Nitrate (µM l-1)
0
10
20
30
40
50
60
70
0
5
10
15
20
25
30
35
Salinity (psu)


TWEED 3: Silicate/Salinity, 16/10/96
Silicate (µm1-1)
0
10
20
30
40
50
0
5
10
15
20
25
30
35
Salinity (psu)

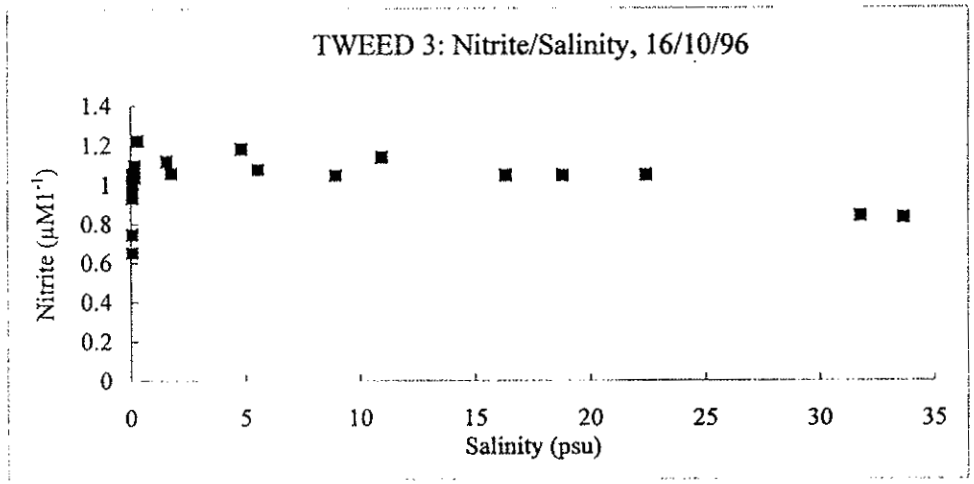
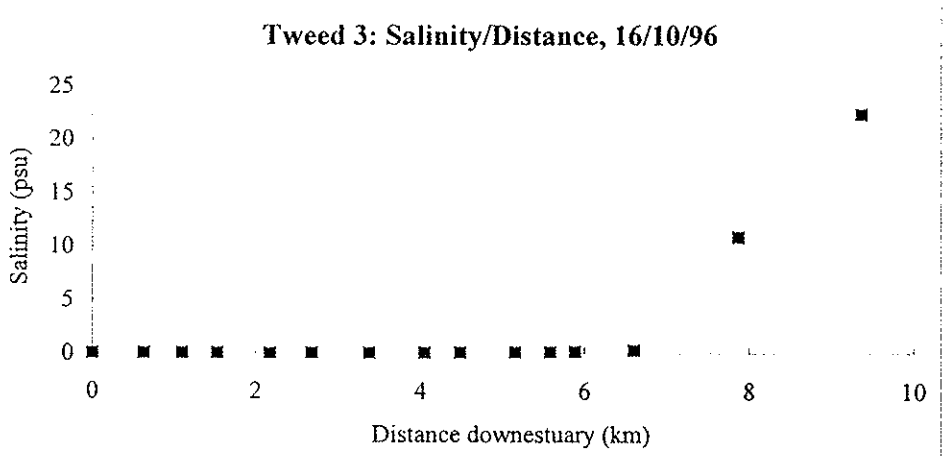
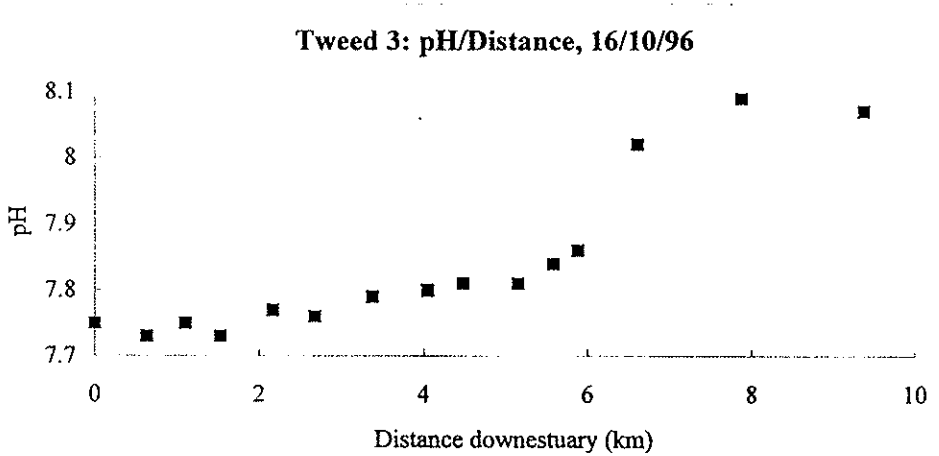
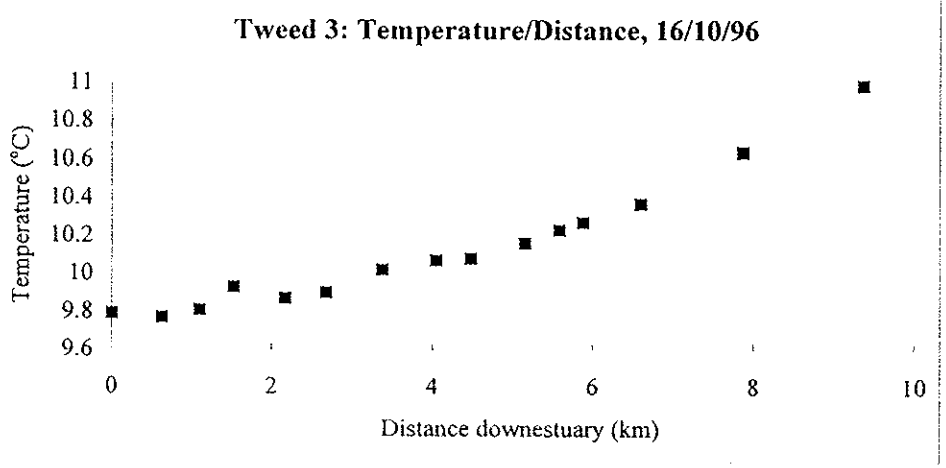

