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NSY PORTSMOUTH
5090.3a

LETTER REGARDING RISK CHARACTERIZATION TABLES FOR THE ECOLOGICAL RISK
ASSESSMENT NSY PORTSMOUTH ME
11/27/1996
NAVFAC NORTHERN



DEPARTMENT OF THE NAVY

NORTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
10 INDUSTRIAL HIGHWAY
MAIL STOP, #82
LESTER, PA 19113-2090

IN REPLY REFER TO

5090
Code 1823/JMC
NOV 27 1996

Ms. Meghan Cassidy
U.S. Environmental Protection Agency Region 1
JFK Federal Building, Mailcode HBT
Boston, MA 02203-2211

Mr. Iver McLeod
Maine Department of Environmental Protection
State House Station 17
Augusta, ME 04333-0017

Subj: RISK CHARACTERIZATION TABLES FOR THE ECOLOGICAL RISK
ASSESSMENT, PORTSMOUTH NAVAL SHIPYARD, KITTERY, ME

Dear Ms. Cassidy/Mr. McLeod

Enclosed please find material produced as a result of the recent ecorisk workshop (October 29 and 30, 1996) conducted for the completion of the ecological risk assessment for Portsmouth Naval Shipyard. Enclosure (1) provides updated tables and definitions developed during the workshop. Enclosures (2-4) document the process used for characterizing risk and completing the risk summary tables. Enclosures (5-10) contain the exposure and effects scatter plots prepared to visualize the weight of evidence of risk for each assessment endpoint by area of concern.

Upon review and concurrence by the ecorisk team, the information contained in the enclosures will be incorporated into the revised draft final ecological risk assessment for Portsmouth Naval Shipyard.

If additional information is required, please contact Ms. Marty Raymond at 207-438-2536 or myself at 610-595-0567, x159.

Sincerely,

A handwritten signature in cursive script, reading "Frederick J. Evans", is written over the typed name.

FREDERICK J. EVANS, P.E.
Remedial Project Manager
By direction of the
Commanding Officer

Subj: CONSENSUS DOCUMENT, NO FURTHER ACTION FOR SOIL AT SWMU 21
PORTSMOUTH NAVAL SHIPYARD, KITTERY, ME

Encl:

- (1) Updated Tables and Definitions as of the Completion of the October 29-30, 1996 Workshop
- (2) Summary of Procedures Used to Complete the Weight of Evidence Analysis to Characterize Risk to Ecological Receptors
- (3) Risk Characterization Tables for Each Area of Concern and Portsmouth Harbor Focus Area
- (4) Characterization of Risk Associated with Environmental Media for the Areas of Concern
- (5) Exposure and Effects Scatter Plots for EPIBENTHIC
- (6) Exposure and Effects Scatter Plots for PELAGIC
- (7) Exposure and Effects Scatter Plots for SALTMARSH
- (8) Exposure and Effects Scatter Plots for EELGRASS
- (9) Exposure and Effects Scatter Plots for BENTHIC
- (10) Exposure and Effects Scatter Plots for AVIAN

Distribution:

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Mr. Guy Petty

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Ms. Carolyn Lepage

PNS (Code 100PAO) w/o encl

Brown and Root Environmental (L. Klink, B. Horne)

UPDATED TABLES AND DEFINITIONS AS OF THE COMPLETION OF THE OCT 29-30TH WORKSHOP

Table 2. Scheme used to interpret outcomes of measurement activities.

Type of Measure	Degree of Response	Interpretation
Exposure	≤ reference condition or below benchmark concentration	negligible exposure
	> qualitative screening level	low exposure
	statistically > reference condition	elevated exposure
	> a conservative benchmark concentration	high exposure
	> a nonconservative benchmark concentration	adverse exposure
Effect	similar to reference condition or below ecologically-relevant threshold	no effect
	high or low relative to reference condition, but not statistically different ¹	potential effect
	statistically higher or lower than reference or control condition	probable effect

1. The data from the AOC are evaluated to determine if there is a problem relative to the reference area .

Table 9a. Interpretation of exposure and effect evidence in determination of risk.

Evidence of Effect	Evidence of Exposure				
	NEGLIGIBLE	LOW	ELEVATED	HIGH	ADVERSE
NO	Negligible	Negligible	Low	Low	Intermediate
POTENTIAL	Negligible	Low	Intermediate	Intermediate	High
PROBABLE	Low	Low	Intermediate	High	High

RISK DEFINITIONS: The following definitions of risk were agreed to during the work shop.

NEGLIGIBLE RISK

Resulted from (1) no evidence of effect and negligible or low evidence of exposure or (2) some evidence of potential effects and negligible evidence of exposure.

Suggests no impacts based on exposure or effects measures. Negligible risk was based on the general lack of evidence of exposure and effects in the field data.

LOW RISK

Resulted from (1) no evidence of effect and elevated or high exposure, (2) evidence of potential effect and low exposure, or (3) evidence of probable effect and negligible or low exposure.

Based on the field measurements, low risk typically lacked demonstratable correlations between exposure and response.

Suggests limited impacts based on exposure or effects measures.

INTERMEDIATE RISK

Resulted from (1) no evidence of effects and evidence of adverse exposure levels, (2) evidence of potential effects and evidence of elevated to high exposure, or (3) evidence of probable effect and evidence of elevated exposure.

Field data lacked quantitative exposure and response correlations and the spatial extent of impacts appeared to be localized.

Suggests possible impacts associated with multiple exposure and effects measures.

HIGH RISK

Resulted from (1) evidence of potential effect and adverse exposure, or (2) evidence of probable effects and evidence of high to adverse exposure.

High risk was associated with quantitative exposure and response relationships in the field data and the spatial extent and impact were likely to be large and persistent.

Suggests probable impacts because multiple measures of exposure and effects indicated risk.

RISK MANAGEMENT CONSIDERATIONS

The following working definitions for risk management decisions were revised during the work shop.

NEGLIGIBLE RISK: Generally no further action recommended. (No actionable risk.)

LOW RISK: Development of PRGs and feasibility study are recommended.

INTERMEDIATE RISK: Development of PRGs and feasibility study are recommended.

HIGH: Development of PRGs and feasibility study is highly recommended. In certain cases, removal actions may be warranted.

-purpose of feasibility study is to evaluate alternatives to remediate risk

-background (ambient) risk should be considered

SUMMARY OF PROCEDURES USED TO COMPLETE THE WEIGHT OF EVIDENCE ANALYSIS TO CHARACTERIZE RISK TO ECOLOGICAL RECEPTORS

The weight of evidence of risk was evaluated for each assessment endpoint by area of concern. In order to visualize the result from weighing the evidence, we used a visual display of the exposure and effects outcomes. By assigning values to the endpoint weights and measure outcomes (Table 9a-2), we constructed scatter plots of the outcomes of the exposure and effects against the endpoint weights.

Table 2a. Values used for constructing scatter plots of effect (EF_i) and exposure (EX_i) versus endpoint weights (EW_i).

Effects Measures	Exposure Measures	Endpoint Weights
(x)	(x)	(y)
Outcome = (EF _i)	Outcome = (EX _i)	Endpoint Weight= (EW _i)
No = 1	Negligible = 1	Low = 1
Potential = 2	Low = 2	Medium = 2
Probable = 3	Elevated = 3	High = 3
	High = 4	
	Adverse = 5	

To help visualize the central tendency of the scatter plot, we plotted the centroid [avg(y), avg(W_x)]. The centroid was calculated by plotting [avg(y), avg(W_x)] where:
 avg(y) = the arithmetic average of the endpoint weights and

avg(W_x) = the weighted average of the exposure or effect outcomes, which was calculated by multiplying the outcome (M_i) by its endpoint weight (W_i), summing the total obtained for all the outcomes, and dividing the total by the sum of the endpoint weights.

$$avg(W_x) = \frac{\sum M_i * W_i}{\sum W_i}$$

For clarity, individual measures were identified on the scatter plots. The scatter plots prepared for EPIBENTHIC, BENTHIC, PELAGIC, EELGRASS, SALTMARSH, and AVIAN assessment endpoints are provided in attachments (1-6). The result of risk characterization for the areas of concern is presented in the following tables (Table 9b - 9h).

Notes on Corrections made to Scatter Plots and Risk Characterization Tables

In reviewing the scatter plots and risk characterization tables prepared during the workshop a few errors and inconsistencies were corrected. The following is a list of changes that were made.

EELGRASS

- CC: rhizome length was above reference (no effect)
- All areas: Eelgrass tissue residues were broken out into two measures, Eelgrass Leaf Tissue Residues and Eelgrass Root Tissue Residues. This is consistent with other residue measure (e.g. lobster tail+claw and hepatopancreas are also two measures of exposure).
- All areas: The endpoint weight for eelgrass tissue residues was changed to medium (instead of high) because Study Design should be medium ("...not enough sampling was performed to account for natural stochasticity/probability...biological significance can not be clearly inferred"). This change makes the endpoint weight for eelgrass residues consistent with the medium endpoint weight assigned to the other biota residues (mussels, adult lobsters, flounder, fucoids, etc.).
- BC: Bulk sediment concentrations exceeded ER-L outcome changed from LOW to HIGH
- DD: Eelgrass Leaf/Root morphology was measured at station 17. Outcomes/ Interpretations were Potential/No Effect for leaf morphology (=1.5; less than ref. for leaf length, within reference for leaf biomass), and No Effect for root morphology (=1).

EPIBENTHIC

- DD: Because no mussels were present at station 13, there is a potential effect to mussel density
- CC: Fuciod biomass, potential/no effect (=1.5)
- CC: Mussel Condition index, no effect
- CC: Fuciod tissue residues was < average, negligible exposure
- SP: Mussel tissue concentration did not exceed any critical values, but because concentration was above mussel watch 98% elevated exposure was identified.
- PH: Adult lobster hepatopancreas residues were significantly higher than reference (elevated exposure), adult lobster tail+claw concentrations were above average (low exposure).

BENTHIC

- SP: DDT and DDD were above ER-M, adverse exposure
- DD: DDT and DDD were above ER-M, adverse exposure
- BC: DDT and DDD were above ER-M, adverse exposure
- SP: pore water toxic unit > 1 for PHEN, adverse exposure

RISK CHARACTERIZATION TABLES FOR EACH AREA OF CONCERN AND PORTSMOUTH HARBOR FOCUS AREA.

Table 9b. Summary of evidence of risk to assessment endpoints in the Clark Cove area of concern.

Assessment Endpoint	[1] Evidence of Effect	[2] Evidence of Exposure	[3] Magnitude of Risk	[4] Confidence In Conclusions
Pelagic	Potential/M	Low/M	Low	Medium
Epibenthic	No/M	Elevated/M	Low	Medium
Benthic	No/H	Elevated/M	Low	High[5]
Eelgrass	Potential/M[6]	Elevated/M	Intermediate	Medium
Salt Marsh	No/M	Elevated/M	Low.	Medium

[1] Entry obtained from scatter plot of effects measures versus the endpoint weights of the effects measures.

[2] Entry obtained from scatter plot of exposure measures versus the endpoint weights of the exposure measures.

[3] Entry obtained from Table 9a.

[4] Confidence reflects the average of the endpoint weights for effects and exposure measures (e.g. average endpoint weight of columns [1] and [2]), the degree of concurrence among the weights (e.g. scatter of weights within columns [1] and [2]), the degree of concurrence between conclusions regarding magnitudes of exposure and effect (e.g. the balance between the average endpoint weight and the scatter of weights column [3]), and professional judgement used to qualify conclusions.

[5] High concordance between conclusions

[6] Eelgrass beds only present at station 3 in Clark Cove

Table 9C. Summary of evidence of risk to assessment endpoints in the SULLIVAN POINT area of concern.

Assessment Endpoint	[1] Evidence of Effect	[2] Evidence of Exposure	[3] Magnitude of Risk	[4] Confidence In Conclusions
Pelagic	No/M	Low/L	Negligible	Medium[7]
Epibenthic	No/M	Elevated/M	Low	Medium
Benthic	Potential/H	High/M	Intermediate	High
Eelgrass	No/Med	Elevated/M	Low	Medium
Saltmarsh	No/M	Elevated/M	Low	Medium

[7] Medium confidence due to agreement between negligible estuarine surface-water concentrations and the absence of surface-water toxicity.

Table 9D. Summary of evidence of risk to assessment endpoints in the DRMO area of concern.

Assessment Endpoint	[1] Evidence of Effect	[2] Evidence of Exposure	[3] Magnitude of Risk	[4] Confidence In Conclusions
Pelagic	No/M	Negligible/M	Negligible	Medium
Epibenthic	No/M	Low/M	Negligible	Medium
Benthic[8]				
Eelgrass[8]				
Saltmarsh[8]				

[8] No sediment, eelgrass, or salt marsh habitat in this area of concern.

Table 9E. Summary of evidence of risk to assessment endpoints in the DRY DOCKS area of concern.

Assessment Endpoint	[1] Evidence of Effect	[2] Evidence of Exposure	[3] Magnitude of Risk	[4] Confidence In Conclusions
Pelagic	No/M	Negligible/M	Negligible	Medium
Epibenthic	No/M	Elevated/M	Low	Medium
Benthic	Potential/H	High/M	Intermediate	High
Eelgrass	No/M	Elevated/M	Low	Medium
Saltmarsh[9]				

[9] No Saltmarsh habitat in this area of concern.

Table 9F. Summary of evidence of risk to assessment endpoints in the BACK CHANNEL area of concern.

Assessment Endpoint	[1] Evidence of Effect	[2] Evidence of Exposure	[3] Magnitude of Risk	[4] Confidence In Conclusions
Pelagic	No/M	Negligible/M	Negligible	Medium
Epibenthic	No/M	Elevated/M	Low	Medium
Benthic	Potential/H	High/M	Intermediate	High
Eelgrass	Potential/M	Elevated/M	Intermediate	Medium
Salt Marsh	No/M	High/M	Low	Medium

Table 9G. Summary of evidence of risk to assessment endpoints in the JAMAICA COVE area of concern.

Assessment Endpoint	[1] Evidence of Effect	[2] Evidence of Exposure	[3] Magnitude of Risk	[4] Confidence In Conclusions
Pelagic	No/M	Low/M	Negligible	Medium
Epibenthic	No/M	Elevated/M	Low	Medium
Benthic	No/H	Elevated/M	Low	High
Eelgrass	No/M	Elevated/M	Low	Medium
Salt Marsh	No/M	Elevated/M	Low	Medium

Table 9H. Summary of evidence of risk to assessment endpoints for PORTSMOUTH HARBOR focus area.

Assessment Endpoint	[1] Evidence of Effect	[2] Evidence of Exposure	[3] Magnitude of Risk	[4] Confidence In Conclusions
Pelagic	No/M	Elevated/M	Low	Medium
Epibenthic	No/M	Elevated/M	Low	Medium
Benthic[10]				
Eelgrass[10]				
Saltmarsh[10]				
Avian	Not Evaluated	Negligible/M	Not Evaluated [11]	Medium[12]

[10] Benthic, eelgrass, salt marsh endpoints not evaluated for Portsmouth Harbor focus area.

[11] With the lack of effects information, the most conservative estimate of risk is Low.

[12] Pertains to the confidence of exposure measures only.

CHARACTERIZATION OF RISK ASSOCIATED WITH ENVIRONMENTAL MEDIA FOR THE AREAS OF CONCERN

The relationship of assessments to environmental media (Figure A) was used to determine entries into Table 10b. Because the PELAGIC and BENTHIC assessment endpoints provided more direct information on the risk from surface water and sediments, respectively, than do the other assessment endpoints, the magnitude of risk from the PELAGIC and BENTHIC assessment endpoints were assigned more weight. The magnitude of risk and confidence level for each assessment endpoint was assigned a numeric value (Table 10a-1) and weighted (Table 10a-2) to evaluate ecological risks associated with the environmental media present at each area of concern. The magnitude of risk from medium (R_M) and confidence in conclusion (C_M) were calculated as the weighted average of the outcomes for surface water and sediment exposure and effects, hence

$$\text{Magnitude of Risk From Medium} = R_M = \frac{\sum R_i * WM_i}{\sum WM_i}$$

and

$$\text{Confidence In Conclusions} = C_M = \frac{\sum C_i * WM_i}{\sum WM_i}$$

where R_i = magnitude of risk
 C_i = confidence of conclusion, and
 WM_i = weight applied to evaluate risk from media.

Table 10a-1. Numerical values assigned to magnitude of risk and confidence in conclusion and look up values for determining magnitude of risk from medium and confidence in conclusions.

Magnitude of Risk (R_i)	Numeric Value	Lookup Cut Off Value	Confidence in Conclusion (C_i)	Numeric Value	Lookup Cut Off Value
Negligible	0	< 0.50	Low	1	< 1.667
Low	1	< 1.25	Medium	2	< 2.333
Intermediate	2	< 2.00	High	3	≤ 3.000
High	3	≤ 3.00			

Table 10a-2. Weights (WM_i) used for calculating magnitude of risk from medium and confidence in conclusions.

Assessment Endpoint	Surface Water	Sediment
PELAGIC	2	0
EPIBENTHIC	1	1
BENTHIC	0	2
EELGRASS	1	1
SALTMARSH	1	1

The weighing scheme was used to calculate the entries for Table 10b. For areas of concern where all endpoints were not assessed (e.g. the Dry Dock area was not assessed for impacts to SALTMARSH receptors, and the DRMO was not assessed for impacts to BENTHIC, EELGRASS, and SALTMARSH receptors) the missing assessment endpoint(s) was(were) excluded from the calculation. For the Portsmouth Harbor focus area the surface water medium was evaluated for the PELAGIC and EPIBENTHIC assessment endpoints and the biota medium was evaluated as dietary exposure to AVIAN receptors. The raw calculations used for Table 10 are attached (Attachment 7). Footnotes were provided to document significant findings and explain the use of professional judgement.

Table 10b. Characterization of ecological risks associated with environmental media at Portsmouth Naval Shipyard by Area of Concern.

Area of Concern	Environmental Medium	Magnitude of Risk From Medium	Confidence In Conclusions
Clark Cove	Surface Water ⁽¹⁾	Low ⁽²⁾	Medium
	Sediment ⁽³⁾	Low	High
Back Channel	Surface Water ⁽¹⁾	Low	Medium
	Sediment	Intermediate	High
Jamaica Cove	Surface Water ⁽¹⁾	Low	Medium
	Sediment ⁽³⁾	Low	High
Sullivan Point	Surface Water	Low	Medium
	Sediment ⁽³⁾	Intermediate	High
Dry Docks ⁽⁴⁾	Surface Water ⁽¹⁾	Low	Medium
	Sediment ⁽³⁾	Intermediate	High
DRMO ⁽⁵⁾	Surface Water ⁽¹⁾	Negligible	Medium
Portsmouth Harbor ⁽⁶⁾	Surface Water ⁽¹⁾	Low	Medium
	Biota ⁽⁷⁾	Negligible	Medium

(1) Evidence of bioaccumulation in mussels is probably related to surface water exposure.

(2) Sediment resuspension may be influencing surface water risks.

(3) Evidence of bioaccumulation in juvenile lobsters may be related to sediment exposure.

(4) No SALTMARSH habitat in Dry Dock area of concern.

(5) No sedimentary habitat at DRMO.

(6) Only PELAGIC, EPIBENTHIC, and AVIAN assessment endpoints were evaluated for Portsmouth Harbor focus area.

(7) Biota evaluated as dietary exposure to AVIAN receptors.

