ANALYTICAL APPROACH

1. Determine which areas will recover and which will not (I have preliminary findings from this and list in Table 1 my preliminary list of stations)

2. Determine if the estimated area that will <u>not</u> recover, is de minimus. That requires some estimate of the original pile footprint, and characterizing the remaining impacted area with little chance for recovery. The EPA team needs to develop the technically sound basis for de minimus, then the comparison can be done fairly easily.

3. Decide whether monitoring after 2 years will assist in determining if the removal has been satisfactory (i.e., recovery is projected to be successful)

PRELIMINARY SUMMARY

Table 1 – Preliminary list of stations with % bone material >50%, predicted to not recover – but some of these are assigned stages that would suggest recovery. **These need to be discussed with JG and stations in grayed boxes need scrutiny for inconsistency**

Station	Assignment	%Bone Material
A-28 B	Indeterminate	100%
A-55 B	Indeterminate	100%
A-73 A	Indeterminate	100%
A-77 C	Indeterminate	100%
A-78 A	Indeterminate	100%
A-78 B	Stage 0	100%
A-69 A	Stage 0	100%
A-73 B	Stage 1	100%
A-26 C	Stage 1	100%
A-67 A	Stage 1	100%
A-67 C	Stage 1	100%
A-68 A	Stage 1	100%
A-68 B	Stage 1	100%
A-68 C	Stage 1	100%
A-71 A	Stage 1	100%
A-71 B	Stage 1	100%
A-26 B	Stage 1 -> 2	100%
A-34 A	Stage 2	100%
A-28 A	Stage 2	100%
A-71 C	Stage 2 -> 3	100%
A-77 B	Stage 2 -> 3	100%
A-67 B	Stage 0	81%
A-26 A	Stage 0	80%
A-28 C	Stage 1	67%
A-74 C	Indeterminate	63%
A-70 A	Indeterminate	60%
A-54 B	Stage 1	59%
A-34 B	Stage 1 on 3	59%
A-69 B	Indeterminate	55%
A-54 C	Indeterminate	54%

Table 1 sorted by Station

Station	Assignment	%Bone Material
A-26 A	Stage 0	80%
A-26 B	Stage 1 -> 2	100%
A-26 C	Stage 1	100%
A-28 A	Stage 2	100%
A-28 B	Indeterminate	100%
A-28 C	Stage 1	67%
A-34 A	Stage 2	100%
A-34 B	Stage 1 on 3	59%
A-54 B	Stage 1	59%
A-54 C	Indeterminate	54%
A-55 B	Indeterminate	100%
A-67 A	Stage 1	100%
A-67 B	Stage 0	81%
A-67 C	Stage 1	100%
A-68 A	Stage 1	100%
A-68 B	Stage 1	100%
A-68 C	Stage 1	100%
A-69 A	Stage 0	100%
A-69 B	Indeterminate	55%
A-70 A	Indeterminate	60%
A-71 A	Stage 1	100%
A-71 B	Stage 1	100%
A-71 C	Stage 2 -> 3	100%
A-73 A	Indeterminate	100%
A-73 B	Stage 1	100%
A-74 C	Indeterminate	63%
A-77 B	Stage 2 -> 3	100%
A-77 C	Indeterminate	100%
A-78 A	Indeterminate	100%
A-78 B	Stage 0	100%

1. DETERMINE WHICH AREAS WILL RECOVER AND WHICH WILL NOT:

Evaluate each picture separately and assign to:

Stage 3 or likely to go to stage 3
Pretty sure will *not* go to stage 3
Unknown if will go to stage 3

To do these assignments:

1: Stage 3 or likely to go to stage 3

My initial approach is to include in this category, “pictures” that are assigned:
stage 3
stage 2->3

stage 1 on 3
Need to discuss with JG whether this is likely true for stage 1 on 3 – what does his assignment mean? Text suggests stage 1is utilizing incoming organic material and not affecting stage 3.

