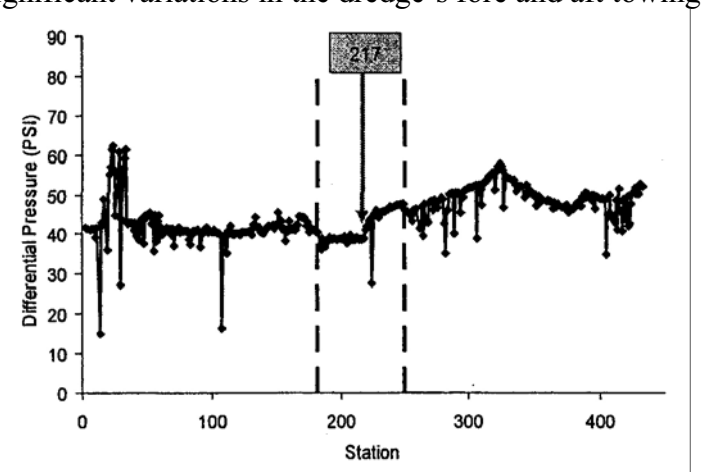
APPENDIX A2. Clam survey tows with poor performance. This appendix describes a proposal for using sensor data to identify NEFSC clam survey tows with poor performance. Current criteria for identifying tows with poor performance are based on data recorded on deck by the watch chief after each tow. In particular, the survey variable "HAUL" can be used to describe problems with tow duration, and the survey variable "GEARCOND" describes the condition of the dredge after a tow. The proposal described below uses sensor data collected on the dredge and on board the ship. Sensor based criteria could not be applied to data for surveys before 1997 because sensors were not used on the ship. The proposal is for discussion and review and does not represent a recommendation by the Invertebrate Subcommittee.

NMFS R/V Delaware II Clam Survey Dredge Development of Good/Bad Tow Selection Criteria[8]

Introduction

From a review of the Survey Sensor Pack (SSP) data from the NMFS 2005 Surf Clam and Ocean Quahog survey, the survey dredge's basic parameters showed a significant variation in the over the course of the survey's three cruise legs. This was primarily both a general upward trend in the manifold's differential pressure and sporadic pressure spikes over the survey (see figure 1). In addition there were occasionally tows that experienced significant variations in the dredge's fore and aft towing angle.



Appendix A2. Figure 1 - Average Survey Dredge Manifold Pressure vs. Survey Station Number

From a previous report (Appendix A2), these parameter variations were explored and their potential effect on the survey dredge's sampling efficiency reviewed. The general upward manifold pressure trend was attributed to a sensor calibration drift, not a true change in manifold pressure, and thus had no likely affect on the dredge's efficiency. The survey tows with manifold pressure spikes and the variations in the dredge's towing angle however were likely causing a significant change in the dredge's sampling efficiency, with the most extreme cases probably preventing the dredge from fishing at all.

Since these survey tows with the manifold pressure spikes and the towing angle variations have a significantly different, and unknown, sampling efficiency than the survey's overall efficiency determined by the depletion studies and other methods,

[8] Prepared by John Womack, Wallace and Associates, Inc.

inclusion of them in the survey will likely create a bias in the final survey results. Because of this, those survey tows that have some of their key parameters that differ significantly from the normal values should be excluded from the survey as "bad" tows.

Key Dredge Performance Parameters

The following general parameters are recorded from the SSP and onboard ship sensors for each of the NMFS clam dredge's survey tows.

Tilt-X - Side to side dredge angle.
Tilt-Y - Fore and aft dredge towing angle.
SSP Ambient Temperature - Sea water temperature at the dredge.
SSP Ambient Pressure - Ambient sea water pressure at the dredge (depth).
Differential Pressure - Dredge's water manifold deferential pressure.
AC Amps - Dredge pump's amperage draw.
AC Volts - Dredge pump's voltage.
AC Freq - Dredge pump's frequency.
Vessel Speed - Speed of the DEII

Of these parameters, the two key ones for the dredge's sampling efficiency are;

Tilt-Y - Fore and aft dredge towing angle.
Differential Pressure - Dredge's water manifold differential pressure.

Both of these are the parameters that are directly associated with how the dredge fishes. The Tilt-Y parameter will indicate if the dredge's knife is in sufficient contact with the sea bottom to be in a fishing position. The Differential Pressure indicates if sufficient water is being forced through the dredge's manifold to adequately liquefy the sea bottom.

The AC Amps, AC Volts, and AC Freq are not key parameters as any changes in them will be reflected in the manifold Differential Pressure values. Similarly, Vessel Speed is also not a key parameter in determining a good or bad tow. In this case any vessel speed variations (and thus the survey dredge) are handled in the standardization of each tow to a set "standard" tow distance. SSP Ambient Temperature and Pressure are not key parameters, as they have no effect on overall dredge performance.