Calculations for Table 10

			0.75				0.6666667			
	Risk		Look Up		Confidence		Look Up			
	Neg	0	0.5		Low	1	1.6666667			
	Low	1	1.25		Med	2	2.33333333			
	Intermediate	2	2		High	3	3			
	High	3	3							
Assessment Endpoint										
Area of Concern	Pelagic		Epibenthic		Benthic		Eelgrass		Saltmarsh	
	risk	confidence	risk	confidence	risk	confidence	risk	confidence	risk	confidence
Clark Cove	1	2	1	2	1	3	2	2	1	2
Sullivan Point	0	2	1	2	2	3	1	2	1	2
DRMO	0	2	0	2						
Dry Docks	0	2	1	2	2	3	2	2		
Back Channel	0	2	1	2	2	3	2	2	1	2
Jamaica Cove	0	2	1	2	1	3	1	2	1	2
Portsmouth Harbor	1	2	1	2						
Water Weights Sediment Weights										
	PELAGIC	2	BENTHIC	2						
	EPI	1	EPI	1						
	EEL	1	EEL	1						
	SM	1	SM	1						
RISK CONFIDENCE RISK CONFIDENCE										
	Water	Sediment	Water	Sediment	Water	Sediment	Water	Sediment		
AOC										
Clark Cove	1.2	1.2	2	2.4	Low	Low	Medium	High		
Sullivan Point	0.6	1.4	2	2.4	Low	Intermediate	Medium	High		
DRMO	0		2		Negligible		Medium			
Dry Docks	0.75	1.75	2	2.5	Low	Intermediate	Medium	High		
Back Channel	0.8	1.6	2	2.4	Low	Intermediate	Medium	High		
Jamaica Cove	0.6	1	2	2.4	Low	Low	Medium	High		
Portsmouth Harbor	1		2		Low		Medium			

**Scatter Plots of Exposure and Effects measures for EPIBENTHIC
Receptors by Area of Concern**

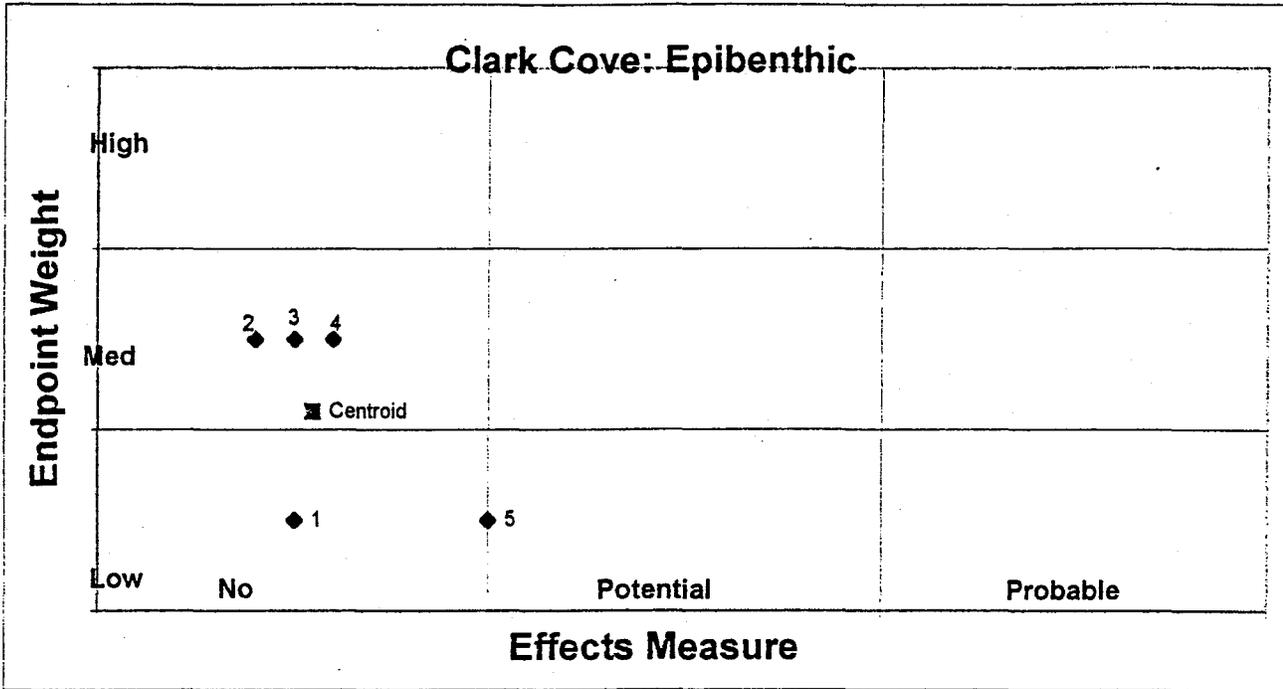
CC-Epibenthic_q

Clark Cove
Epibenthic

				Exposure			
name	effect	Effect ew		name	exposure	ew	
1 Lobster Density		1	1	A Surface Water	1		2
2 Mussel Density		0.9	2	B Furoid Res	1.1		2
3 Mussel Length		1	2	C Juvenile Lobster He	3		3
4 Mussel Condition In		1.1	2	D Juvenile Lobster Ta	3.1		3
5 Furoid Biomass		1.5	1	E Seeps	4		2
6				F Mussel Residues	4.1		2

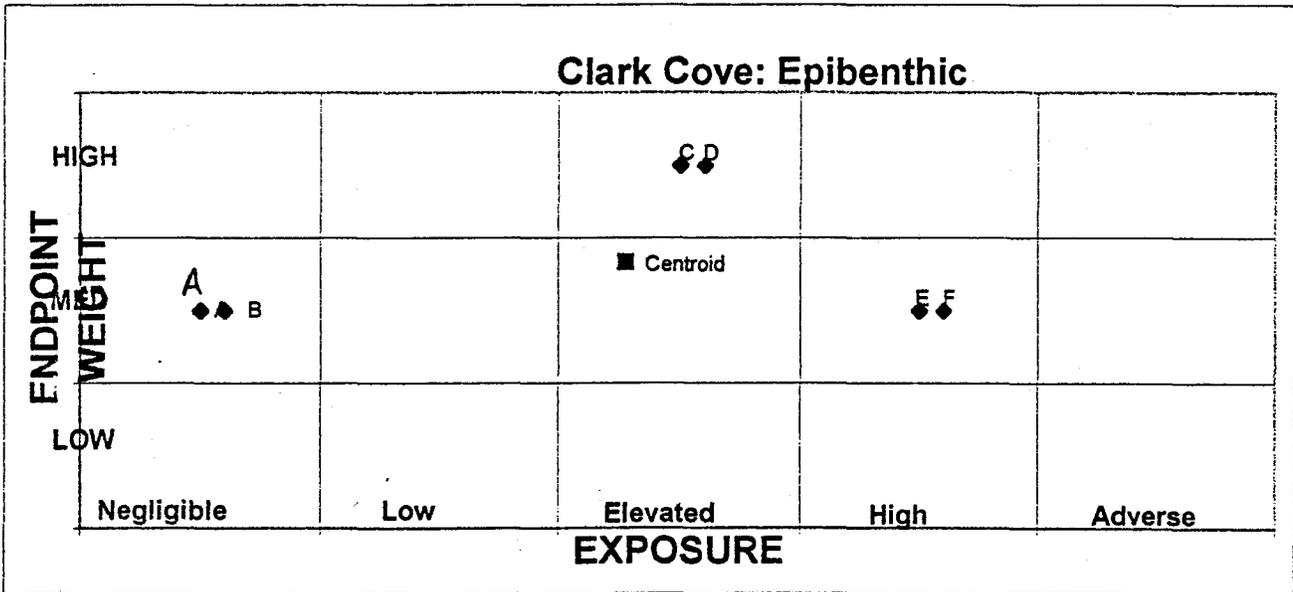
Plotted Values are offset by 0.5 units

AVERAGE	0.6	1.1	2.217	1.8
WEIGHTED CENTROID	0.5	1.1	2.277	1.833333



Lobster Density 1
 Mussel Density 2
 Mussel Length 3
 Mussel Condition Index 4
 Fucoïd Biomass 5

No/M



Surface Water A
 Fucoïd Res B
 Juvenile Lobster Hepato Residues C
 Juvenile Lobster Tail+Claw Residues D
 Seeps E
 Mussel Residues F

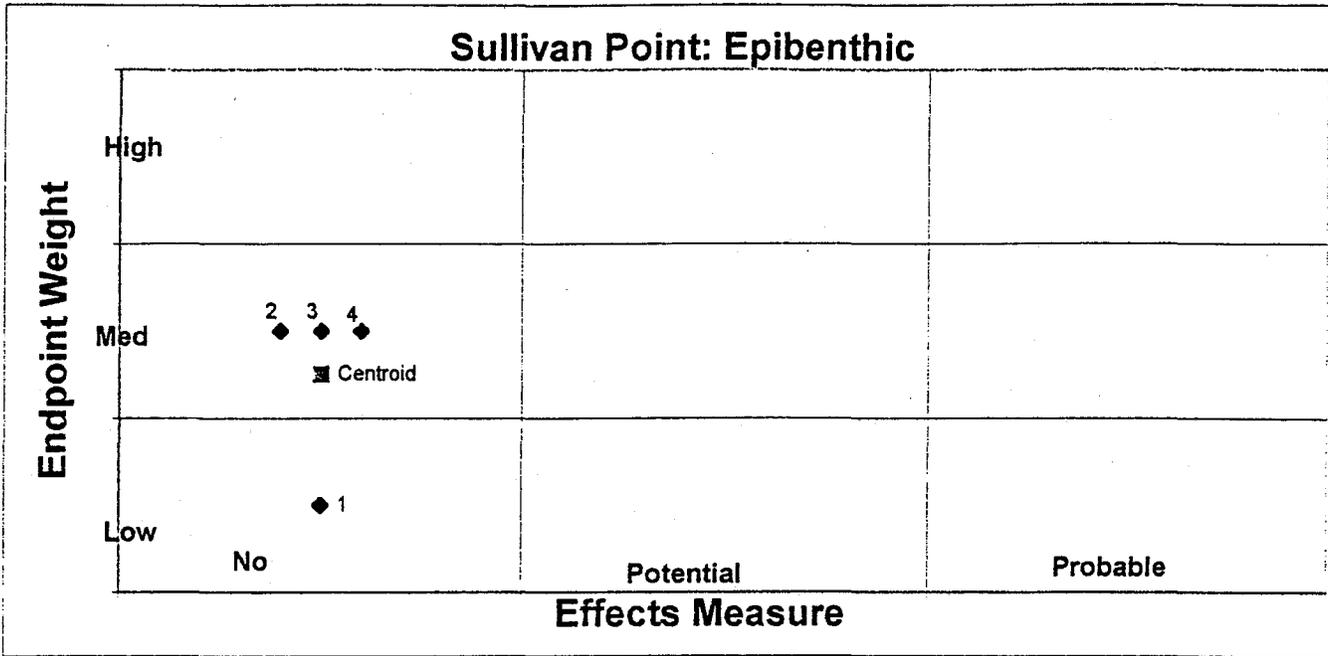
Elevated/M

SP-Epibenthic_q

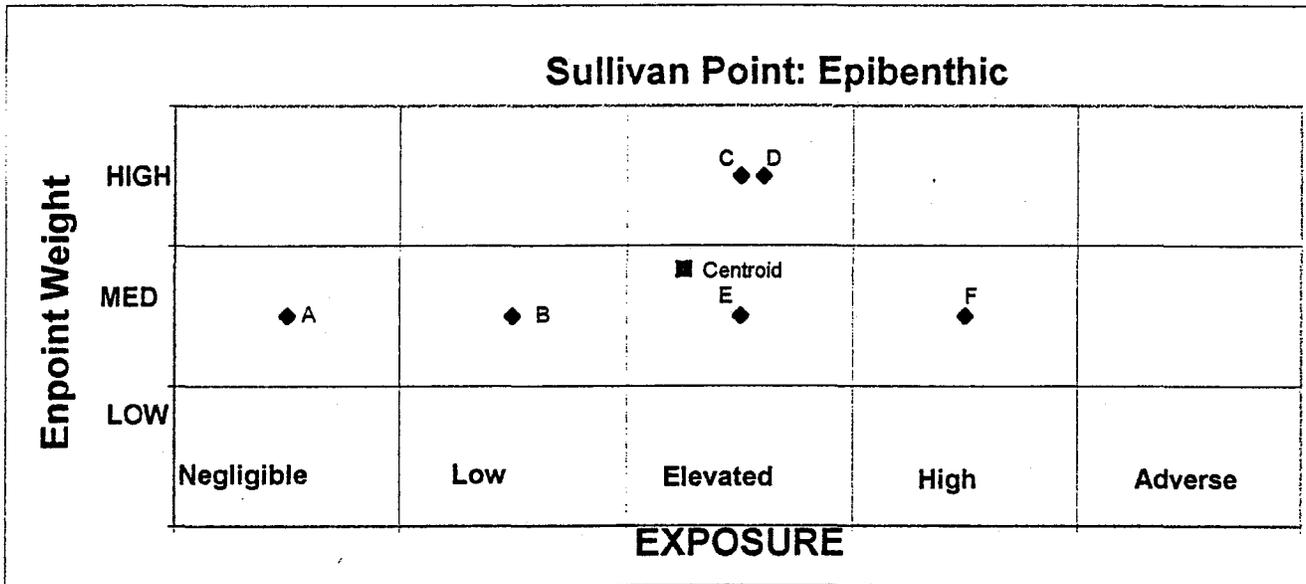
name	Effect		name	Exposure	
	effect	ew		exposure	ew
1 Furoid Biomass	1	1	A Surface Water	1	2
2 Mussel Condition Inde:	0.9	2	B Furoid Algae Residue	2	2
3 Mussel Density	1	2	C Juvenile Lobster Hep. Re	3	3
4 Mussel Length	1.1	2	D Juvinle Lobster Tail+Claw	3.1	3
5			E Mussel Residues	3	2
6			F Seep Water	4	2

Ploted values are offset by 0.5

AVERAGE	0.50	1.25	2.18	1.83
CENTROID	0.50	1.25	2.25	1.83



Furoid Biomass 1
 Mussel Condition Index 2 No/M
 Mussel Density 3
 Mussel Length 4



Surface Water A
 Furoid Algae Residue B
 Juvenile Lobster Hep. Residues C Elevated/M
 Juvenile Lobster Tail+Claw Residues D
 Mussel Residues E
 Seep Water F

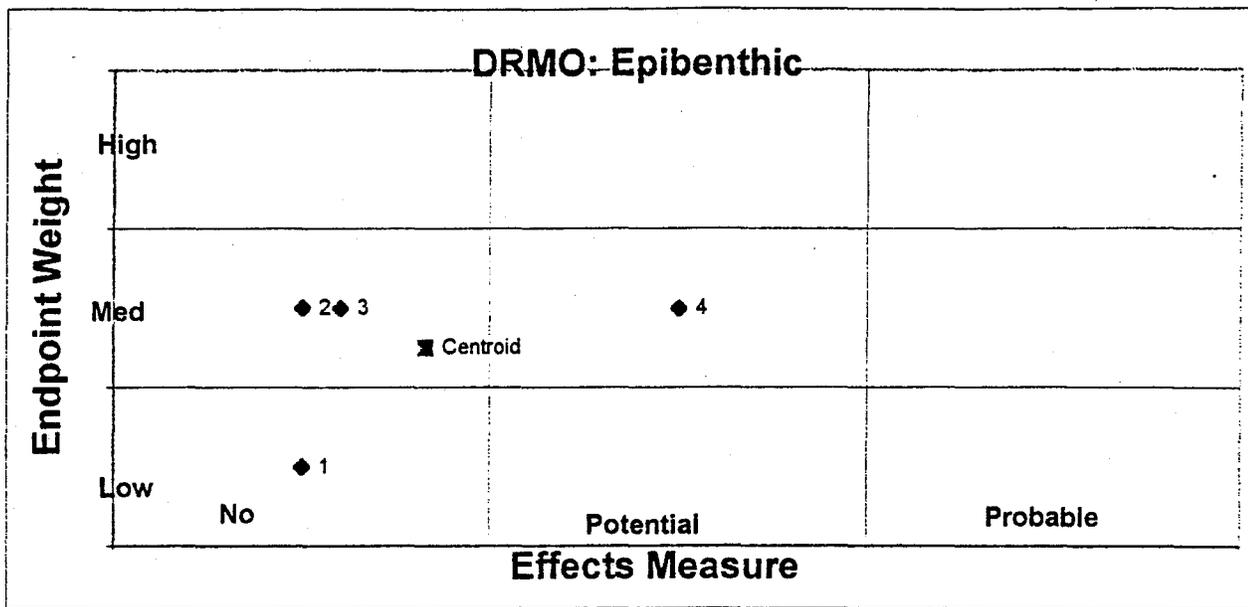
DRMO-Epibenthic

name	effect	Effect		name	exposure	Exposure	
		ew				ew	
1 Fucoid Biomass		1	1	A Surface Water	1		2
2 Mussel Condition Index		1	2	B Fucoid Algae Residue	2		2
3 Mussel Density		1.1	2	C Mussel Residues	4		2
4 Mussel Length		2	2	D			
5				E			
6				F			

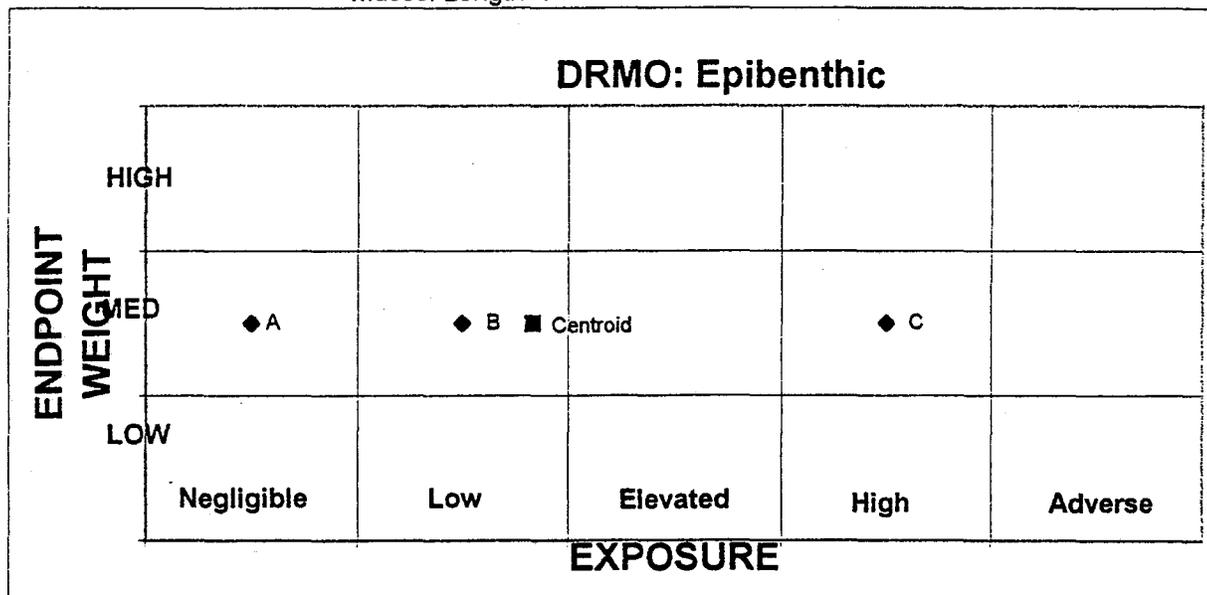
Ploted Values are offset by 0.5 units

AVERAGE	0.78	1.25	1.83	1.50
WEIGHTED CENTROID	0.83	1.25	1.83	1.50

DRMO-Epibenthic



- Fucoid Biomass 1
- Mussel Condition Index 2
- Mussel Density 3
- Mussel Length 4



- Surface Water A
- Fucoid Algae Residue B
- Mussel Residues C

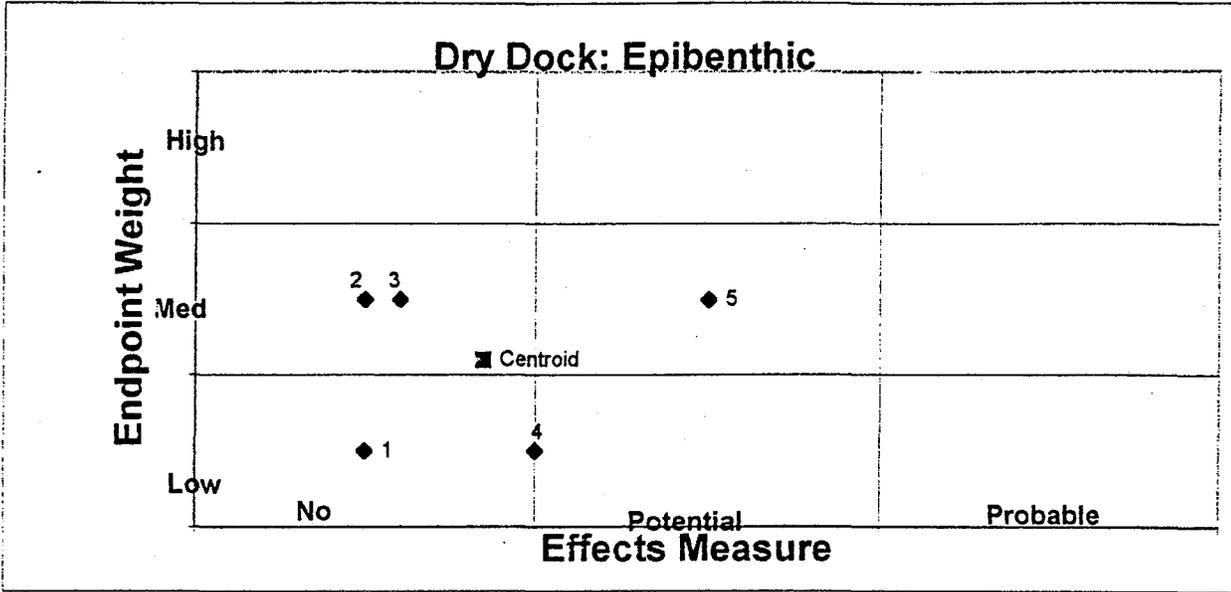
DD-Epibenthic_q

Dry Dock
Epibenthic

Effect			Exposure		
name	effect	ew	name	exposure	ew
1 Lobster Density	1	1	A Surface Water	1	2
2 Mussel Length	1	2	B Furoid Residue	2	2
3 Mussel Condition	1.1	2	C Juvenile Lobster Hepatop	3	3
4 Furoid Biomass	1.5	1	D Juvenile Lobster Tail+Cla	3.1	3
5 Mussel Density	2	2	E Mussel Residues	4	2
6			F		