2: Will not go to stage 3

This is based on the observations from pile X, where, after an unknown # years, there is no recovery on top of bones and from pile A, where, after 16 years, there is no recovery on top of bones.
Need to discuss with JG what the age of this pile is. Pile A was abandoned in late 1991. Not sure when pile X was abandoned.

3: Unknown if will go to stage 3: Look at relationship between stage and amount of bone material

Bone material – normalize the area of bone to area of photo, express as %; normalize the bone layer mean depth to the penetration depth, express as %. Use the max of the two percentages as the metric for bone material.

Use DO as secondary indicator.

Need to discuss with JG the use of other secondary indicators (clasts, roughness, etc.)

Stage – use the designations as follows
3=3; 2=2, 1=1, 0=0
Assign stages for intermediates as follows
Stage 1 -> 2 = 1.5
Stage 1 on 3 = 2.25
Stage 2 -> 3 = 2.5

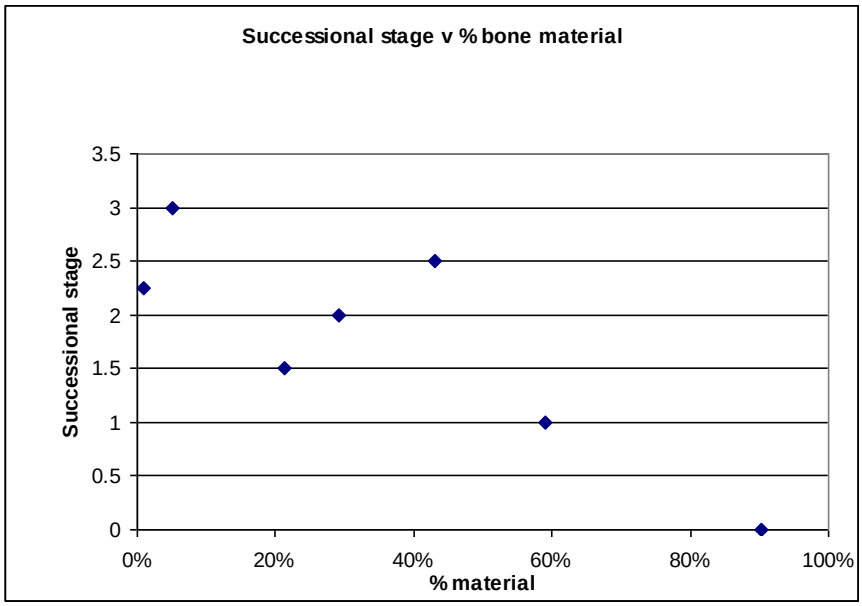
Indeterminate = use relationship to assign based on % bone

Need to discuss with JG these assignments

Stage	Stage value	Ave of max % bone	N	
0	0	90%	4	
1	1	59%	18	
1 -> 2	1.5	21%	6	
2	2	29%	7	
1 on 3	2.25	1%	127	

2 -> 3	2.5	43%	5	
3	3	5%	13	
Indeterminate		9 have >50% bone	29	

Plot of Stage value as a function of ave % bone for that category:



This relationship allows us to better quantify the suspected relationship between bone material and the ability of the infauna to utilize the seafloor.

A first cut of assuming stages 1->2 and 2 may go to 3 gives us a cutoff of 50% bone material.

This can then be used to assign the Indeterminates to OK or not OK status. As a double-check, all stations say between 25 and 75% can be culled out to see if they are likely to fit this cutoff paradigm. Thus, we can modify the above table somewhat

Stage	Stage value	Ave of max % bone	N	Recover?
Indeterminate		>50%	9	N
0	0	90%	4	N
1	1	59%	18	N
1 -> 2	1.5	21%	6	Y?
2	2	29%	7	Y?
1 on 3	2.25	1%	127	Y?
2 -> 3	2.5	43%	5	Y
3	3	5%	13	Y
Indeterminate		<50% bone	20	Y
Indeterminate		>25% & <75%	5	?
Total indeterminate is 29				

This suggests no likely recovery for 31 but with perhaps 5 to check individually for assignment. These 31 can also be plotted (similar to Table 1) and see if they present random, de minimus, missed spots or a general area that was missed. Note that there is some lack of concordance between % bone and successional stage for several stations.

