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Via Electronic Filing
September 7, 2011

Anne-Marie Erickson
Secretary of the Board
National Energy Board
444 Seventh Avenue S.W.
Calgary, AB T2P 0X8

Dear Ms. Erickson:

Re: Arctic Offshore Drilling Review, NEB File: OF-EP-Gen-AODR 01
Letter of Comment, S.L. Ross Spill Response Gap Study for the Canadian Beaufort Sea and the Canadian Davis Straight

On behalf of WWF-Canada, please find attached our letter of comment regarding the consultant S.L. Ross's Spill Response Gap Study.

Yours sincerely,

Will Amos
Counsel, representing WWF-Canada

WWF Comments on the Response Gap Study Submitted to the National Energy Board

Executive Summary

Environmental conditions in the Arctic can sometimes make it impossible to respond to an offshore oil spill.[1] Until now, no one has attempted to quantify the percentage of time when no response is possible − the oil spill 'response gap' – for Canada's Arctic offshore. The report **Spill Response Gap Study for the Canadian Beaufort Sea and the Canadian Davis Strait** (Response Gap Study) commissioned by the National Energy Board (NEB) and produced by S.L. Ross Environmental Research Limited (S.L. Ross) is a valuable contribution and first step in this important analysis. WWF-Canada agrees with the study's conclusion that spill countermeasures[2] are often not possible due to environmental conditions that prevail during the proposed drilling season; however, additional analysis shows that the response gap is even more significant than S.L. Ross predicts when all ice conditions and limiting factors are taken into consideration.

WWF-Canada makes a number of recommendations in these comments to further refine the Response Gap Study. Our most significant concern is that the estimates provided by S.L. Ross present an incomplete picture of the response gap. S.L. Ross's estimates apply only to the relatively favourable periods of open water during summer and fall. Instead, WWF-Canada submits, the response gap should be estimated as the fraction of time that a spill response is not possible in the potential drilling season (i.e., summer and fall) irrespective of periods of open water, because an oil spill response may be required in either a period of open water or ice cover. No response is possible for the seven to eight months of winter.

When the response gap is re-calculated as the percentage of time when no response is possible due to environmental conditions, irrespective of periods of open water, it is substantially larger. Using the same data presented in the Response Gap Study, the table below compares WWF-Canada's response gap calculations (the percentage of time when no response is possible) to S.L. Ross's calculations (the percentage of open water periods when no response is possible). The table shows, for example, that the response gaps for June in the near and far offshore Beaufort Sea are 66% and 82% respectively, as compared to the 20% reported for both by S.L. Ross for open water periods only. A spill response in the Beaufort Sea would not be possible more than half the time from June through September. By October, no response would be possible more than four fifths of the time and no response is possible from November to May. These results should be factored in to the drilling operating season decision making process.

[1] WWF 2006; WWF 2007; WWF 2009; Pew, 2010, WWF 2011.

[2] Mechanical recovery, *in situ* burning, and aerial dispersant application.

WWF-Canada recommends that the Response Gap Study be revised to address this concern and incorporate the additional recommendations described in this letter.

Percentage of Time When No Response Is Possible[3]									
		Jan-May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beaufort Sea	Near Offshore	≤100	66	54	56	62	81	≤100	≤100
	Far Offshore	≤100	82	65	66	66	84	≤100	≤100
Davis Strait	Central	≤100	≤100	83	44	44	59	84	≤100
	West Central	≤100	≤100	≤100	45	48	59	84	≤100

Percentage of Open Water Periods When No Response Is Possible[4]									
		Jan-May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beaufort Sea	Near Offshore		20	23	40	56	65		
	Far Offshore		20	22	41	56	65		
Davis Strait	Central			27	37	44	59	83	
	West Central				35	44	58	84	

Note: The dark shaded cells represent months outside the potential drilling season, when no countermeasure is possible. These cells are left blank in the lower table because there are no open water periods in those months.

[3] WWF-Canada calculations from Appendix A, Column X. S.L. Ross's Tables 5, 6, 11, and 12 showed that there would essentially be 100% ice cover and no response possible from late December through May; therefore, this table reflects an essentially 100% response gap for that time. These percentages take into account industry's statement that containment and recovery would play no significant role in the response to a large spill.

[4] S.L. Ross, Tables 8, 10, 14, and 16. S.L. Ross's study only examined, in detail, the response gap during June – through November.

The Response Gap Includes Periods of Open Water ***and*** Ice Cover

An oil spill response gap is the percentage of time when specific oil spill countermeasures are not possible due to environmental operating limits. It is not only the period of time when response is impossible in open water conditions. This is an important distinction because Canada does not currently limit drilling operations to periods of open water.

S.L. Ross investigated the operating limits for *in situ* burning, containment and recovery, and aerial dispersant application. The percentage gaps they presented, as large as they are, represent only a fraction of the actual response gaps for these countermeasures, because the gap was calculated for the relatively favourable periods of open water in the summer and fall months, whereas an oil spill response could occur either in a period of open water or a period of ice cover during those months.