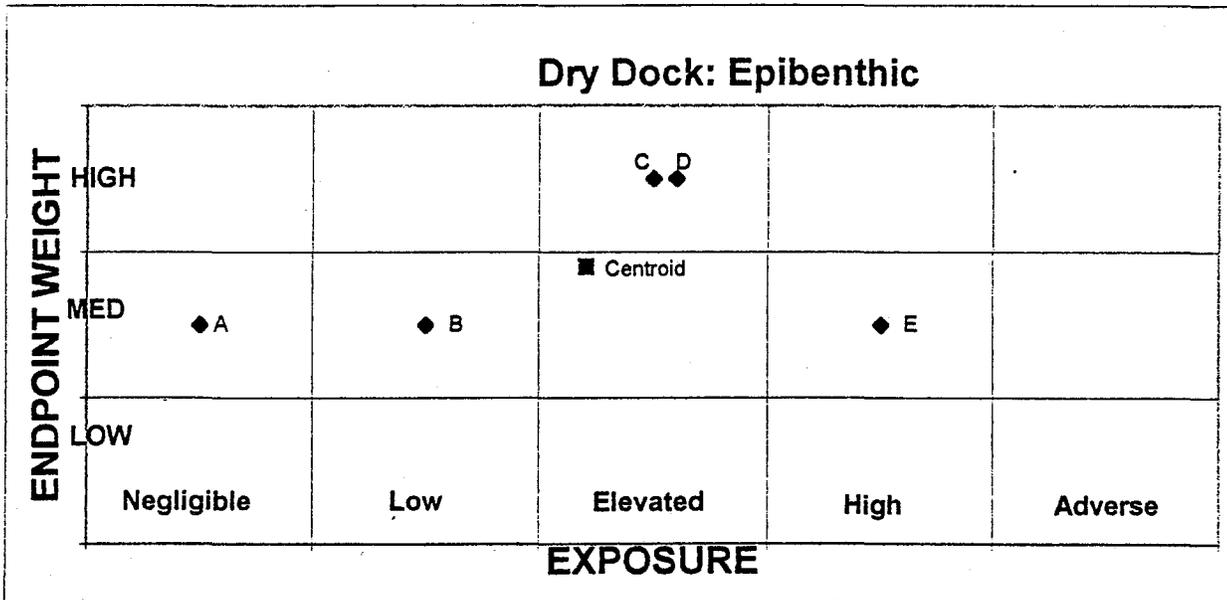
Ploted Values are offset by 0.5 units

AVERAGE	0.82	1.10	2.12	1.90
WEIGHTED CENTROID	0.85	1.10	2.21	1.90



Lobster Density 1
 Mussel Length 2
 Mussel Condition Index 3
 Fucoi Biomass 4
 Mussel Density 5

No/M



Surface Water A
 Fucoi Residue B
 Juvenile Lobster Hepatopancreas Residue C
 Juvenile Lobster Tail+Claw Residues D
 Mussel Residues E

Elevate/M

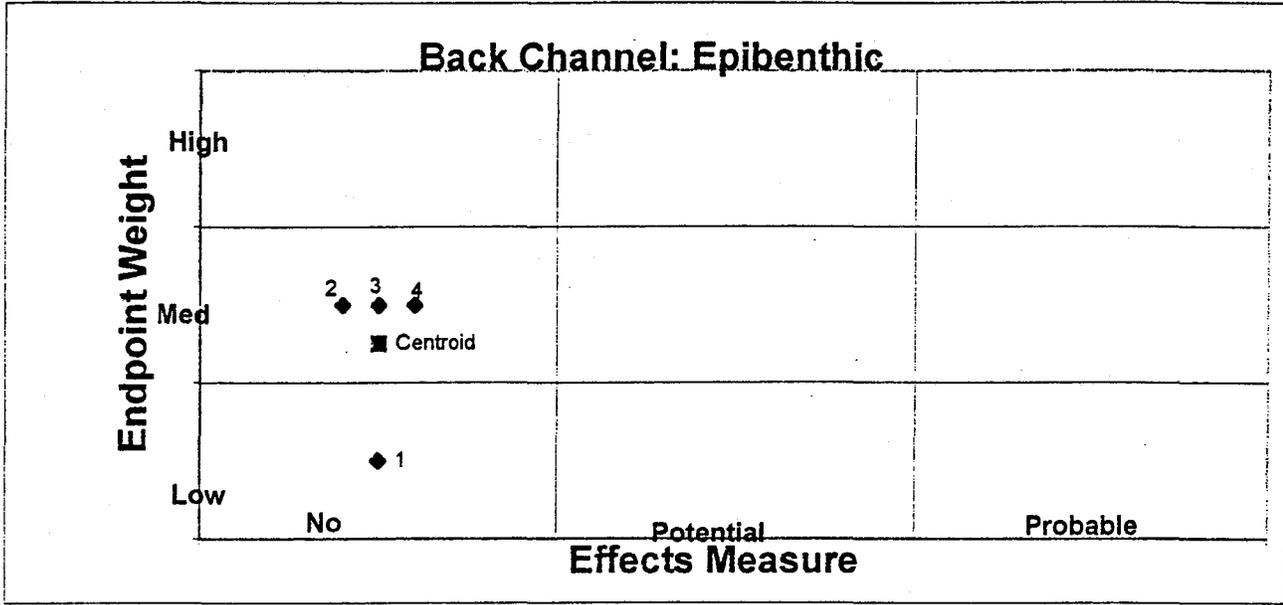
BC-Epibenthic_q

Back Channel
Epibenthic

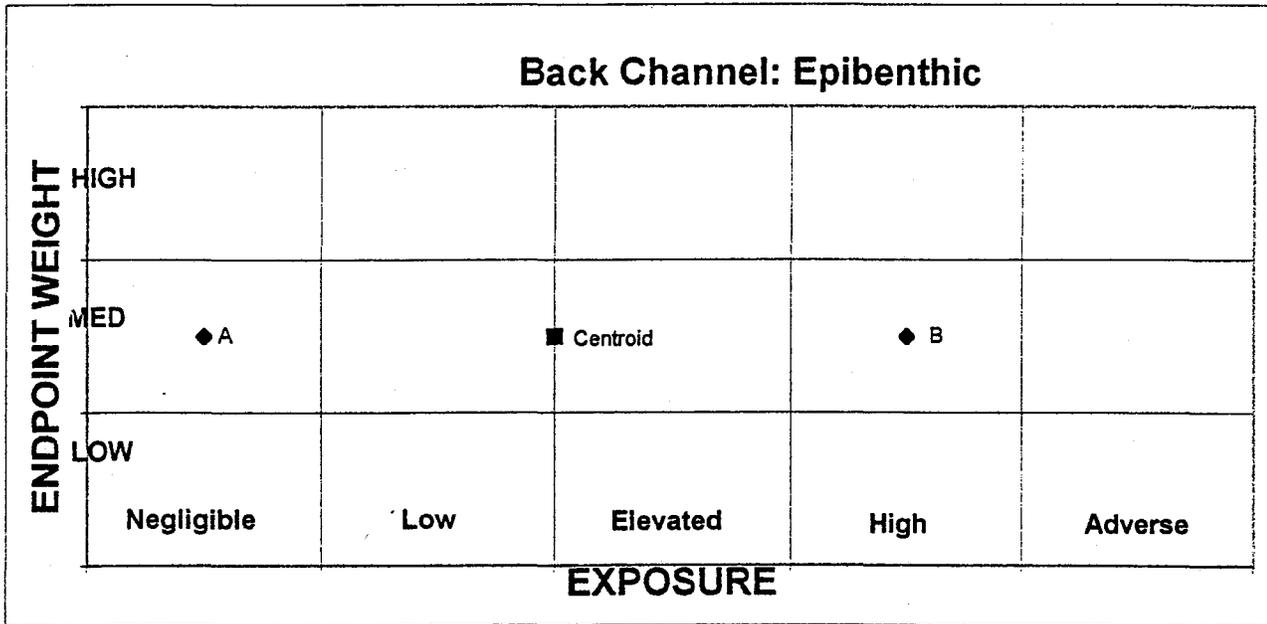
Effect			Exposure		
name	effect	ew	name	exposure	ew
1 Lobster Abundance		1	A Surface Water	1	2
2 Mussel Length	0.9	2	B Mussel Residues	4	2
3 Mussel Density	1	2	C		
4 Mussel Condition Index	1.1	2	D		
5			E		
6			F		

Ploted Values are offset by 0.5 units

AVERAGE	0.50	1.25	2.0	1.5
WEIGHTED CENTROID	0.50	1.25	2.0	1.5



Lobster Abundance 1
 Mussel Length 2 No/M
 Mussel Density 3
 Mussel Condition Index 4



Surface Water A Elevated/M
 Mussel Residues B

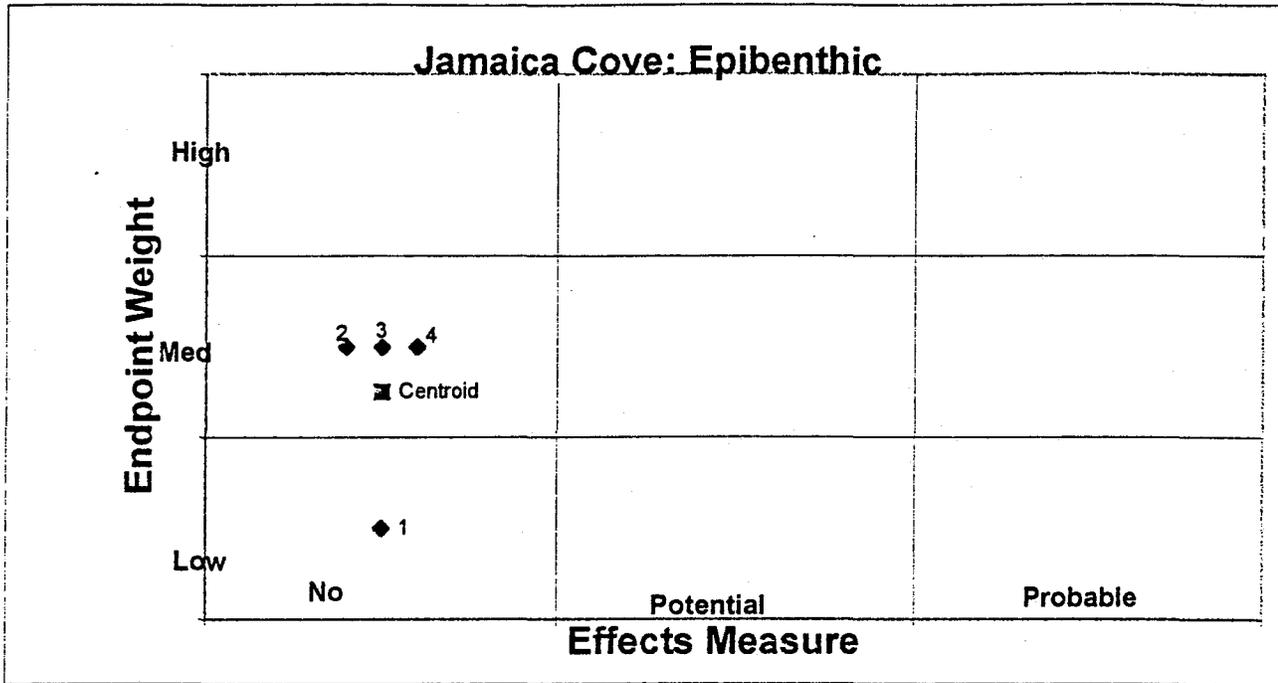
JC-Epibenthic_q

Jamaica Cove
Epibenthic

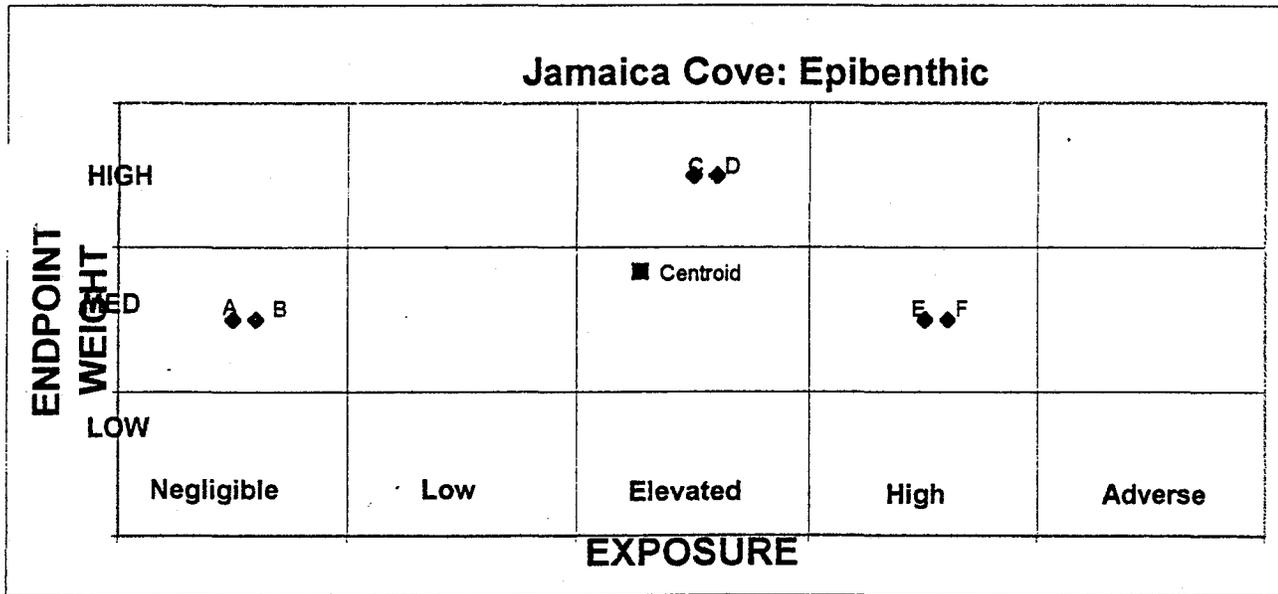
Effect			Exposure		
name	effect	ew	name	exposure	ew
1 Furoid Biomass	1.0	1	A Furoid Algae Residue	1.0	2
2 Mussel Length	0.9	2	B Surface Water	1.1	2
3 Mussel Density	1.0	2	C Juvenile Lobster Hepatop	3.0	3
4 Mussel Condition Index	1.1	2	D Juvenile Lobster Tail+Cla	3.1	3
5			E Seep Water	4.0	2
6			F Mussel Residues	4.1	2

Ploted Values are offset by 0.5 units

AVERAGE	0.50	1.25	2.22	1.83
WEIGHTED CENTROID	0.50	1.25	2.28	1.83



- Fucoid Biomass 1
- Mussel Length 2
- Mussel Density 3
- Mussel Condition Index 4



- Fucoid Algae Residue A
- Surface Water B
- Juvenile Lobster Hepatopancreas Residue C
- Juvenile Lobster Tail+Claw Residue D
- Seep Water E
- Mussel Residues F

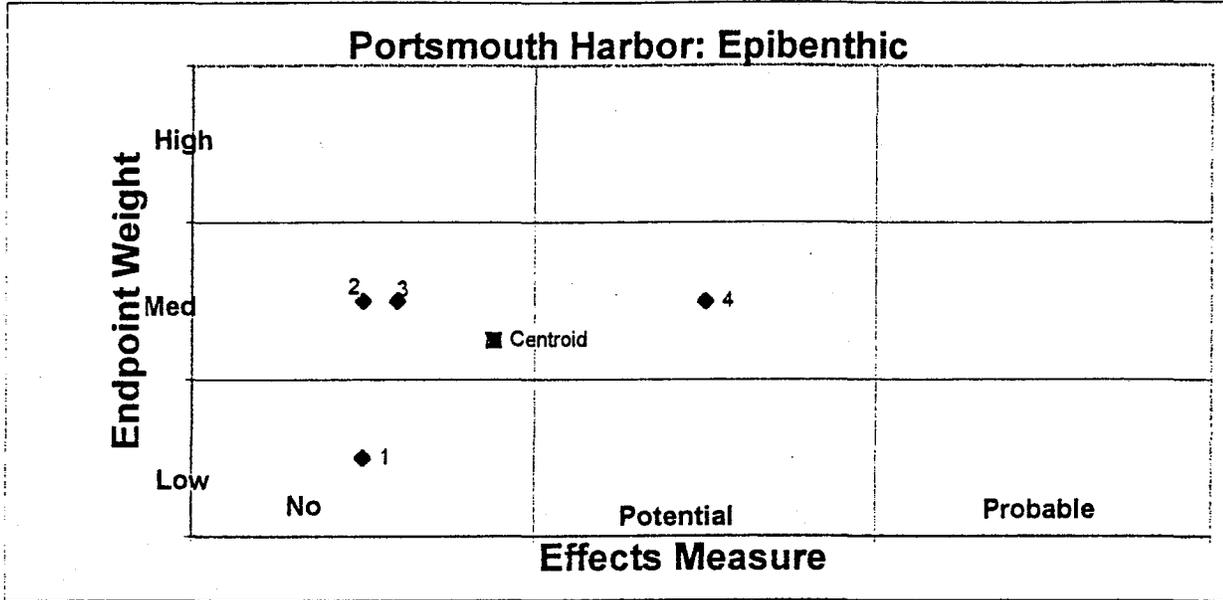
PH-Epibenthic_q

Portsmouth Harbor
Epibenthic

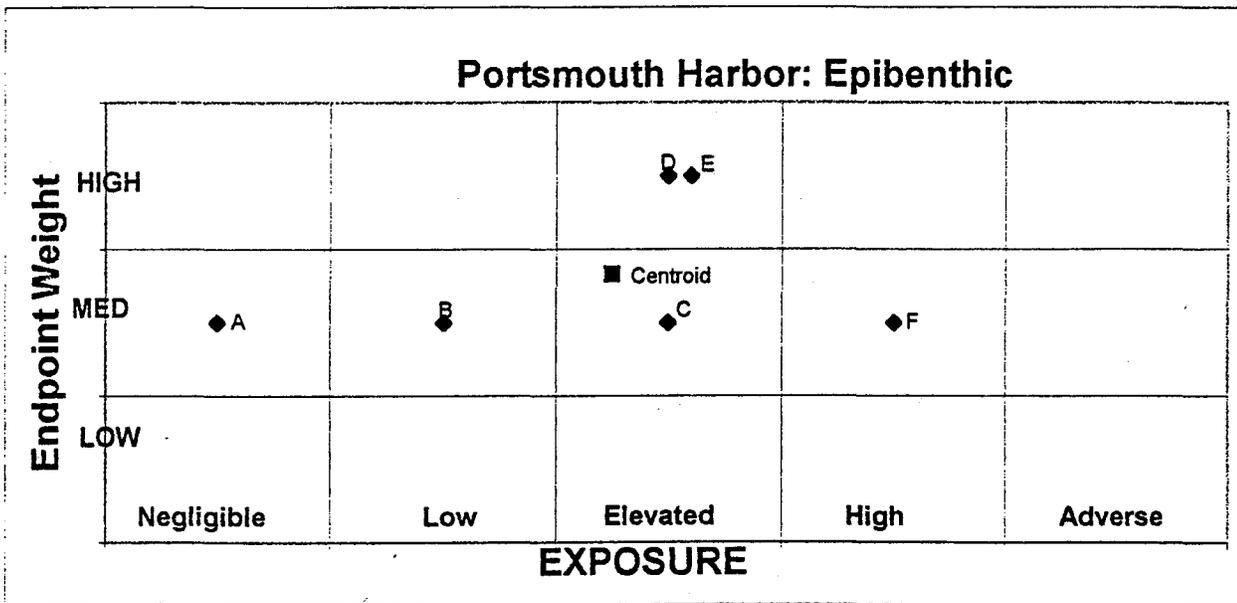
name	effect	Effect		name	exposure	Exposure	
		ew				ew	
1 Loster Density		1	1	A Surface Water	1		2
2 Mussel Density		1	2	B Adult Lobster Tail Residu	2		2
3 Mussel Length		1.1	2	C Adult Lobster Hepato	3		2
4 Mussel Condition		2	2	D Juvenile Lobster Hepato I	3		3
5				E Juvenile Lobster Tail Res	3.1		3
6				F Mussel Residues	4		2

Ploted values are offset by 0.5

AVERAGE	0.78	1.25	2.18	1.83
CENTROID	0.88	1.25	2.25	1.83



Loster Density 1
 Mussel Density 2 No/M
 Mussel Length 3
 Mussel Condition 4



Surface Water A
 Adult Lobster Tail Residues B
 Adult Lobster Hepato C Elevated/M
 Juvenile Lobster Hepato Res D
 Juvenile Lobster Tail Res E
 Mussel Residues F

Scatter Plots of Exposure and Effects measures for PELAGIC Receptors by Area of Concern