2. DETERMINE DE MINIMUS AREA

Estimate the original pile size.
Need to discuss with JG what information he has

I would suggest one estimate of the boundary be generated between stations showing a trace of bones and those with no trace.

Data Table

Station & Replicate Image	Successional Stage	Stage	%area =bone	% depth= bone	max bone	TOTAL Bone Layer Area (sq. cm)	Bone Layer MEAN Depth (cm)
A-18 F	Stage 2	2	0%	2%	2%	Trace	Trace
A-19 A	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-24 A	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-24 B	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-24 C	Stage 1 on 3	2.25	0%	2%	2%	Trace	Trace
A-27 A	Stage 1 -> 2	1.5	0%	1%	1%	Present	Present
A-27 B	Stage 3	3	0%	1%	1%	Present	Present
A-27 C	Stage 1 on 3	2.25	0%	1%	1%	Present	Present
A-29 B	Stage 3	3	0%	1%	1%	Present	Present
A-29 C	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-30 A	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-30 B	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-32 A	Stage 1 on 3	2.25	0%	1%	1%	Present	Present
A-32 B	Stage 1 on 3	2.25	0%	1%	1%	Present	Present
A-32 C	Stage 1	1	0%	3%	3%	Present	Present
A-35 A	Stage 2 -> 3	2.5	0%	1%	1%	Present	Present
A-35 B	Stage 1 on 3	2.25	0%	1%	1%	Present	Present
A-35 C	Indeterminate		0%	1%	1%	Present	Present
A-36 C	Stage 1	1	0%	1%	1%	Trace	Trace
A-37 B	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-37 C	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-38 A	Stage 1 on 3	2.25	0%	1%	1%	Present	Present
A-38 B	Stage 1 on 3	2.25	0%	1%	1%	Present	Present
A-38 C	Stage 1 on 3	2.25	0%	1%	1%	Present	Present
A-39 A	Stage 2	2	0%	1%	1%	Trace	Trace
A-43 C	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-46 C	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-53 A	Indeterminate		0%	3%	3%	Trace	Trace
A-53 B	Indeterminate		0%	5%	5%	Trace	Trace
A-53 C	Indeterminate		0%	3%	3%	Trace	Trace
A-54 A	Indeterminate		0%	4%	4%	Present	Present
A-55 A	Indeterminate		-	-	0%	Present	Present
A-55 C	Indeterminate		-	-	0%	Present	Present
A-56 A	Indeterminate		-	-	0%	Present	Present
A-56 B	Indeterminate		-	-	0%	Present	Present
A-56 C	Indeterminate		-	-	0%	Present	Present
A-66 A	Stage 1 -> 2	1.5	0%	1%	1%	Trace	Trace
A-66 B	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-66 C	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-72 A	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-72 B	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-72 C	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-74 A	Stage 3	3	0%	1%	1%	Present	Present
A-75 B	Stage 3	3	0%	1%	1%	Present	Present
A-75 C	Stage 3	3	0%	0%	0%	Trace	Trace
A-76 A	Stage 2	2	0%	1%	1%	Present	Present
A-76 B	Stage 1 on 3	2.25	0%	1%	1%	Trace	Trace
A-76 C	Stage 3	3	0%	1%	1%	Present	Present
A-77 A	Stage 1 on 3	2.25	0%	1%	1%	Present	Present
A-78 C	Stage 1	1	0%	2%	2%	Present	Present

An inner boundary might be derived from consideration of characteristics that indicate raking occurred.
Need to discuss with JG which are the best indicators of raking.

3. DECIDE IF MONITORING IS NECESSARY

No determination yet