2005 NMFS Ocean Clam Survey Average Survey Dredge Tow Angle

Station #	Average Towing Angle - Degrees
20	2.56
29	2.14
39	2.39
50	2.71
59	2.53
69	2.03
78	1.94
90	2.52
103	2.22
114	2.47
124	2.52
134	2.89
143	2.23
152	2.24
159	2.29
162	2.28
173	2.47
262	2.21
270	2.13
280	2.11
291	1.72
303	2.29
313	2.24
322	2.32
335	2.54
Average	2.32
Average Deviation	0.19
Median	2.29

The Tilt-Y and Manifold Pressure parameters will each be handled separately, but with a similar method, in determining a good or bad survey tow. A bad tow would then occur when either parameter varies by a specified difference from their normal values.

Good/Bad Tow Tilt-Y Selection Criteria

The Tilt-Y parameter is a fixed fishing, not fishing (i.e. pass/fail) situation. From previous studies of the NMFS survey dredge the knife theoretically makes contact with the bottom at 4.4 degrees and is fully down at 0 degrees, referenced to the dredge side

runners. For the selection criteria the pass/fail cutout was set at the mid point of 2.2 degrees when the knife is at its half fishing depth in the sea bottom.

The dredge however does not tow with the side runners level as the aft end of the dredge will settle into the trough created in the ocean bottom by the water manifold while the forward dredge end rides on the bottom surface. From the table above this angle is approximately 2.3 degrees. This angle needs to be added to the 2.2 degree pass/fail point above to adjust for the dredge towing angle from the SSP data, which gives an adjusted pass/fail point of 4.5 degrees.

To use this set point, the SSP data will be evaluated by first calculating the total time the dredge Tilt-Y towing angle is above the 4.5 degree set point versus the total time the dredge was on the bottom. The tow will be deemed a bad tow if this time equals or exceeds 20% of the total towing time. For the four quahog strata survey stations deemed as a bad tow, the resultant time values using the 4.5 degree set point are tabulated below. Based on these Tilt-Y criteria, Station 218 is considered to be a bad tow and should be removed from the survey.

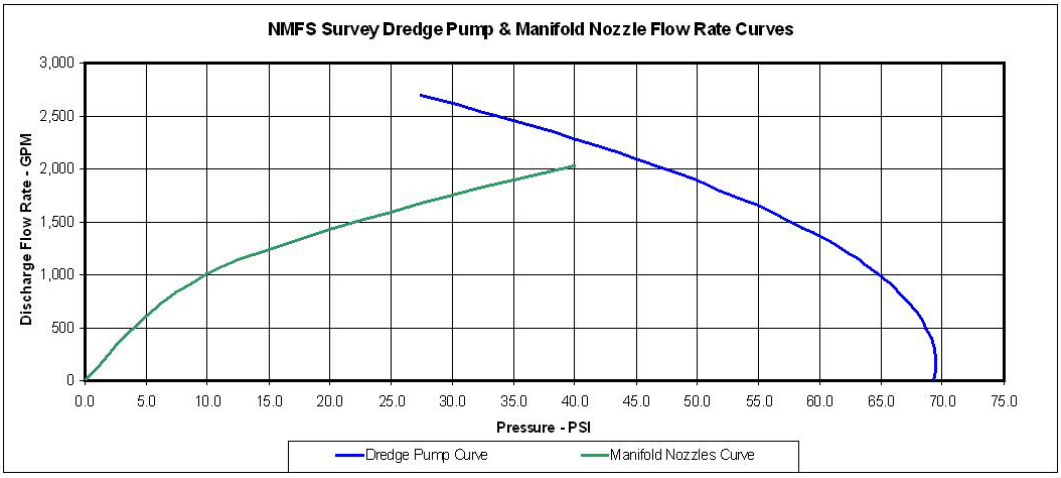
Good/Bad Dredge Towing Angle Time Summary - Seconds

Station #	218	225	262	282
Time Above 4.5 Degrees	111	120	64	78
Time Below 4.5 Degrees	337	545	485	469
Total Survey Tow Time	448	665	549	547
Precent Time Above 4.5 Degrees	24.8%	18.0%	11.7%	14.3%

Good/Bad Tow Manifold Pressure Selection Criteria

While the Tilt-Y parameter could be handled as a "Knife Edged" pass/fail selection criteria, this will not work for the Manifold Pressure parameter. First there are two different problem modes that can occur, a manifold pressure above or below the normal value. In addition a linear variation in the pressure doesn't correspond into a linear variation in the water flow through the nozzles.

When the manifold pressure drops below the normal value (37-39 PSI), this is indicating a blocked pump intake which is restricting water flow through the manifold nozzles. A manifold pressure increase on the hand is indicating a blockage in the manifold and/or nozzles. This blockage though is also restricting the water flow through the manifold nozzles. These variations in water flow versus manifold pressure are shown in the graph below.