TWEED 3: Nitrite/Salinity, 16/10/96
Nitrite (µM1-1)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
5
10
15
20
25
30
35
Salinity (psu)

Fig 4c


Tweed 3: Salinity/Distance, 16/10/96
Salinity (psu)
25
20
15
10
5
0
0
2
4
6
8
10
Distance downestuary (km)


Tweed 3: pH/Distance, 16/10/96
pH
8.1
8
7.9
7.8
7.7
0
2
4
6
8
10
Distance downestuary (km)


Tweed 3: Temperature/Distance, 16/10/96
Temperature (°C)
11
10.8
10.6
10.4
10.2
10
9.8
9.6
0
2
4
6
8
10
Distance downestuary (km)

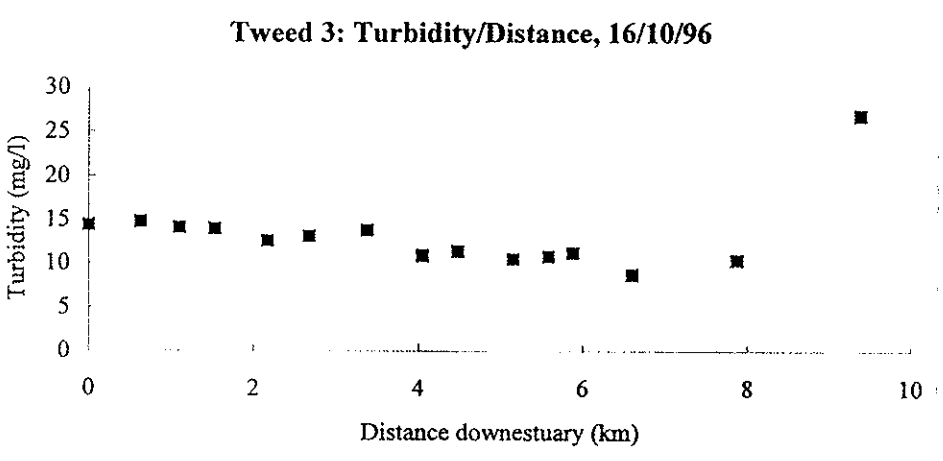
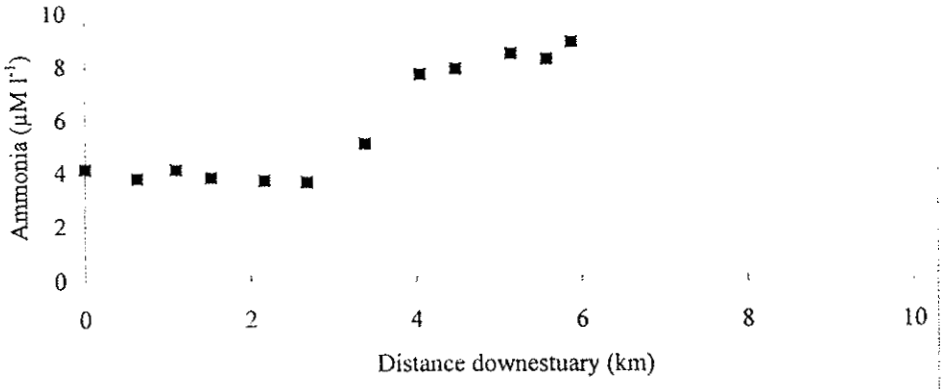
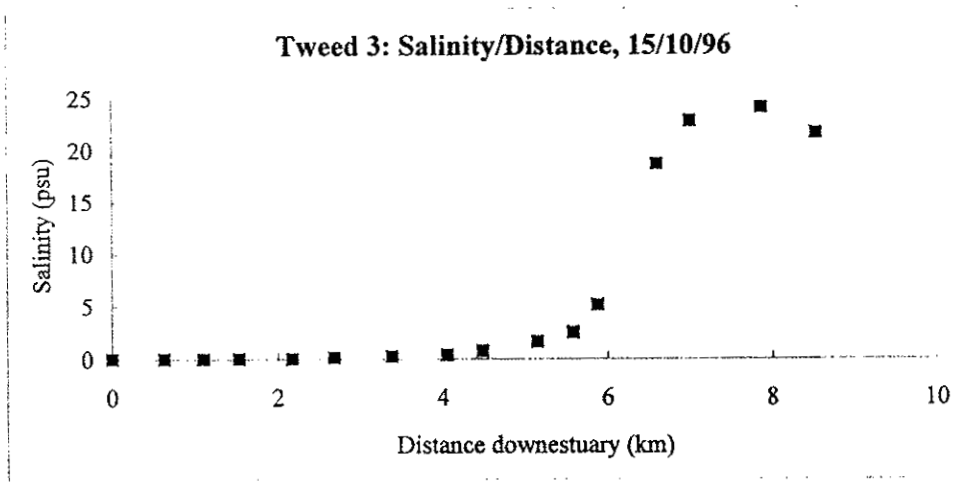