S.L. Ross divided the summer and fall months into periods of ice cover, defined as greater than 50% ice, and periods of open water, defined as less than 50% ice. During periods of ice cover, they concluded that none of the three countermeasures could be deployed:

> "During periods of ice cover waves are not present and none of the three countermeasure operations is possible in a conventional implementation."[5]

S.L. Ross explained that during periods of ice cover, booms employed to contain and recover or burn oil *in situ* become unworkable and aerially applied dispersants are either intercepted by ice or fail to mix adequately with oil due to the lack of wave energy.

S.L. Ross acknowledged that the feasibility of countermeasures (and consequently the response gap) could be calculated by multiplying the frequency of open water conditions by the favourable operating conditions. Yet, in their view, it would be misleading to do so:

> "From a strictly mathematical perspective, one could combine, for example, the 65% open water frequency for August (Table 6) with the percent favourable[6] due to other environmental factors, however this would be misleading. In fact, the 65% frequency of

[5] S.L. Ross, p 17. Although none of these three countermeasures is possible during periods of ice cover, S.L. Ross suggested that modified tactics might be tried. The potential value of alternative measures conducted under conditions that prevent the deployment of the three primary countermeasures as they are normally practiced is uncertain. Any such alternative measures would also be subject to operating limits, which cannot be evaluated in the absence of specific proposals.

[6] The operating limits for each of the three countermeasures were categorized as favourable, marginal or not possible – see Tables 2-4, page 12, 13.

> open water is composed of, roughly, 65% of the years with close to 100% open water, and 35% with little open water."[7]

Instead, S.L. Ross chose to estimate the response gap solely for periods of open water.

In contrast, WWF-Canada believes that focusing on the response gap during periods of open water, while ignoring the percentage of time when a response is not possible during the less favourable periods of ice cover, would be misleading.[8] Instead, we calculate the percentage feasibility of response measures by multiplying the frequency of open water conditions by the frequency of favourable operating conditions. The actual response gap for any future month will depend on the environmental conditions that prevail at the time, which could be more or less favourable than the average conditions that prevailed during the period of record used to derive the response gap estimates.

S.L. Ross suggest that years with little open water,

> … would not represent a gap, rather it would necessitate a change in tactics, the use of burning in dense ice, or a combination of containment and recover, burning, and/or dispersant use in moderate to light ice conditions.[9]

Approaches beyond the conventional implementation of the three primary countermeasures addressed in the S.L. Ross study might be possible during ice-covered conditions, and an assessment of their availability, environmental response operating limits and efficiencies would require additional analysis beyond the S.L. Ross study. Yet, as S.L. Ross acknowledges, none of the three primary countermeasures is possible in a conventional implementation during ice cover. The response gap for these specific response options would clearly be worse during years with little open water.

[7] S.L. Ross, p 20.

[8] A strict analogy might illustrate this point: An electrical systems engineer assessing potential gaps in electricity production from wind turbines would not make her calculations based solely on periods when conditions are favourable for wind generation. She would need to know the fraction of time when wind generation wouldn't be possible on both windy and calm days.

[9] S.L. Ross, p 20.

Additional Limitations on the Use of Countermeasures

Containment and Recovery

Industry has acknowledged that oil skimming encounter and recovery rate limitations and logistical constraints in the remote Arctic will largely confine the use of containment and recovery to small (Tier 1) (< 100 bbl) spills.[10] Accordingly, WWF-Canada calculated the response gaps with and without containment and recovery as a response option to assess the effect that the availability of this countermeasure would have on the response gap for the combined countermeasures. The results of this analysis are presented in Appendix A and an example is provided in the graphs below. The graphs show that if mechanical containment and recovery is limited to small Tier 1 spills, then the response gap is actually larger than S.L. Ross predicts.

Dispersants

The advisability of applying dispersants in response to oil spills in the Arctic is controversial. Much remains to be learned about dispersant toxicity, potential for bioaccumulation, community impacts, effectiveness and operating limitations. The United States Geological Survey (USGS) recently examined scientific gaps in dispersant application understanding. The USGS recommended against dispersant use until further scientific work is completed:

> 5.15 Recommendation: Our examination suggests that substantial scientific and technical work as outlined by various expert groups still must be done before dispersants can be considered a practical response tool for the Arctic.[11]

Therefore WWF-Canada calculated the response gap with and without dispersants as a response option, in order to see whether a precautionary prohibition of dispersant use would have a material effect on the response gap. The results of this analysis are presented in Appendix A and an example is provided in the graphs below. The graphs show that if dispersant use is prohibited or limited, then the response gap is actually larger than S.L. Ross predicts.

In Situ Burning Employing Chemical Herders

Chemical herding agents may facilitate *in situ* burning in seawater containing ice under calm conditions, by thickening the oil to a burnable level. S.L. Ross's study assumes that the window for *in situ* burning can be extended from 10% to 30% ice cover if chemical herders are used

[10] "Mechanical recovery equipment would mainly be used for Tier 1 minor spills (i.e., spills of about 50 bbl to 100 bbl) in and around the drilling location", ConocoPhillips, 2011, p 7-6; see also, Chevron, 2011, p 30; "based on their limited encounter rate and recovery rate, skimmers are best suited to working among relatively small ice pieces and for spills that cover a small area." Imperial Oil, 2011, p 5-7.