Because of this non-linearity, the good/bad selection criteria for the Manifold Pressure parameter will need to take into account the magnitude of the difference from normal values. That is the farther the Manifold Pressure value at a given time is from the normal value, the larger the influence that time period will have on the tow being declared a bad tow. This will allow for several different bad tow scenarios to be designated. They are.

1) A small increase or decrease in pressure over the entire tow period.
2) A large increase or decrease in pressure over a short portion of a tow.
3) A combination of small or large pressure variations during a tow.

The selection criteria time period weighting factor (WF) for the Manifold Pressure parameter will be formatted using the following formulas.

WF = 2 x (MP-40)/40 when the Manifold Pressure is Higher than Normal or

WF = 1 when the Manifold Pressure is in the Normal range or

WF = 2 x ((35-MP)/35 x 0.83) when the Manifold Pressure is Lower than Normal

where MP = SSP measured Manifold Pressure in PSI.

The "0.83" is used to bring the potential below value range (0 to 35 PSI) into same magnitude as the potential above value range (40 to 69 PSI or 29 PSI range). An average normal Manifold Pressure value of 35-40 PSI was selected based on previous analysis of the 2005 SSP survey data in "R/V Delaware II Clam Dredge Pump Performance" which showed a range in manifold pressure from 39 PSI at the start to 36 PSI at the end of the survey. The doubling of the difference is used to account for the non-linearity by increasing the weighting factor disproportionably for Manifold Pressures farther from the normal value.

For the SSP data the weighting factor will be calculated for each data point which represents a one second time interval. The weighting factors for each second period will then be added to get a total weighted towing time. A bad tow will be declared when this weighted towing time exceeds the actual towing time that was within the normal range by more then 25%. See sample table below for examples.

Based on these Manifold Pressure criteria, Stations 225, 262, and 282 are considered to be a bad tow and should be removed from the survey.

Good/Bad Manifold Pressure Time Summary - Seconds

Station #	218	225	262	282
Weighted Time Above 40 PSI	0.00	0.13	0.00	0.00
Time in Normal Range	14	337	190	159
Weighted Time Below 35 PSI	0.335	446.83	156.62	398.33
Precent Time Outside Normal	2.4%	132.6%	82.4%	250.5%

NMFS Clam Survey Dredge - Manifold Pressure Good/Bad Tow Selection Criteria Examples

	Good Survey Tow				Bad Tow - Pressure Slightly Abv Normal				Bad Tow - Pressure Slightly Abv Normal				Bad Tow - Pressure Moderatly Abv Normal				Bad Survey Tow - Exterme Pressure Spikes			
Time	Manifold Pressure PSI	Over Range Weighting Factor	In Normal Weighting Factor	Under Range Weighting Factor	Manifold Pressure PSI	Over Range Weighting Factor	In Normal Weighting Factor	Under Range Weighting Factor	Manifold Pressure PSI	Over Range Weighting Factor	In Normal Weighting Factor	Under Range Weighting Factor	Manifold Pressure PSI	Over Range Weighting Factor	In Normal Weighting Factor	Under Range Weighting Factor	Manifold Pressure PSI	Over Range Weighting Factor	In Normal Weighting Factor	Under Range Weighting Factor
1	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
2	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
3	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
4	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	62	1.10	0.00	0.00
5	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	62	1.10	0.00	0.00
6	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	62	1.10	0.00	0.00
7	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	62	1.10	0.00	0.00
8	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	62	1.10	0.00	0.00
9	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	12	0.00	0.00	1.09
10	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	12	0.00	0.00	1.09
11	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	12	0.00	0.00	1.09
12	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	12	0.00	0.00	1.09
13	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	12	0.00	0.00	1.09
14	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	12	0.00	0.00	1.09
15	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
16	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
17	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
18	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
19	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
20	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
21	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
22	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
23	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
24	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
25	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
26	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
27	40	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
28	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
29	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
30	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
31	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
32	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
33	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	45	0.25	0.00	0.00	38	0.00	1.00	0.00
34	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
35	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
36	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
37	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
38	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
39	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
40	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
41	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
42	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
43	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
44	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
45	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
46	38	0.00	1.00	0.00	41	0.05	0.00	0.00	42	0.10	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
47	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
48	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
49	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
50	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
51	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
52	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
53	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
54	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
55	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
56	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
57	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
58	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
59	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
60	38	0.00	1.00	0.00	41	0.05	0.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00	38	0.00	1.00	0.00
60	WF Sums	0.0	60.0	0.0	WF Sums	3.0	0.0	0.0	WF Sums	4.3	17.0	0.0	WF Sums	7.5	30.0	0.0	WF Sums	5.5	49.0	6.5
	% Over+Under of All		0%		% Over+Under of All		100%		% Over+Under of All		25%		% Over+Under of All		25%		% Over+Under of All		25%	