6
Enc 1 (●)

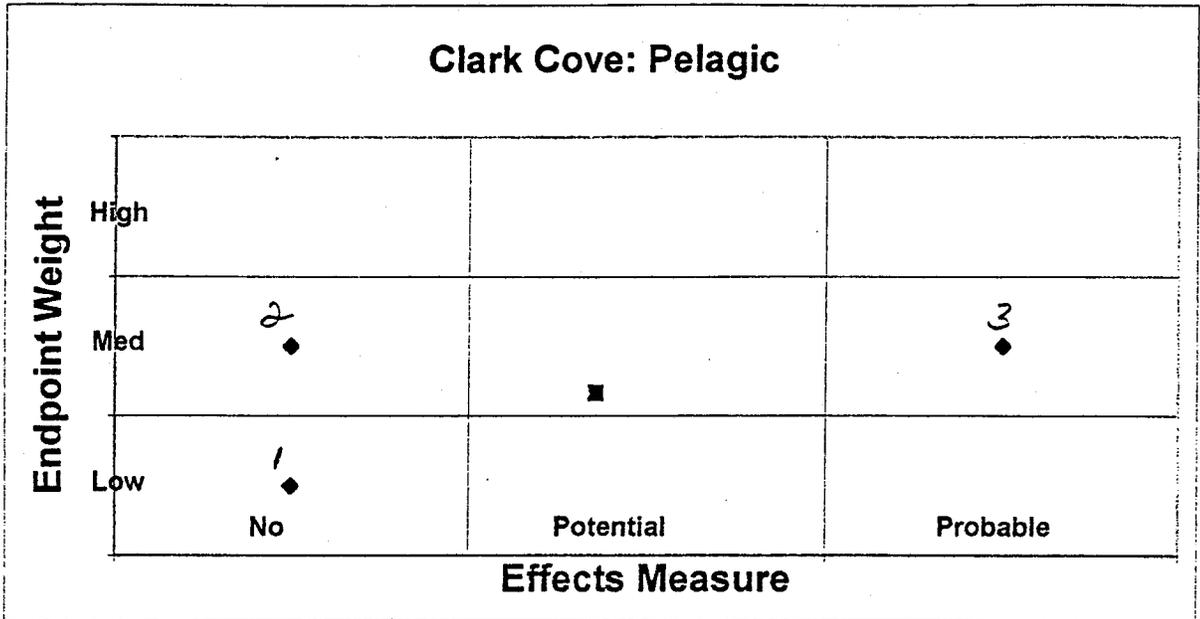
CC-pelagic-q

Clark Cove
Pelagic

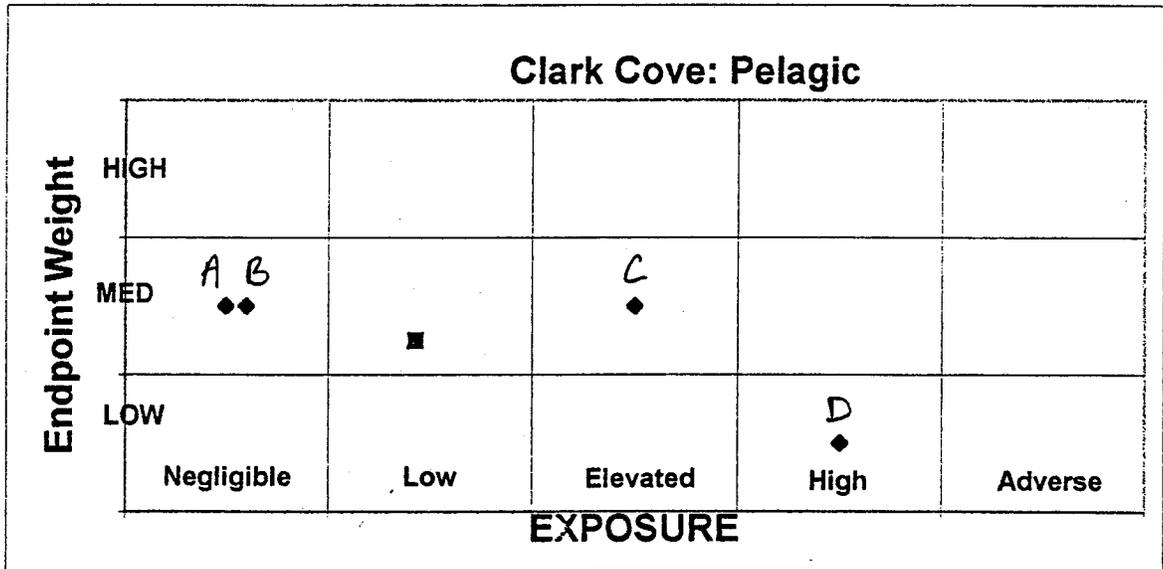
Effect			Exposure		
name	effect	ew	name	exposure	ew
Phytoplankton Biomass	1	1	Surface Water	1	2
Deployed Mussel SFG (:	1	2	Deployed Mussel I	1.1	2
Arbacia Toxicity	3	2	Deployed Mussel II	3	2
			Seep	4	1

Plotted Values are offset by 0.5 units

AVERAGE	1.2	1.2	1.78	1.25
WEIGHTED CENTROID	1.4	1.2	1.43	1.25



- Phytoplankton Biomass 1
- Deployed Mussel SFG (Scope For Growth) 2
- Arbacia Toxicity 3
- Potential/M 4
- 5
- 6



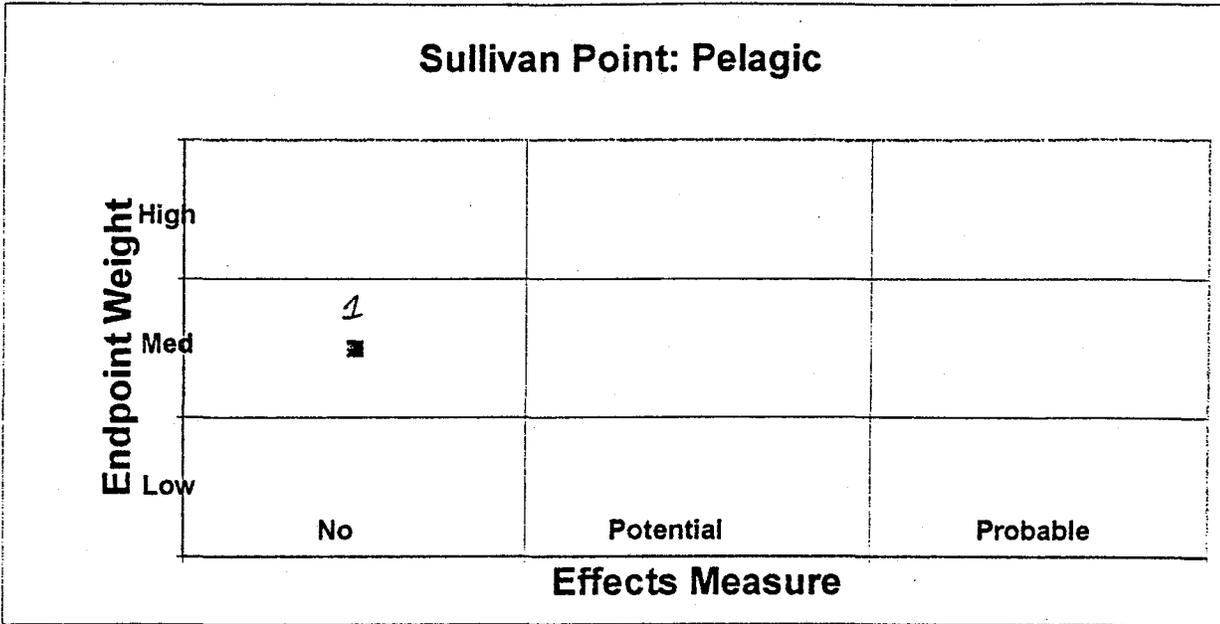
- Surface Water A
 - Deployed Mussel I (PHASE I) B
 - Deployed Mussel II (PHASE II) C
 - Seep D
 - E
 - F
 - G
- Low/M

SP-pelagic_q

Effect			Exposure		
name	effect	ew	name	exposure	ew
Arbacia Toxicity	1	2	Surface Water	1	2
			Seep Water	4	1

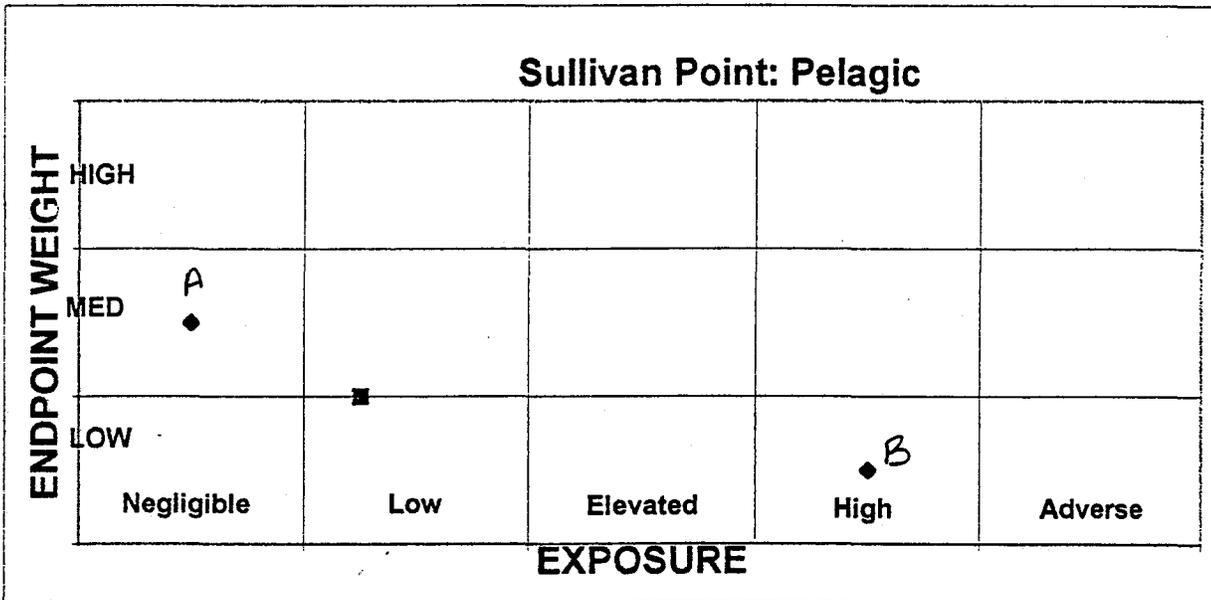
Ploted values are offset by 0.5

AVERAGE	0.50	1.5	2.00	1.00
CENTROID	0.50	1.5	1.25	0.00 1,00



Arbacia Toxicity 1

No/M



Surface Water A
Seep Water B

Low/L

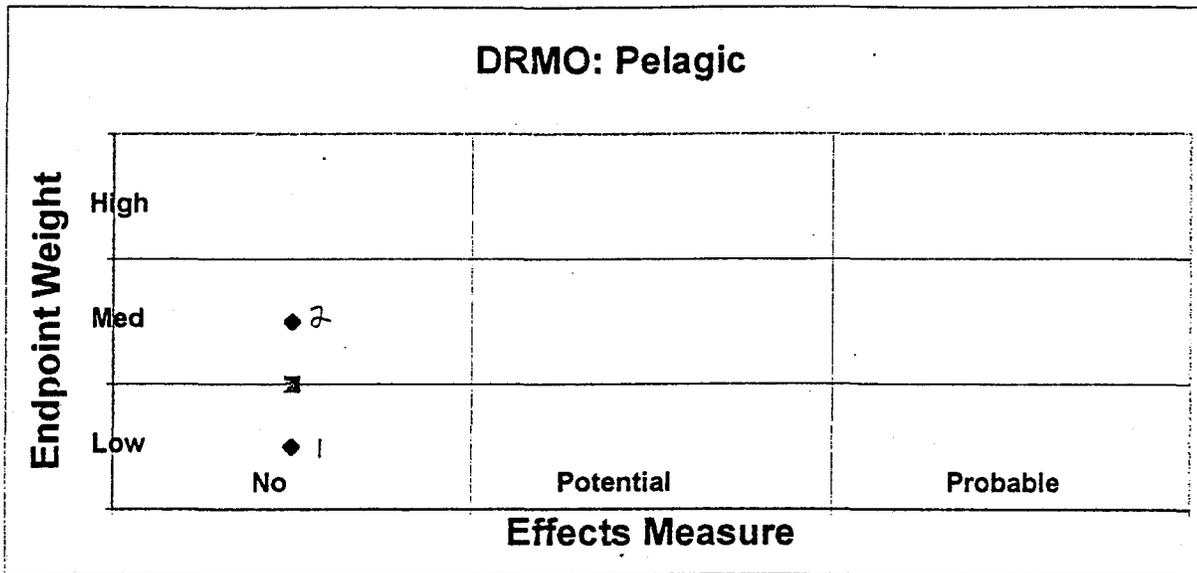
DRMO-pelagic_q

DRMO
Pelagic

name	effect	Effect		name	exposure	Exposure	
		ew				ew	
Phytoplankton Biomass	1	1		Surface Water	1	2	
Arbacia Toxicity	1	2					

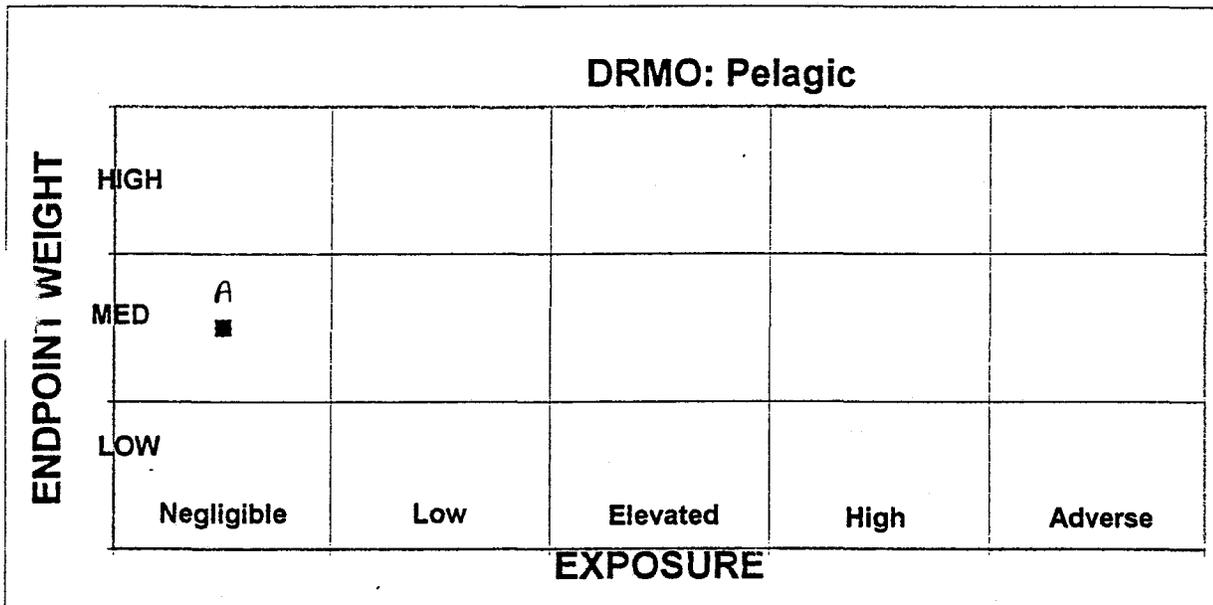
Ploted Values are offset by 0.5 units

AVERAGE	0.5	1.0	0.5	1.5
WEIGHTED CENTROID	0.5	1.0	0.5	1.5



Phytoplankton Biomass 1
Arbacia Toxicity 2

No/M



Surface Water A

Negligible/M

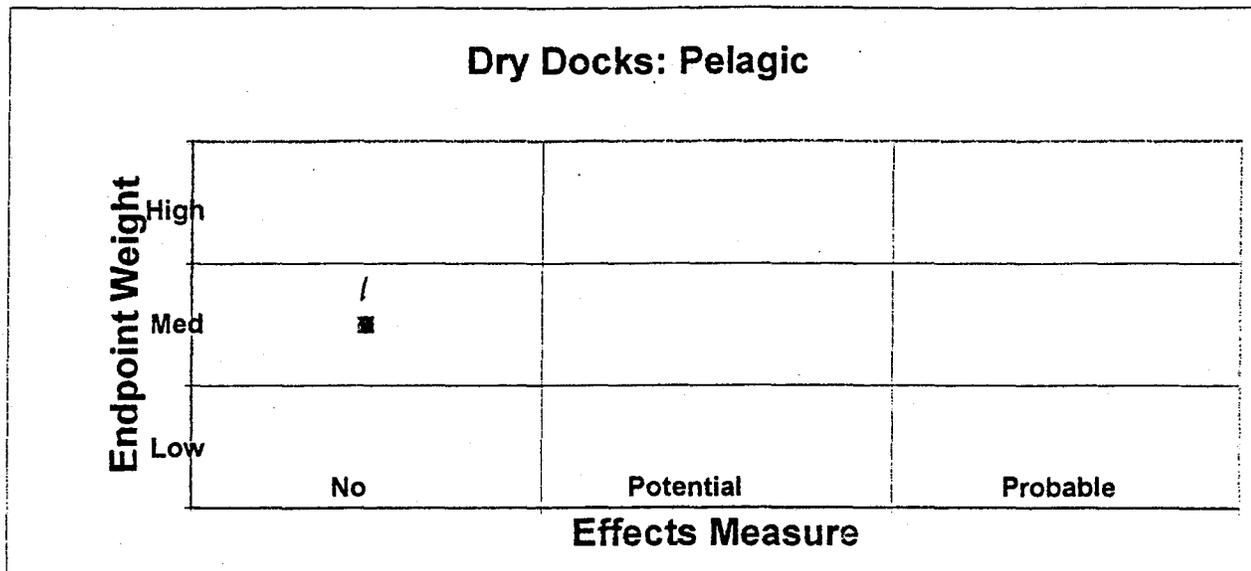
DD-pelagic_q

Dry Docks
Pelagic

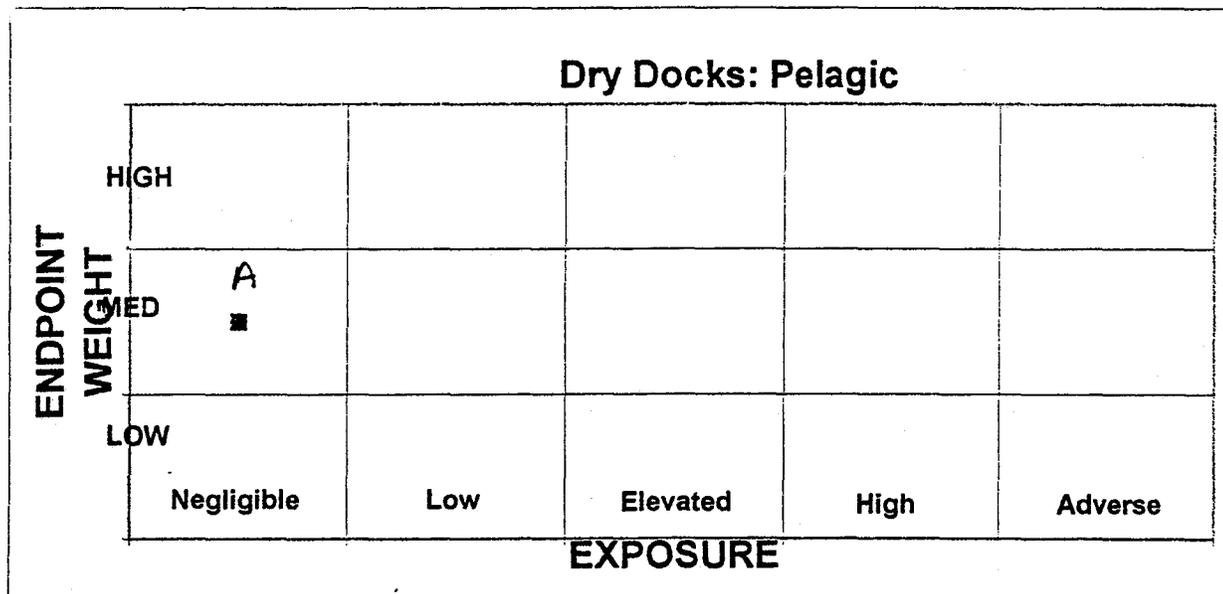
name	effect	Effect		name	exposure	Exposure	
		ew				ew	
Arbacia Toxicity		1	2	Surface Water		1	2

Plotted Values are offset by 0.5 units

AVERAGE	0.50	1.50	0.5	1.5
WEIGHTED CENTROID	0.50	1.50	0.5	1.5



Arbacia Toxcity 1



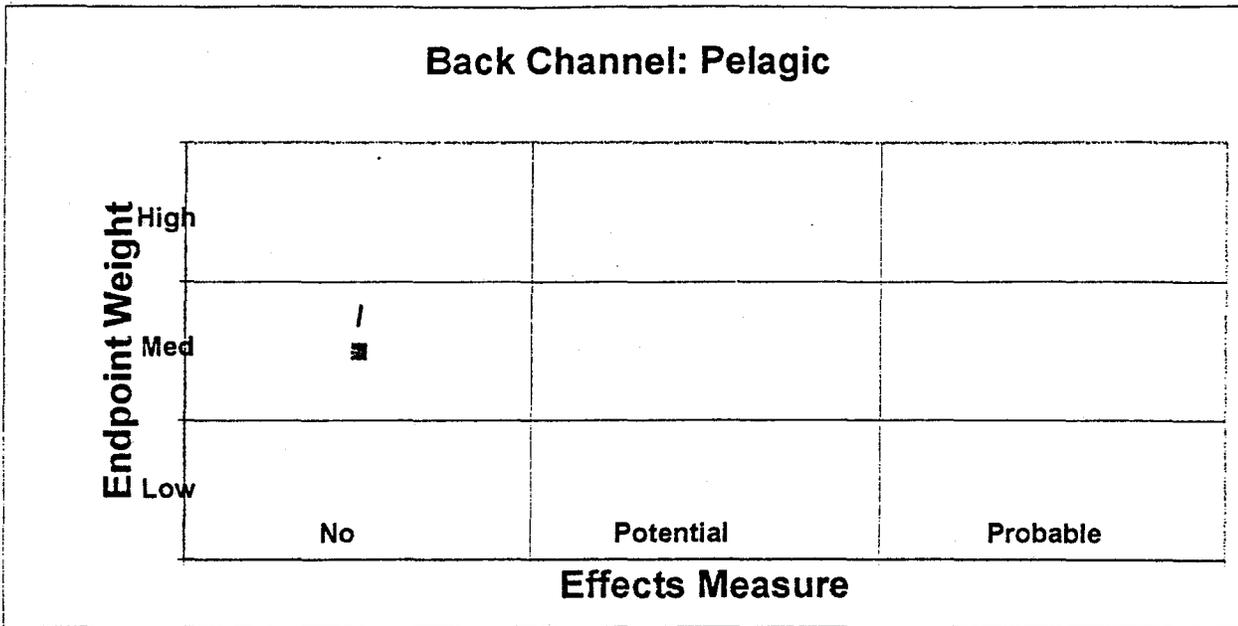
Surface Water A

BC-pelagic_q

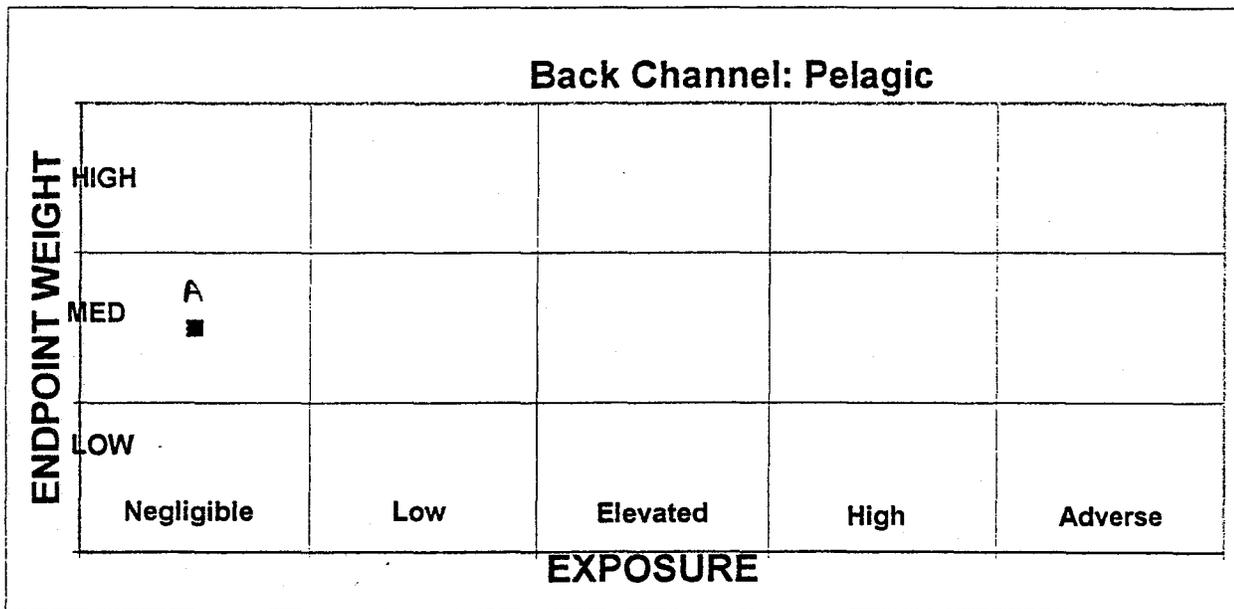
name	effect	Effect		name	exposure	Exposure	
		ew	ew			ew	ew
Arbacia Toxicity		1	2	Surface Water		1	2