Tweed 3: Turbidity/Distance, 16/10/96
Turbidity (mg/l)
30
25
20
15
10
5
0
0
2
4
6
8
10
Distance downestuary (km)

Fig 5a


Tweed 3: Ammonia/Distance, 15/10/96
Ammonia (µM l-1)
Distance downestuary (km)
0
2
4
6
8
10


Tweed 3: Salinity/Distance, 15/10/96
Salinity (psu)
Distance downestuary (km)
0
5
10
15
20
25

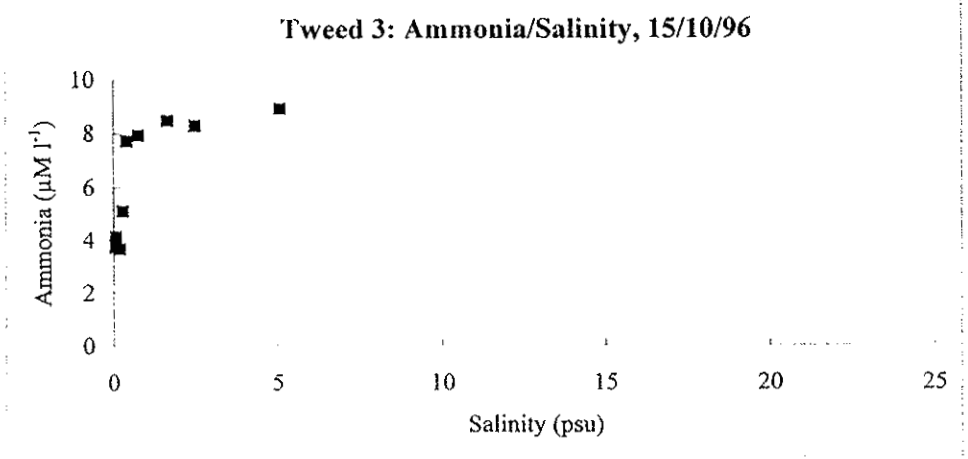
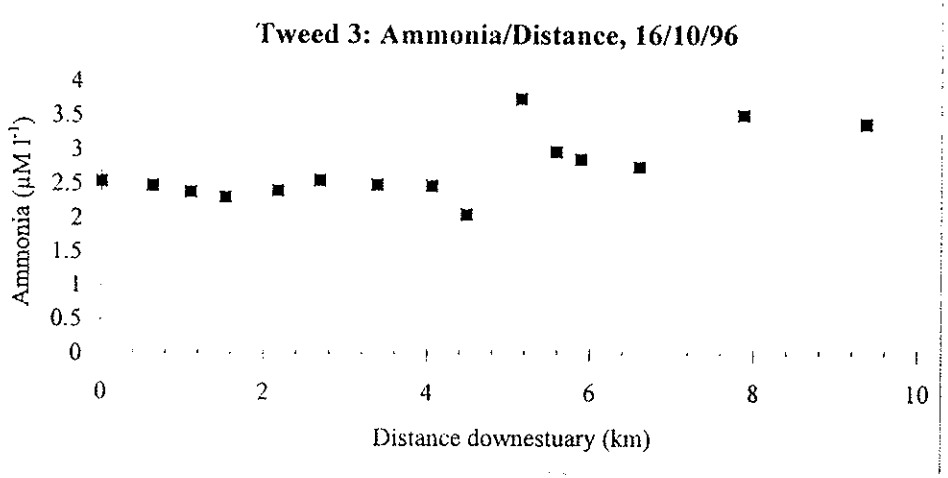
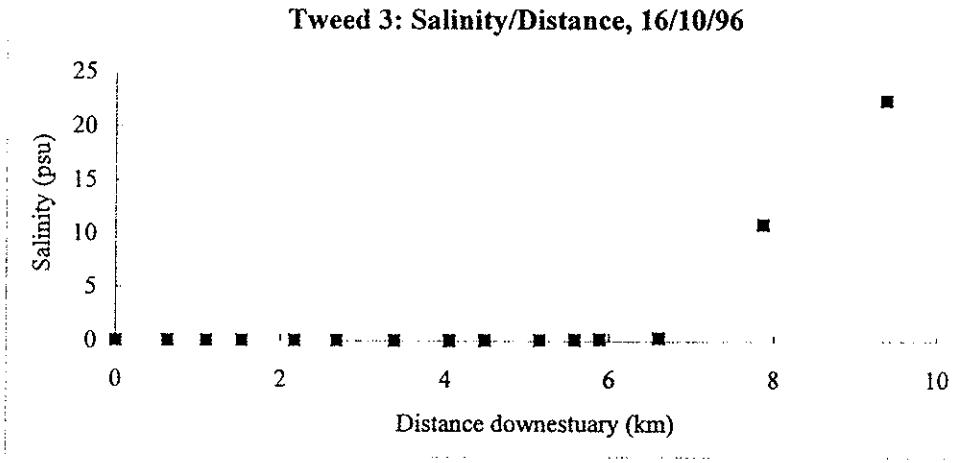
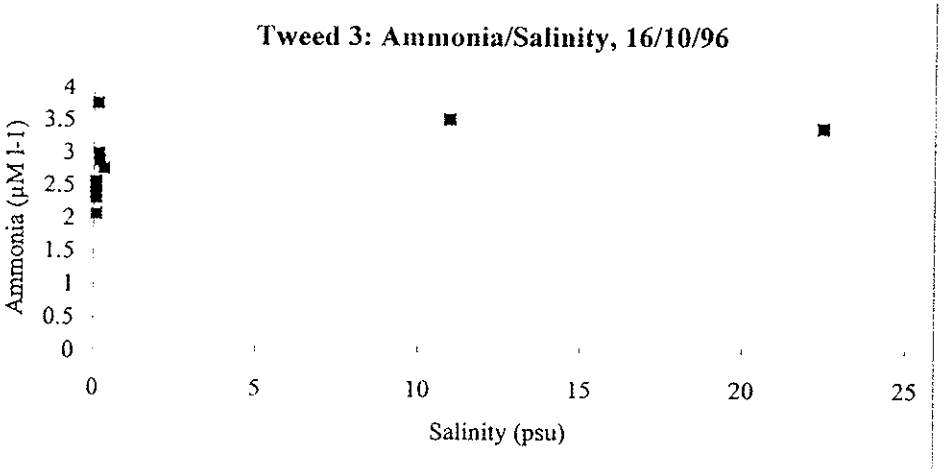

Tweed 3: Ammonia/Salinity, 15/10/96
Ammonia (µM l-1)
Salinity (psu)
0
2
4
6
8
10
15
20
25

Fig 56


Tweed 3: Ammonia/Distance, 16/10/96
Ammonia (µM l-1)
4
3.5
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
10
Distance downestuary (km)


Tweed 3: Salinity/Distance, 16/10/96
Salinity (psu)
25
20
15
10
5
0
0
2
4
6
8
10
Distance downestuary (km)


Tweed 3: Ammonia/Salinity, 16/10/96
Ammonia (µM l-1)
4
3.5
3
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
Salinity (psu)