Plotted Values are offset by 0.5 units

AVERAGE	0.5	1.5	0.5	1.5
EIGHTED CENTROID	0.5	1.5	0.5	1.5



Arbacia Toxicity 1



Surface Water A

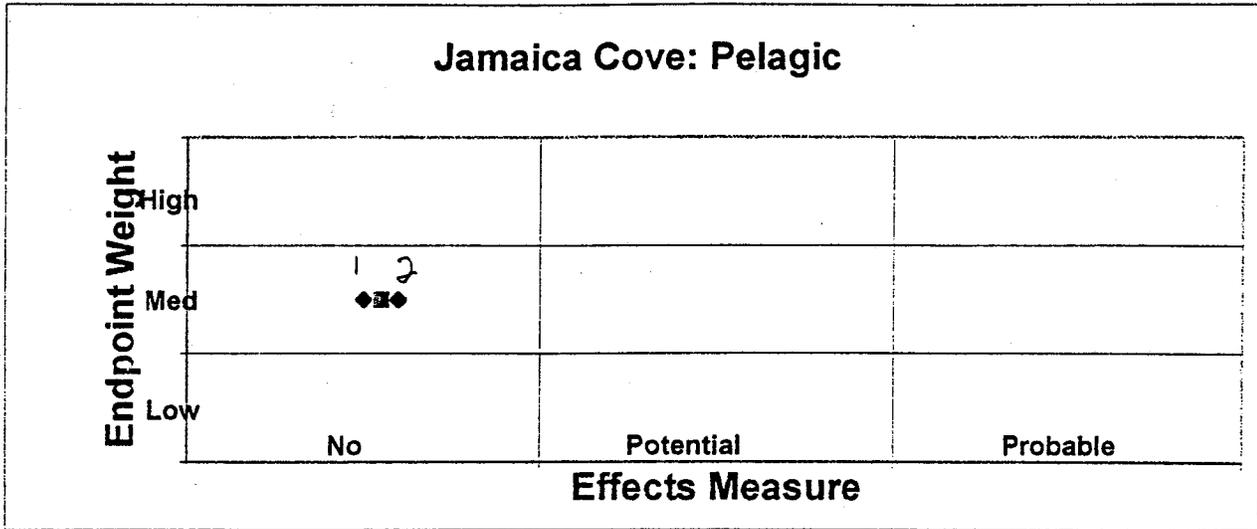
JC-pelagic_q

name	Effect effect	ew
Deployed Mussel Scope for	1	2
Arbacia Toxicity	1.1	2

name	Exposure exposure	ew
Surface Water	1	2
Deployed Mussel Re	1.1	2
Deployed Mussel Re	3	2
Seep Water	4	1

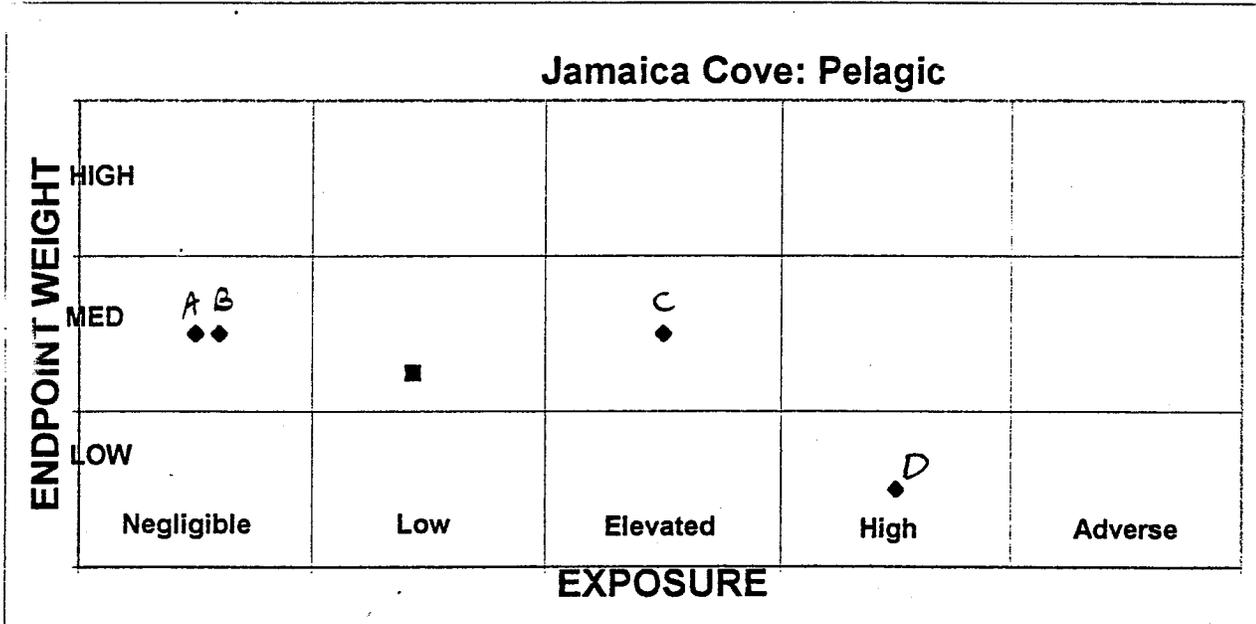
Plotted Values are offset by 0.5 units

AVERAGE	0.6	1.50	1.78	1.25
WEIGHTED CENTROID	0.6	1.50	1.43	1.25



Deployed Mussel Scope for Growth (SFG) 1
 Arbacia Toxicity 2

No/m



Surface Water A
 Deployed Mussel Residues (PHASE I) B Low/M
 Deployed Mussel Residue (PHASE II) C
 Seep Water D

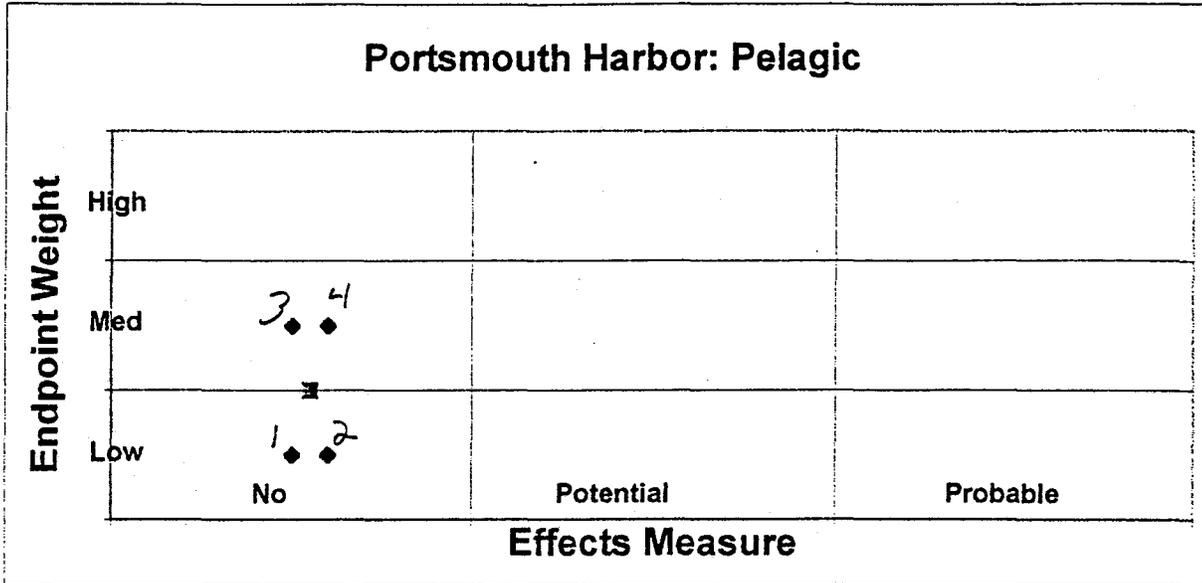
PH-pelagic_q

Portsmouth Harbor
Pelagic

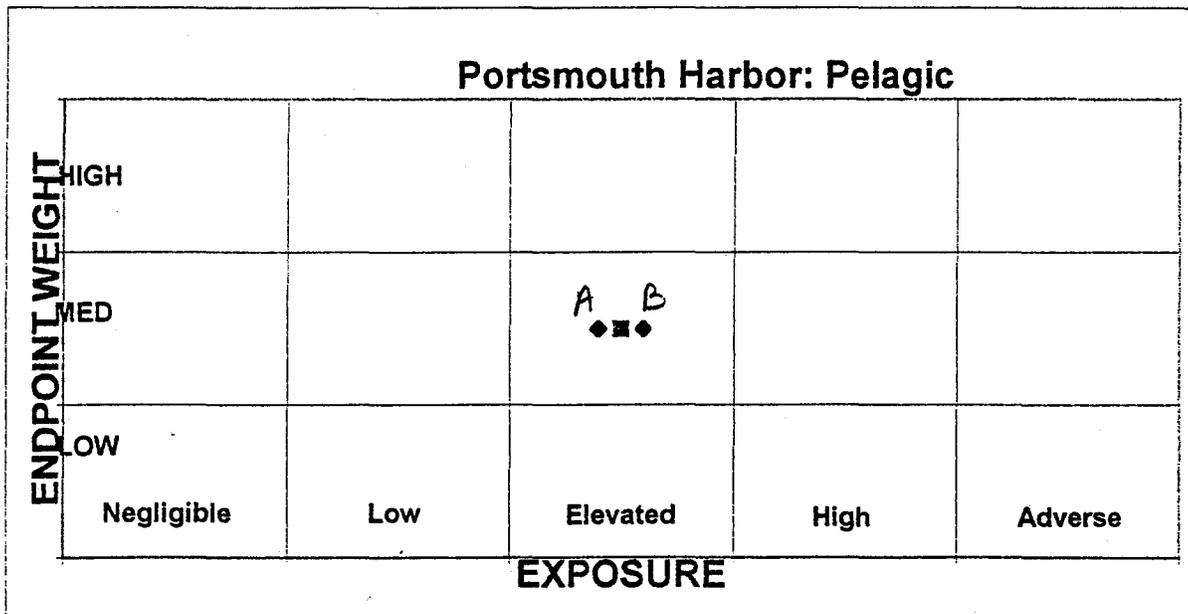
name	effect	Effect		name	exposure	Exposure	
		ew				ew	
Flounder Abundance	1	1	1	Flounder Liver R	2.9	2	2
Flounder Condition	1.1	1	1	Flounder Tissue F	3.1	2	2
Flounder Histopathology	1	2	2				
Flounder Spleen Histology	1.1	2	2				

Plotted values are offset by 0.5

AVERAGE	0.55	1.00	2.50	1.50
CENTROID	0.55	1.00	2.50	1.50



Flounder Abundance 1
 Flounder Condition 2 No/M
 Flounder Histopathology 3
 Flounder Spleen Histopathology 4



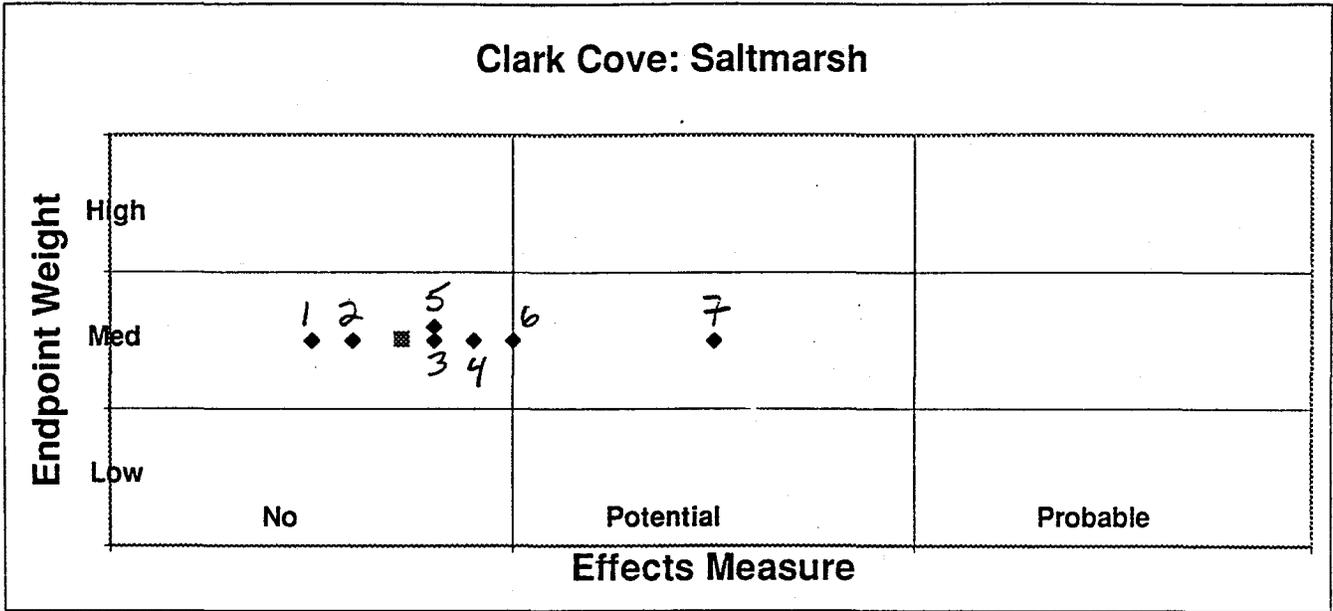
Flounder Liver Residue A
 Flounder Tissue Residue B Elevated/M

**Scatter Plots of Exposure and Effects measures for SALTMARSH
Receptors by Area of Concern**

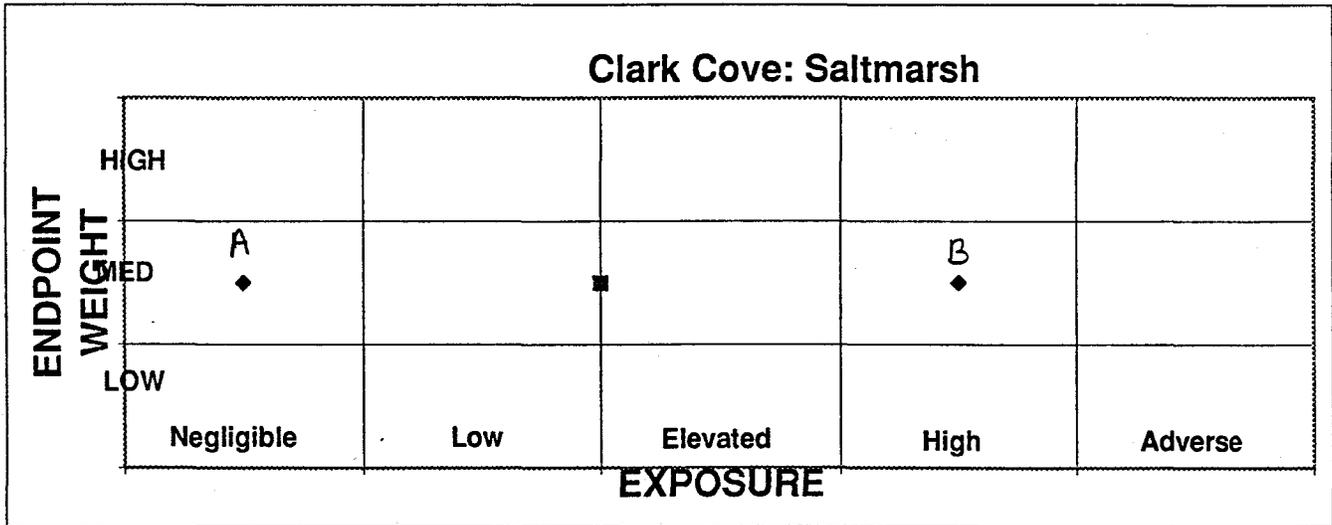
CC-saltmarsh_q

Clark Cove
Saltmarsh

name	effect	ew	Effect	Exposure	
				name exposure	ew
Spartina Cover <i>100%</i>	1	1	2	Spartina Residue	1 2
Spartina Morphometrics	1.1	1	2	Bulk Sediment	4 2
Amphipod Density	1.3	1	2		
Mollusc Abundance	1.4	1	2		
Number of Animal Taxa	1.3	1	2.1		
Vascular Plants	1.5	1	2		
Littorina Live:Dead	2	1	2		
Ploted Values are offset by 0.5 units					
AVERAGE	0.9	1	1.5	2.0	1.5
WEIGHTED CENTROID	0.7	1	1.5	2.0	1.5



- Spartina Cover 1
 - Spartina Morphometrics 2
 - Amphipod Density 3
 - Mollusc Abundance 4
 - Number of Animal Taxa 5
 - Vascular Plants 6
 - Littorina Live:Dead 7
- No/M*



- Spartina Residue A
 - Bulk Sediment B
 - C
 - D
 - E
 - F
- Elevated/M*

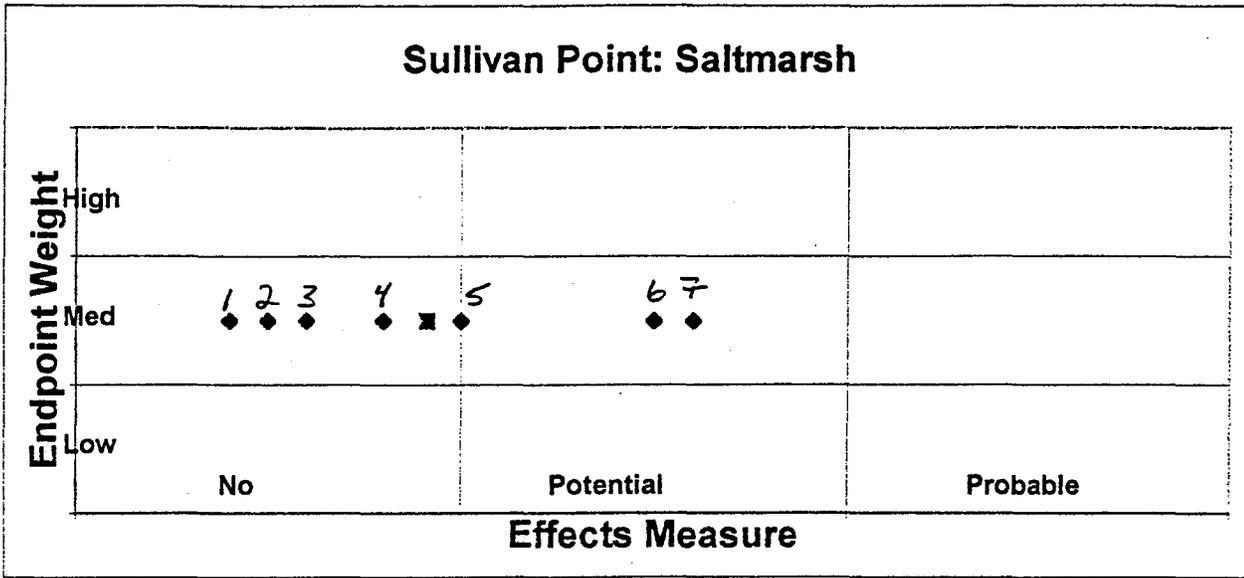
SP-saltmar_q

Sullivan Point
Saltmarsh

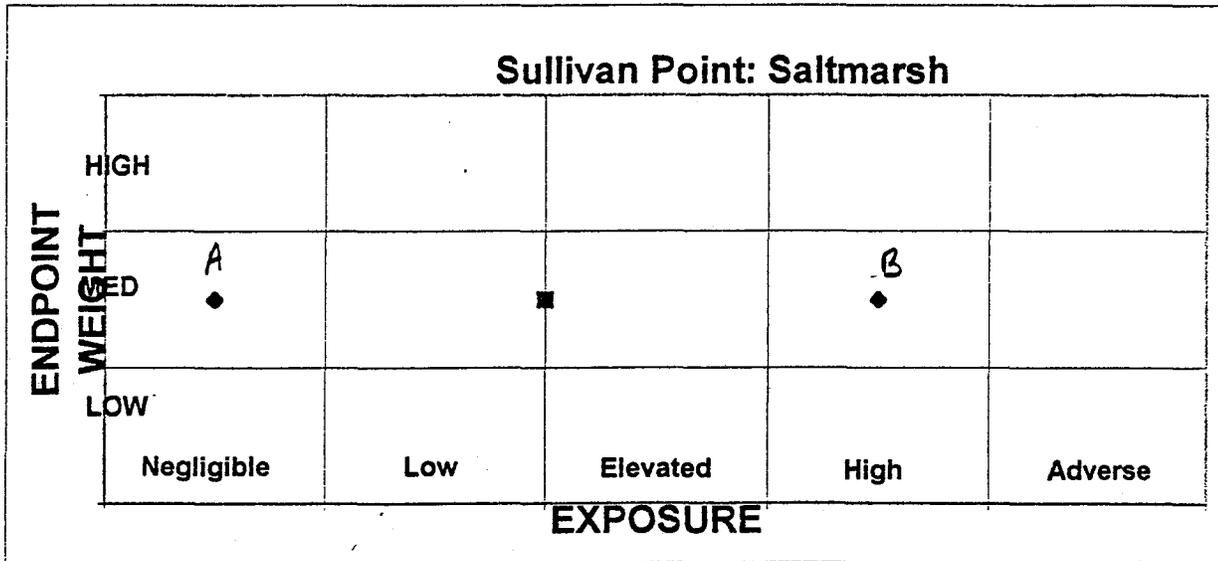
name	effect	Effect		name	exposure	Exposure	
		ew				ew	
Spartina Cover	0.9	2		Spartina Tissue Residue	1	2	
Littorina Live:Dead	1	2		Bulk Sediment	4	2	
Spartina Morphometeri	1.1	2					
Number of Animal Taxa	1.3	2					
Mollusc Abundance	1.5	2					
Amphipod Abundance	2	2					
Vascular Plant Cover	2.1	2					

Plotted values are offset by 0.5

AVERAGE	0.91	1.50	2.00	1.50
CENTROID	0.91	1.50	2.00	1.50



- Spartina Cover 1
 - Littorina Live:Dead 2
 - Spartina Morphometrics 3
 - Number of Animal Taxa 4
 - Mollusc Abundance 5
 - Amphipod Abundance 6
 - Vascular Plant Cover 7
- No/M



- Spartina Tissue Residue A
 - Bulk Sediment B
- Elevated/m*

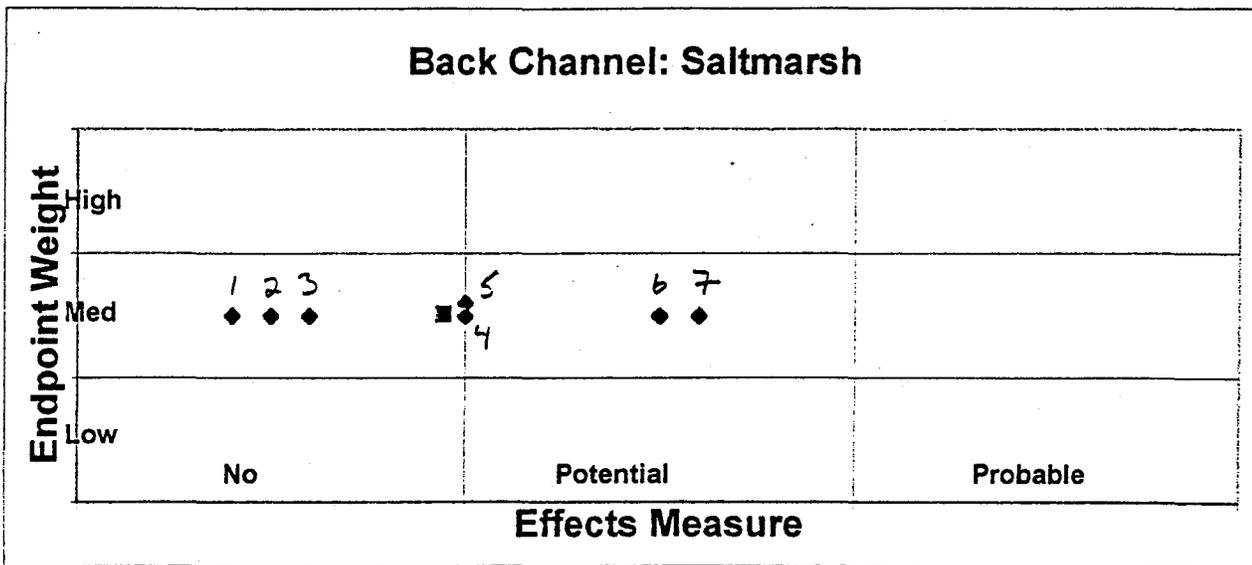
BC-saltmarsh_q

Back Channel
Saltmarsh

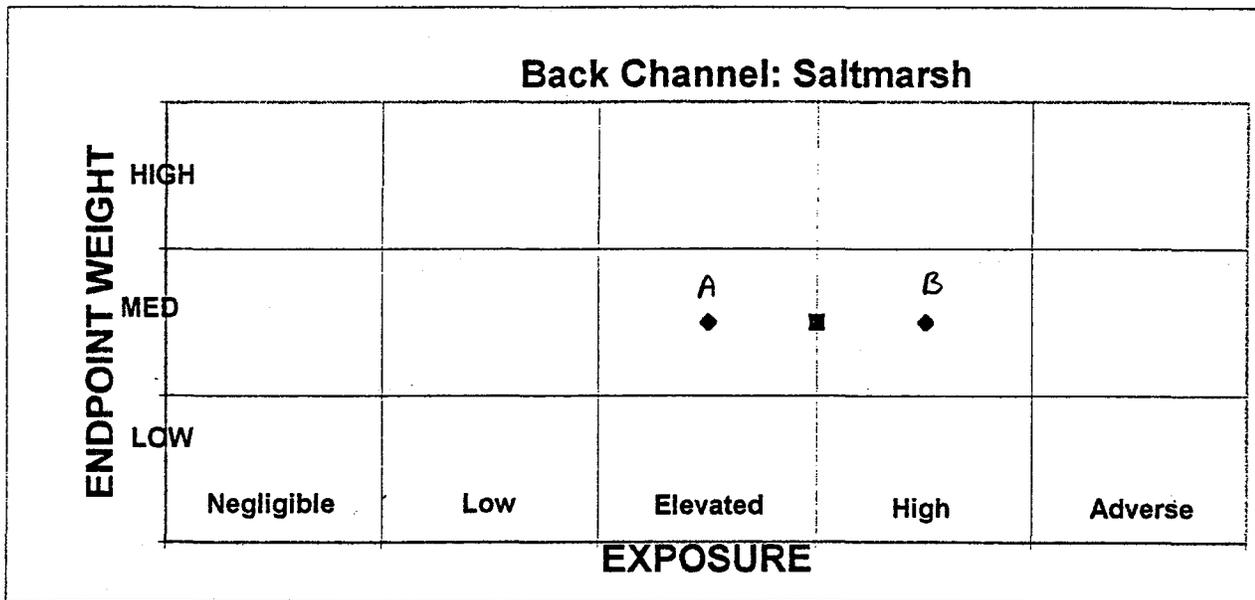
name	effect	Effect		name	exposure	Exposure	
		ew				ew	
Spartina Cover	0.9		2	Spartina Residues	3		2
Mollusc Abundance	1		2	Bulk Sediment	4		2
Spartina Morphology	1.1		2				
Littorina Live:Dead	1.5 ³		2				
Number of Animal Taxa	1.5 ³		2.1				
Amphipod Abundance	2		2				
Vascular Plant Cover	2.1		2				

Ploted Values are offset by 0.5 units

AVERAGE	0.9	1.51	3.0	1.5
WEIGHTED CENTROID	0.9	1.51	3.0	1.5



- Spartina Cover 1
 - Mollusc Abundance 2
 - Spartina Morphology 3
 - Littorina Live:Dead 4
 - Number of Animal Taxa 5
 - Amphipod Abundance 6
 - Vascular Plant Cover 7
- No/m*



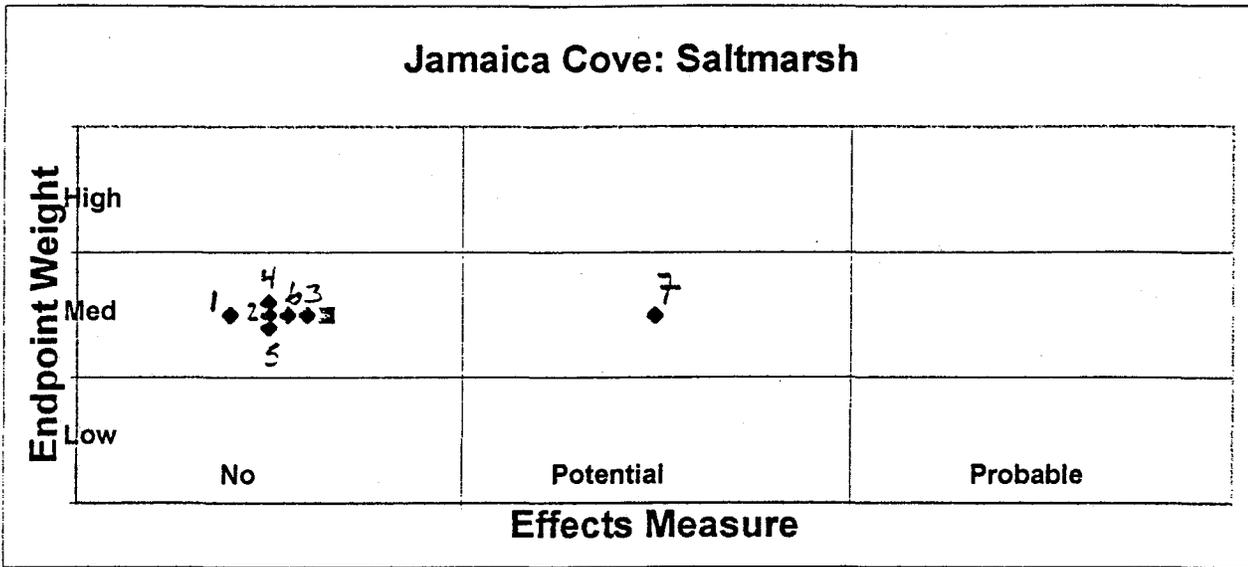
- Spartina Residues A
 - Bulk Sediment B
- High/m*

JC-saltmarsh_q

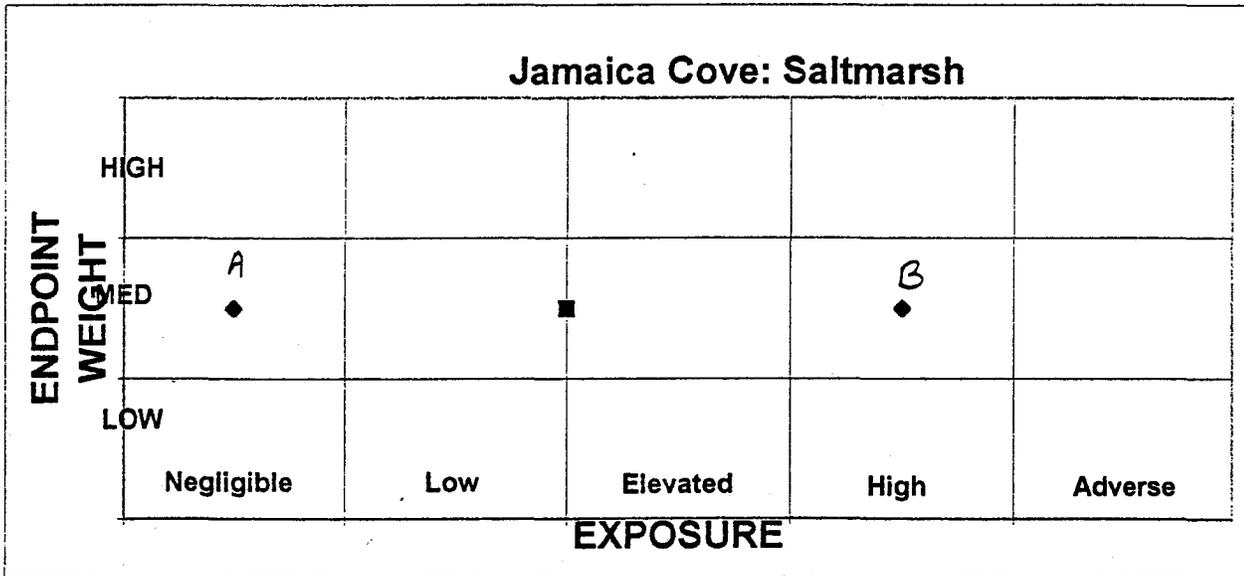
name	effect	Effect		name	exposure	Exposure	
		ew				ew	
Spartina Cover	0.9		2	Spartina Residu	1		2
Spartina Morphology	1		2	Bulk Sediment	4		2
Mollusc Abundance	1.1		2				
Number of Animal Taxa	1		2.1				
Vascular Plant Cover	1		1.9				
Littorina Live:Dead	1.05		2				
Amphipod Abundance	2		2				

Ploted Values are offset by 0.5 units

AVERAGE	0.65	1.50	2.0	1.5
WEIGHTED CENTROID	0.65	1.50	2.0	1.5



- Spartina Cover 1
- Spartina Morphology 2
- Mollusc Abundance 3 No/M
- Number of Animal Taxa 4
- Vascular Plant Cover 5
- Littorina Live:Dead 6
- Amphipod Abundance 7



- Spartina Residue A
- Bulk Sediment B Elevated/M

**Scatter Plots of Exposure and Effects measures for EELGRASS
Receptors by Area of Concern**

CC-eelgrass_q

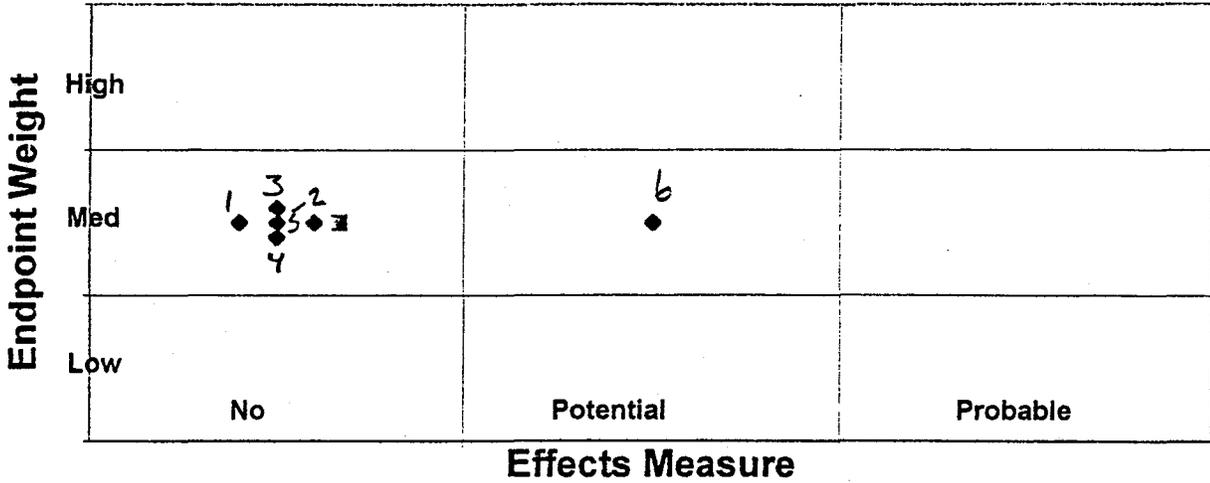
Clark Cove
Eelgrass

EFFECTS			EXPOSURE		
name	effect	ew	name	exposure	ew
Root Morphology	0.9	2	Bulk Chemsitry	1	1
Leaf Morphology	1.1	2	Leaf Tissue Residue	3	2
Shoot Density	1	2.1	Root Tissue Residue	3.1	2
Reproductive Shoot Density	1	1.9			
Leaf:Shoot Length Ratio	1	2			
Spatial Distribution	2	2			

Ploted Values are offset by 0.5 units

AVERAGE	0.7	1.5	1.9	1.207
WEIGHTED CENTROID	0.7	1.5	2.3	1.16667

Clark Cove: Eelgrass

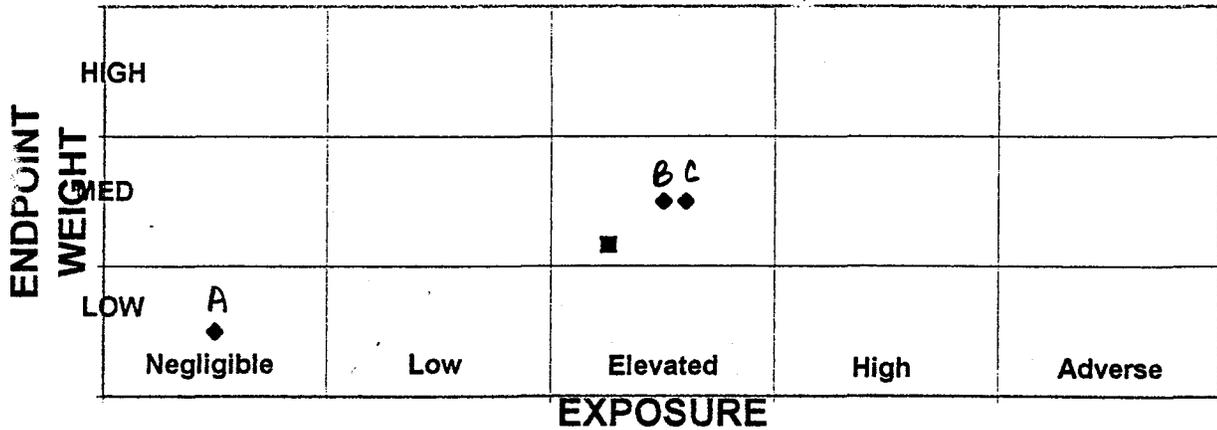


- Root Morphology 1
- Leaf Morphology 2
- Shoot Density 3
- Reproductive Shoot Density 4
- Leaf:Shoot Length 5
- Spatial Distribution 6

Potential/M

Eelgrass beds only present at station 3 in Clark Cove

Clark Cove: Eelgrass



- Bulk Chemistry A
- Leaf Tissue Residue B
- Root Tissue Residue C
- D
- E
- F

Elevated/M

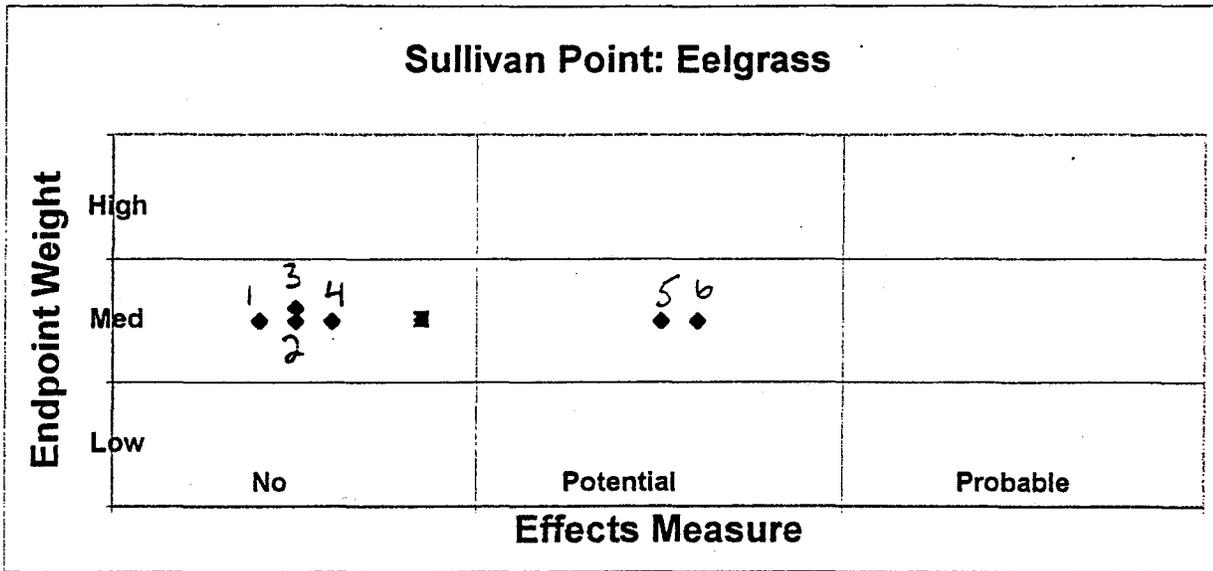
SP-eelgrass_q

Sullivan Point
Eelgrass

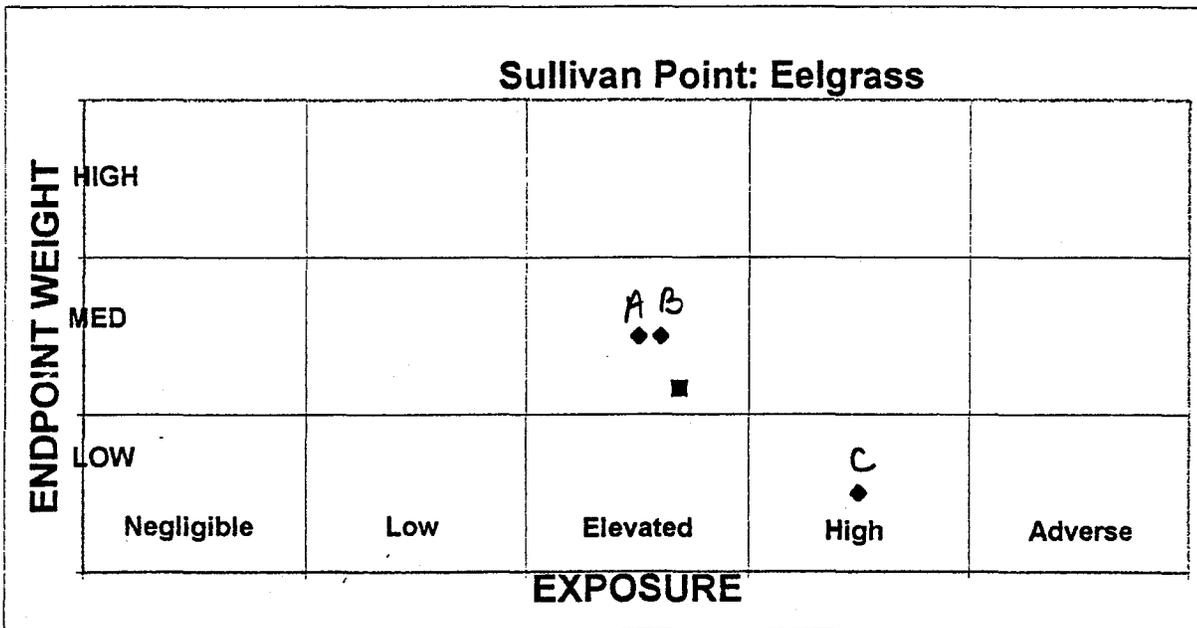
name	effect	Effect		name	exposure	Exposure	
		ew				ew	
Reproductive Shoot D	0.9		2	Eeelgrass Leaf Tiss	3		2
Leaf:Shoot Ratio	1		2	Eelgrass Root Tissu	3.1		2
Spatial Distribution	1	2.1		Bulk Chemsitry	4		1
Leaf Morphoplyg	1.1		2				
Root Morphology	2		2				
Shoot Density	2.1		2				

Ploted values are offset by 0.5

AVERAGE	0.85	1.52	2.87	1.17
CENTROID	0.85	1.52	2.69	1.17



Reproductive Shoot Density 1
 Leaf:Shoot Ratio 2 No/Med
 Spatial Distribution 3
 Leaf Morphology 4
 Root Morphology 5
 Shoot Density 6



Eelgrass Leaf Tissue Residue A
 Eelgrass Root Tissue B Elevated/M
 Bulk Chemistry C

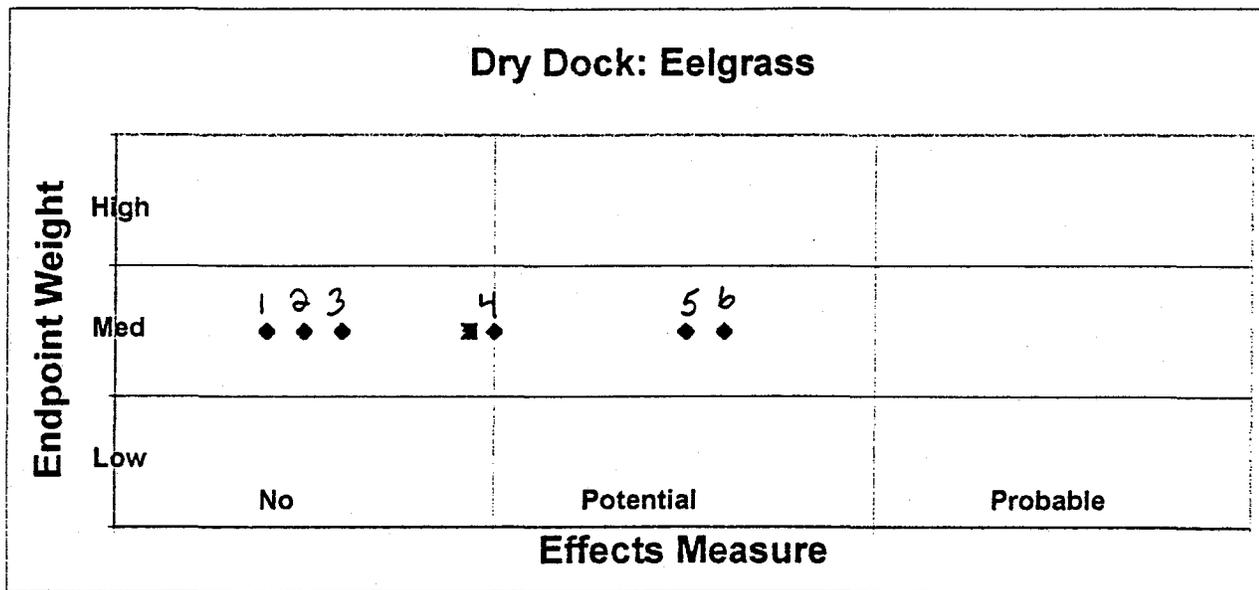
DD-eelgrass_q

Dry Dock
Eelgrass

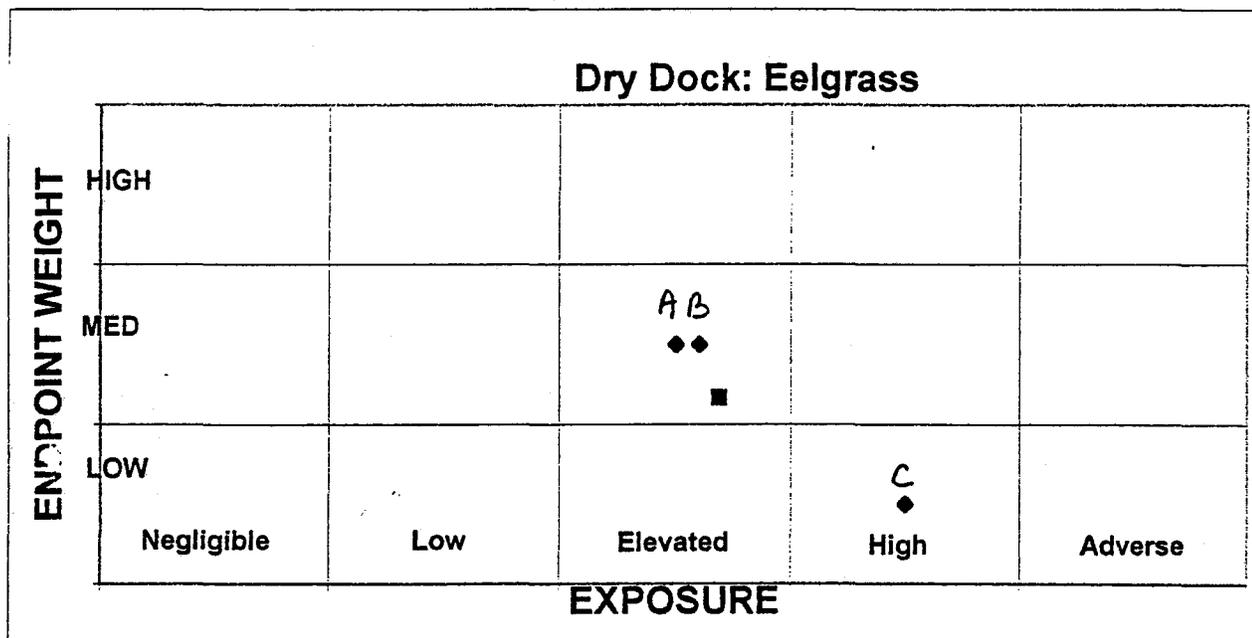
name	effect	Effect		name	exposure	Exposure	
		ew				ew	
Spatial Distribution	0.9	2		Eelgrass Leaf Tiss	3	2	
Leaf:Shoot Ratio	1	2		Eelgrass Root Tis:	3.1	2	
Root Morphology	1.1	2		Bulk Chemsitry	4	1	
Leaf Morphology	1.5	2					
Shoot Density	2	2					
Reproductive Shoot Density	2.1	2					

Ploted Values are offset by 0.5 units

AVERAGE	0.93	1.50	2.87	1.17
WEIGHTED CENTROID	0.93	1.50	2.69	1.17



Spatial Distribution 1
 Leaf: Shoot Ratio 2
 Root Morphology 3 No/M
 Leaf Morphology 4
 Shoot Density 5
 Reproductive Shoot Density 6



Eelgrass Leaf Tissue Residue A
 Eelgrass Root Tissue Residue B Elevated/M
 Bulk Chemsitry C

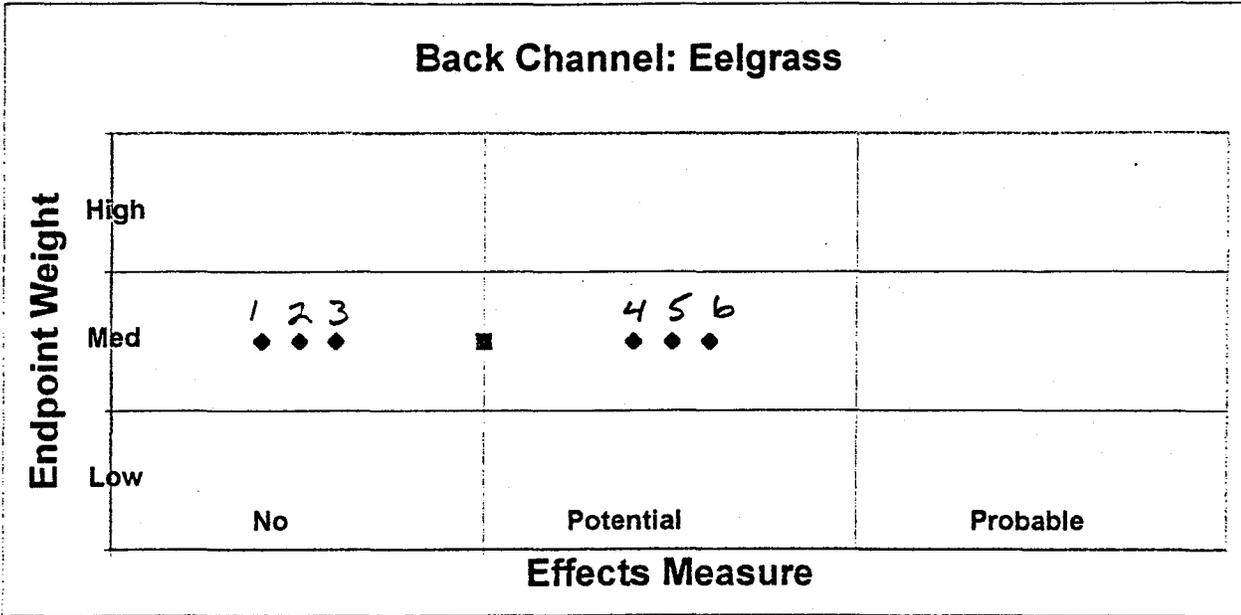
BC-eelgrass_q

Back Channel
Eelgrass

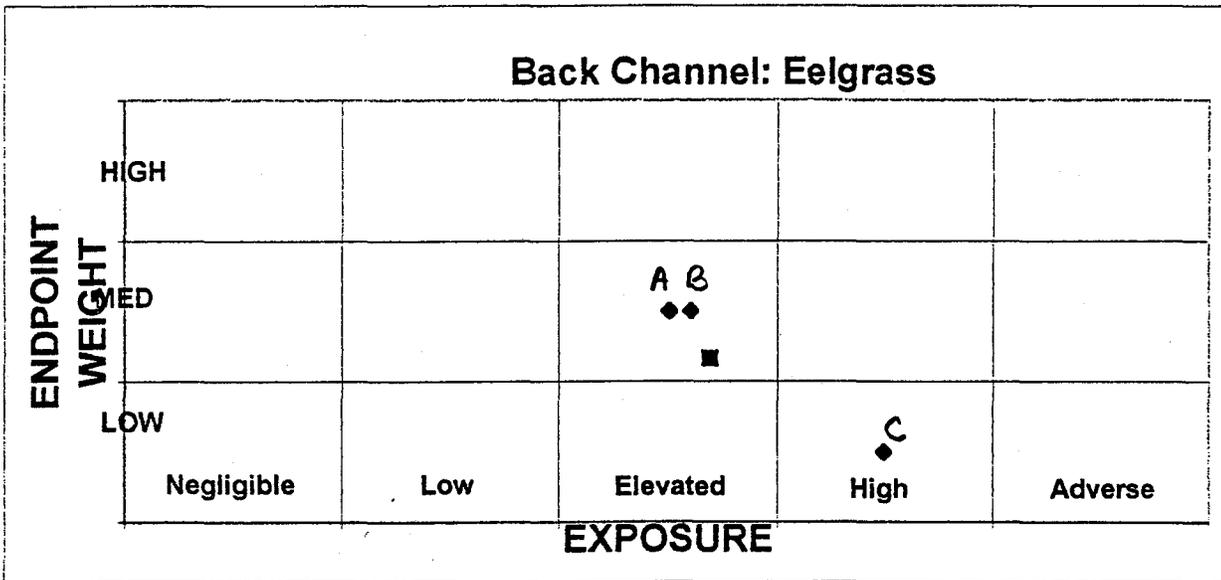
Effect			Exposure		
name	effect	ew	name	exposure	ew
Shoot Density	0.9	2	Leaf Tissu	3	2
Leaf:Shoot Ratio	1	2	Root Tissu	3.1	2
Leaf Morphology	1.1	2	Bulk Chem	4	1
Root Morphology	1.9	2			
Reproductive Shoot Densit	2	2			
Spatial Distribution	2.1	2			

Ploted Values are offset by 0.5 units

AVERAGE	1.0	1.5	2.9	1.2
WEIGHTED CENTROID	1.0	1.5	2.7	1.2



- Shoot Density 1
 - Leaf:Shoot Ratio 2
 - Leaf Morphology 3
 - Root Morphology 4
 - Reproductive Shoot Density 5
 - Spatial Distribution 6
- Potential/M



- Leaf Tissue Residue A
 - Root Tissue Residues B
 - Bulk Chemsitry C
- Elevated/M

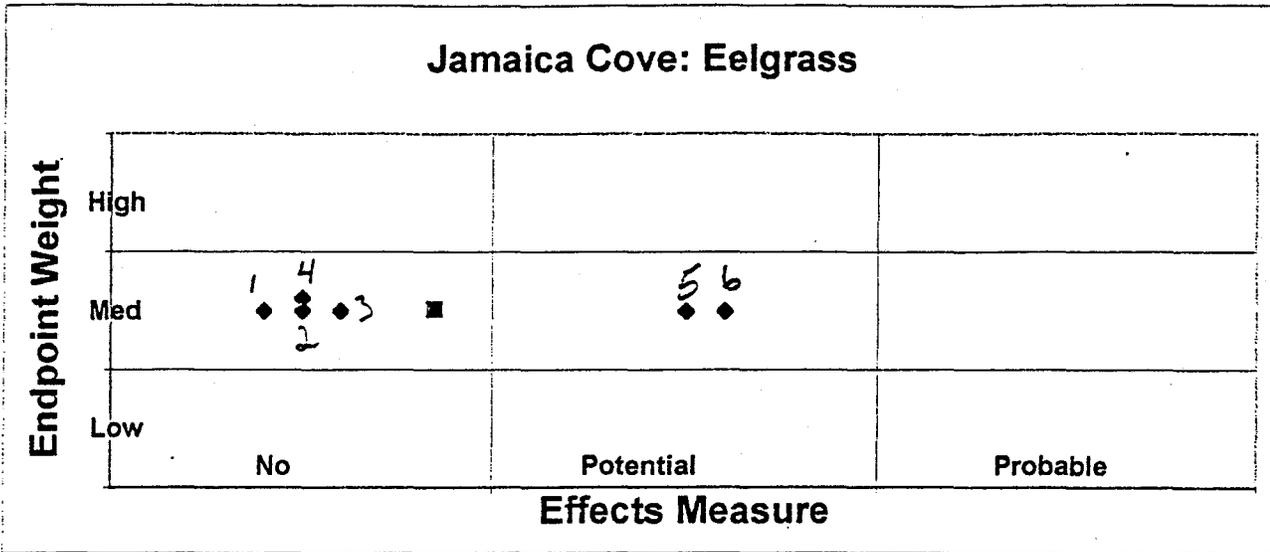
JC-eelgrass_q

Jamaica Cove
Eelgrass

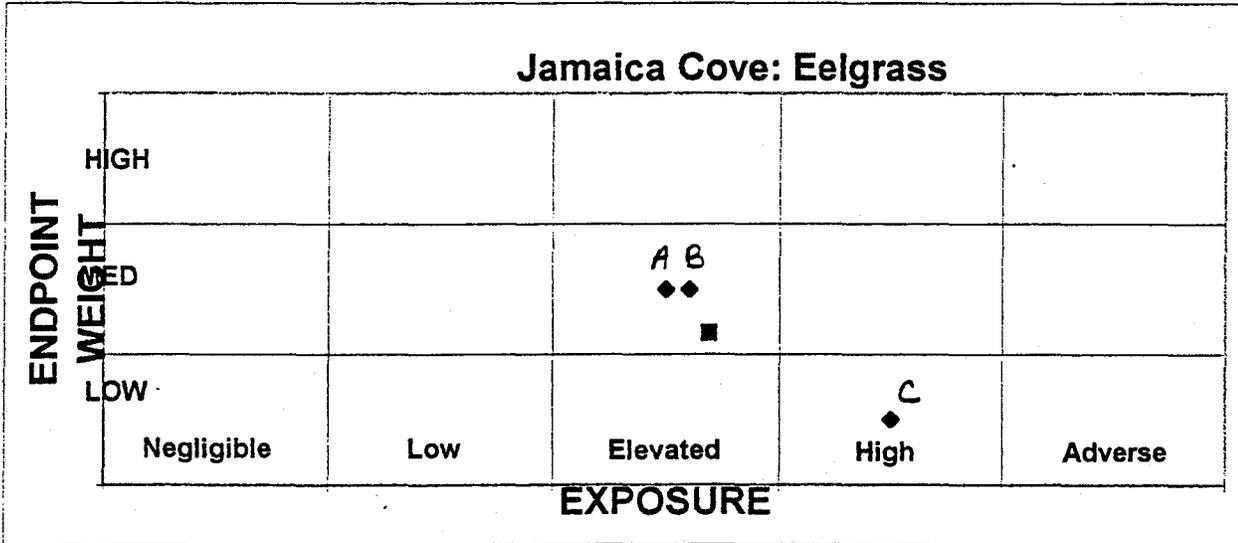
name	Effect		name	Exposure	
	effect	ew		exposure	ew
Reproductive Shoot Density	0.9	2	Eelgrass Leaf Tis:	3	2
Leaf:Shoot Ration	1	2	Eelgrass Root Tis	3.1	2
Shoot Density	1.1	2	Bulk Chemsitry	4	1
Leaf Morphology	1	2.1			
Root Morphology	2	2			
Spatial Distribution	2.1	2			

Ploted Values are offset by 0.5 units

				Centroid
AVERAGE	0.85	1.52	2.87	1.17
WEIGHTED CENTROID	0.85	1.52	2.69	1.17



Reproductive Shoot Density 1
 Leaf:Shoot Ration 2
 Shoot Density 3 No/L
 Leaf Morphology 4
 Root Morphology 5
 Spatial Distribution 6



Eelgrass Leaf Tissue Residue A
 Eelgrass Root Tissue Residues B Elevated/M
 Bulk Chemistry C

**Scatter Plots of Exposure and Effects measures for BENTHIC
Receptors by Area of Concern**

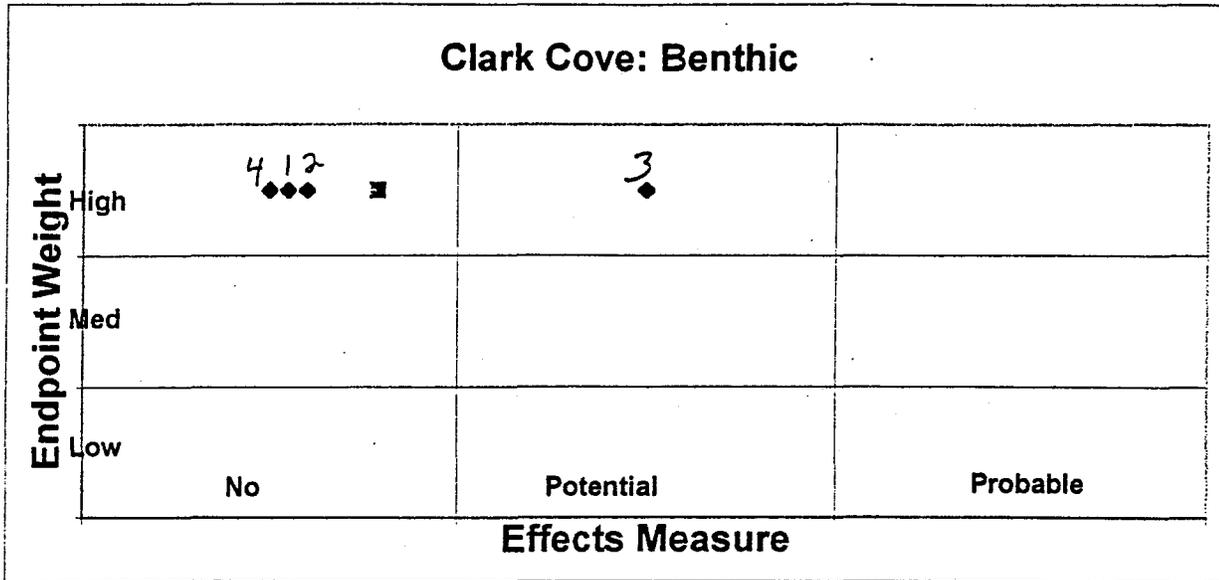
CC-benthic_q

Clark Cove
Benthic

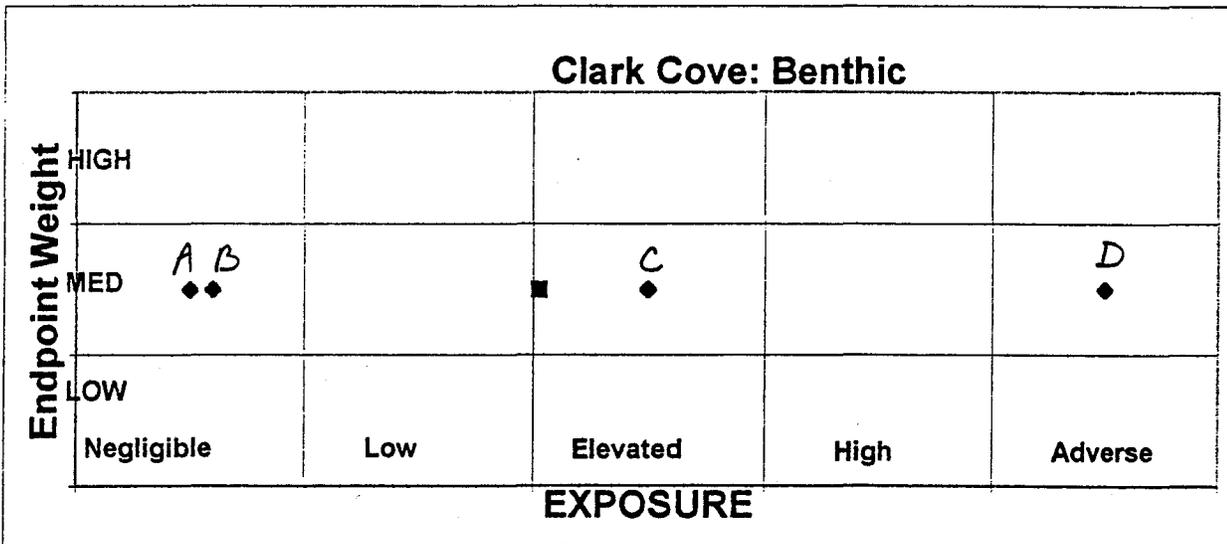
name	effect	Effect		name	exposure	ew
			ew			
Invertebrate Density		1	3	SEM-AVS	1	2
Species Richness		1.1	3	Pore Water	1.1	2
Species Evenness		2	3	Crustal Ratio	3	2
Amphipod Toxicity		1.05	3	Bulk Sediment	5	2

Ploted Values are offset by 0.5 units

AVERAGE	0.8	2.5	2.0	1.5
WEIGHTED CENTROID	0.8	2.5	2.0	1.5



Invertebrate Density 1
 Species Richness 2 *No / H*
 Species Evenness 3
 Amphipod Toxicity 4
 5
 6



SEM-AVS A
 Pore Water B *Elevated / M*
 Crustal Ratio C
 Bulk Sediment D
 E

SP-benthic_q

Sullivan Point
Benthic

Effect			Exposure		
name	effect	ew	name	exposure	ew
Species Evenness	0.9	3	Crustal Ratio	2.9	2
Invertebrate Density	1	3	Pore Water	5	2
Species Richness	1.1	3	Bulk Sediment	5.1	2
Amphipod Toxicity	3	3			

Ploted values are offset by 0.5

AVERAGE	1.00	2.5	3.83	1.50
CENTROID	1.00	2.5	3.83	1.50

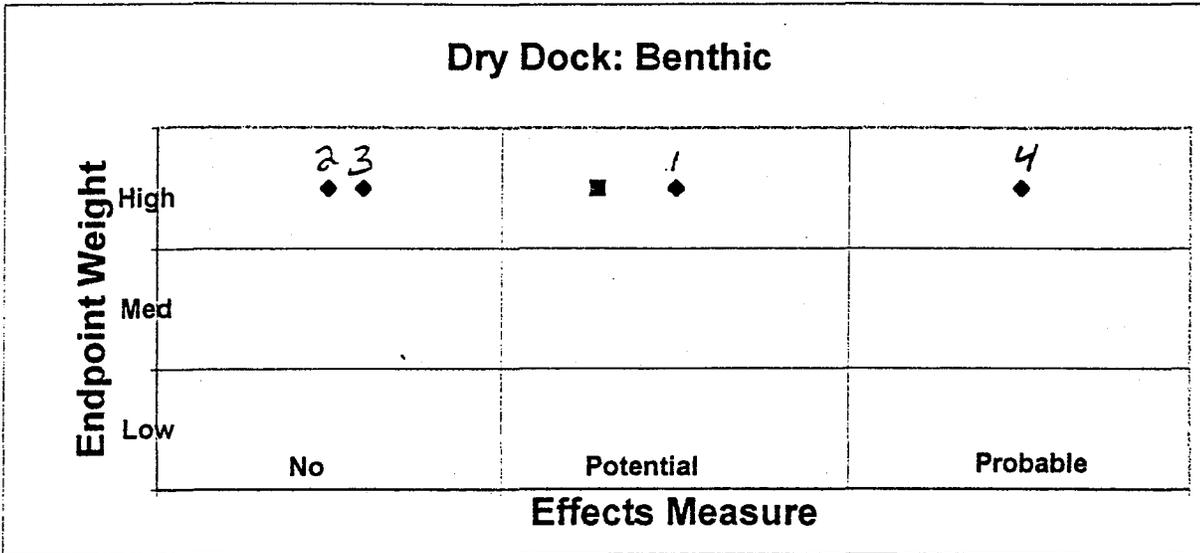
DD-benthic_q

Dry Dock
Benthic

name	effect	Effect		name	exposure	Exposure	
		ew				ew	
Invertebrate Density		2	3	SEM-AVS	1		2
Species Richness		1	3	Crustal Rai	3		2
Species Evenness		1.1	3	Bulk Sedim	5		2
Amphipod Toxicity		3	3	Pore Water	5.1		2

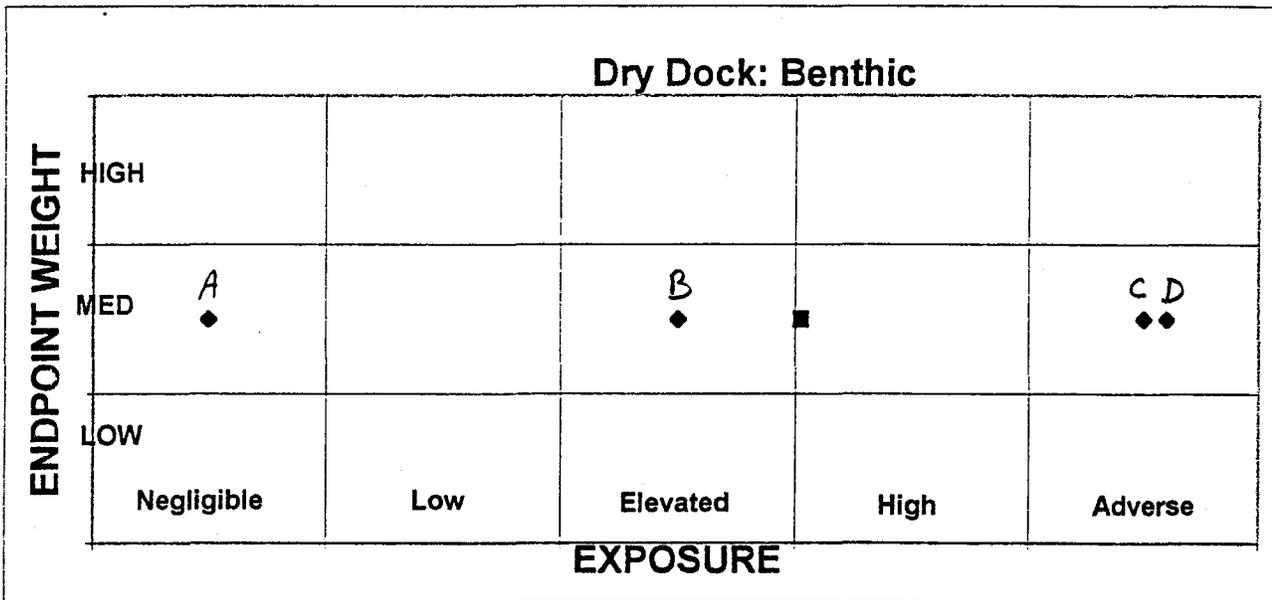
Plotted Values are offset by 0.5 units

AVERAGE	1.28	2.50	3.0	1.5
WEIGHTED CENTROID	1.28	2.50	3.0	1.5



Invertebrate Density 1
 Species Richness 2
 Species Evenness 3
 Amphipod Toxicity 4

Potential/H



SEM-AVS A
 Crustal Ration B
 Bulk Sediment C
 Pore Water D

High/M

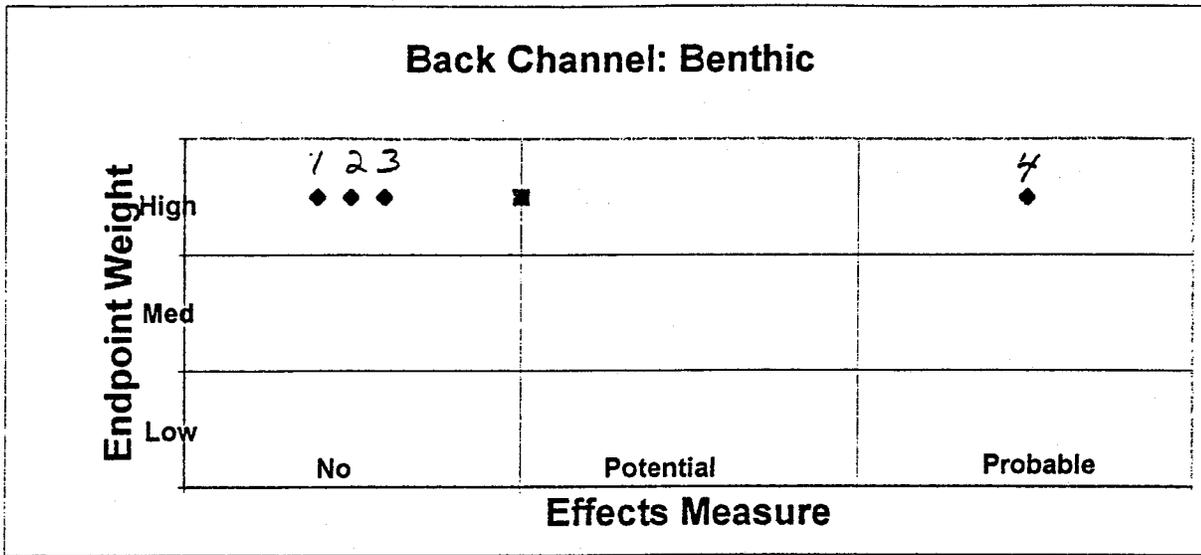
BC-benthic_q

Back Channel
Benthic

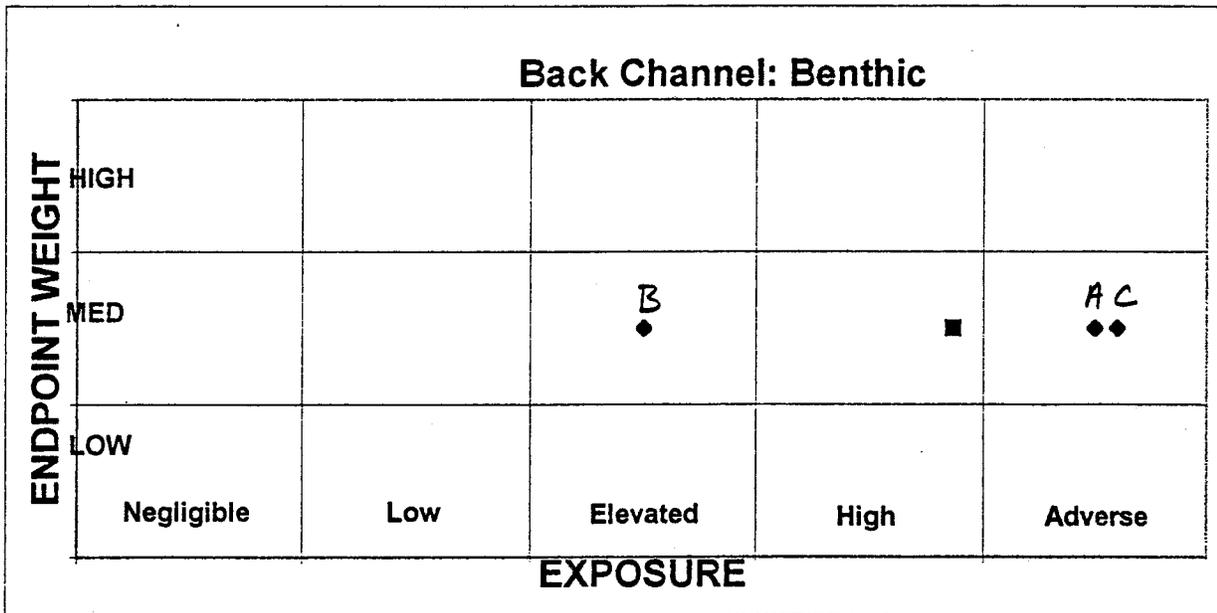
name	effect	Effect		name	Exposure	
		ew			exposure	ew
Invertebrate Abundance	0.9	3		Bulk Sedin	5	2
Species Richness	1	3		Crustal Rai	3	2
Species Evenness	1.1	3		Pore Water	5.1	2
Amphipod Toxicity	3	3				

Ploted Values are offset by 0.5 units

AVERAGE	1.0	2.5	3.9	1.5
WEIGHTED CENTROID	1.0	2.5	3.9	1.5



Invertebrate Abundance 1
 Species Richness 2 Potential/H
 Species Evenness 3
 Amphipod Toxicity 4



Bulk Sediment A
 Crustal Ration B High/M
 Pore Water C

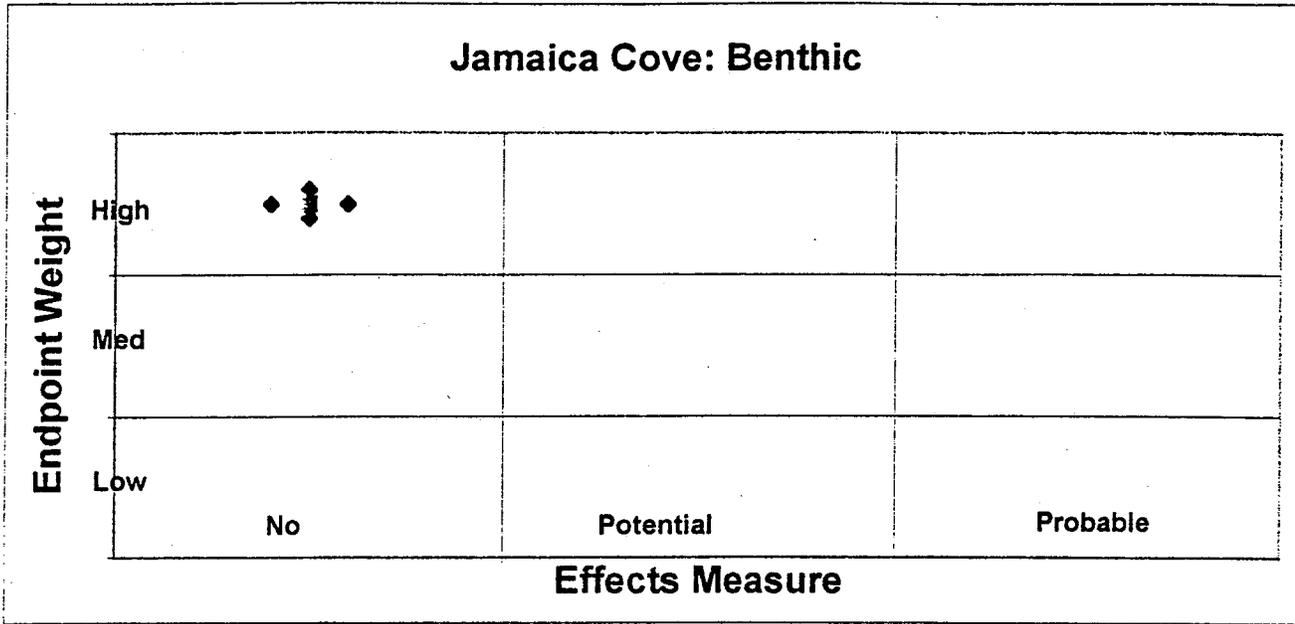
JC-benthic_q

Jamaica Cove
Benthic

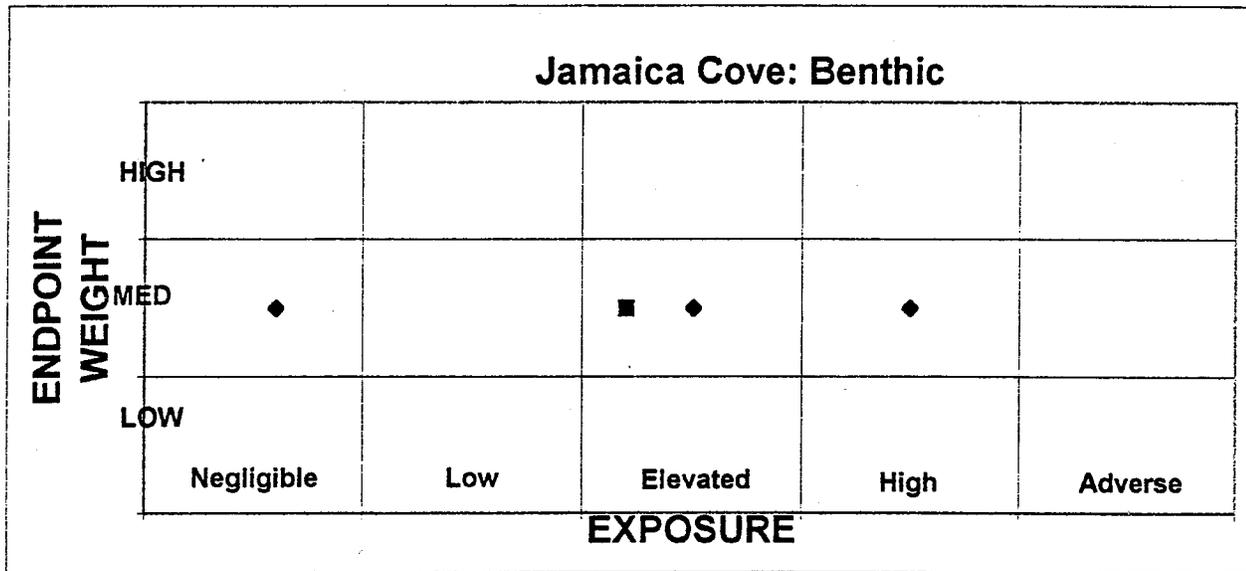
Effect			Exposure		
name	effect	ew	name	exposure	ew
Invertebrate Density	0.9	3	Pore Water Toxic	1.1	2
Species Richness	1.1	3	Crustal Ratio	3	2
Species Evenness	1	2.9	Bulk Sediment	4	2
Amphipod Toxicity	1	3.1			

Ploted Values are offset by 0.5 units

AVERAGE	0.5	2.50	2.2	1.5
WEIGHTED CENTROID	0.5	2.50	2.2	1.5



Invertebrate Density 1
 Species Richness 2 No/H
 Species Evenness 3
 Amphipod Toxicity 4



Pore Water Toxic Unit A
 Crustal Ratio B Elevated/M
 Bulk Sediment C

**Scatter Plots of Exposure and Effects measures for AVIAN Receptors
for the Portsmouth Harbor Focus Area**

PH-Avian

Portsmouth Harbor
Avian

name	effect	Effect	name	exposure	Exposure
		ew			ew
1	Not Assessed		Canada Goose	0.9	2
2			Black Duck	1.1	2
3			Osprey	1	2.1
4			Herring Gull	1	1.9

Ploted values are offset by 0.5

AVERAGE	0.5	1.5
CENTROID	0.5	1.5

Portsmouth Harbor: Avian					
Endpoint Weight	High				
	Med				
	Low	No	Potential	Probable	
Effects Measure					

Not Assessed 1

Portsmouth Harbor: Avian						
ENDPOINT WEIGHT	HIGH					
	MED	A	C	B		
	LOW		D			
		Negligible	Low	Elevated	High	Adverse
EXPOSURE						

- Canada Goose A
 - Black Duck B
 - Osprey C
 - Herring Gull D
- Negligible/M