[11] USGS, 2011. p 139.

instead of booms to thicken the oil (Table 2); however, chemical herders are not currently approved for use during an actual Arctic oil spill.

Chemical herding agents are currently in the experimental stage, and warrant substantial additional scientific study prior to Government of Canada approval for use as a countermeasure. At the 2011 International Oil Spill Conference, S.L. Ross scientist Ian Buist provided the most recent results from arctic chemical herding experiments, and confirmed that while promising, chemical herders have not received US or Canadian approval for actual use during an arctic oil spill.[12]

Additionally, the USGS[13] recommends

> "Large-scale field trials to investigate the influence of wind and sea conditions on this potential spill mitigation countermeasure," with a key objective "…to determine how long a herded slick can maintain its thickness with regular re-application of the surfactant under a realistic scale".

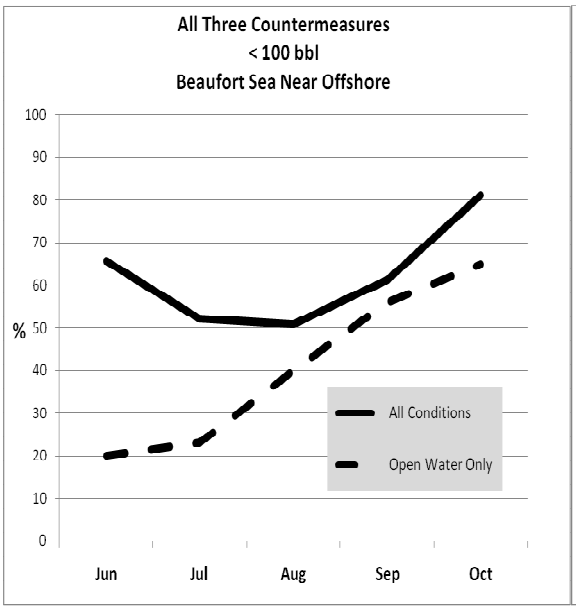
We followed S.L. Ross in including herders in our Appendix A analysis, but we believe this is an assumption that should be tested. If chemical herders are not approved for use during an Arctic spill, the response gap is actually larger than S.L. Ross predicts.

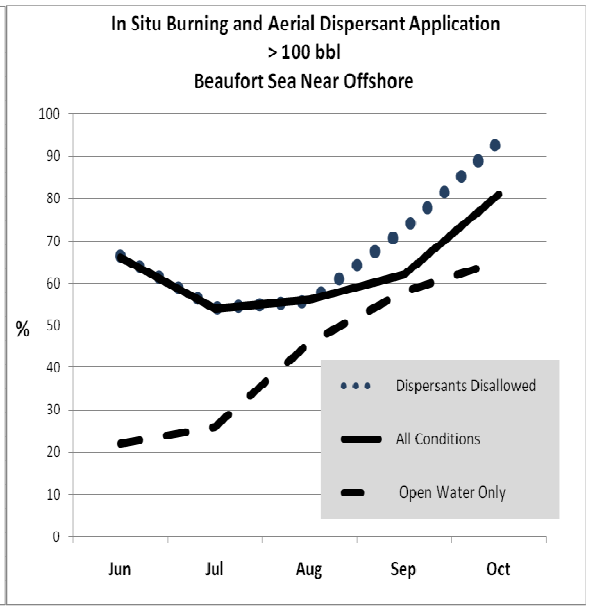
Results

WWF-Canada's re-calculation of the response gaps is presented in Appendix A, in the form of spreadsheets and graphs depicting the percentages of time when no response is possible for the three countermeasures in the S.L. Ross report, both individually and in combination. Here we present a table comparing the monthly response gap percentages and graphs for the near offshore Beaufort Sea to illustrate the results. Interested parties are referred to Appendix A for details on this and the other Arctic sites.

[12] Buist, 2011. In response to audience questions at the 2011 International Oil Spill Conference, Ian Buist (S.L. Ross) confirmed that chemical herders have not been approved by the US or Canadian governments.

[13] USGS, 2011, p 140.





Percentage of Time When No Response Is Possible[14]									
		Jan-May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beaufort Sea	Near Offshore	≤100	66	54	56	62	81	≤100	≤100
	Far Offshore	≤100	82	65	66	66	84	≤100	≤100
Davis Strait	Central	≤100	≤100	83	44	44	59	84	≤100
	West Central	≤100	≤100	≤100	45	48	59	84	≤100

Percentage of Open Water Periods When No Response Is Possible[15]									
		Jan-May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beaufort Sea	Near Offshore		20	23	40	56	65		
	Far Offshore		20	22	41	56	65		
Davis Strait	Central			27	37	44	59	83	
	West Central				35	44	58	84	

Note: The dark shaded cells represent months outside the potential drilling season, when no countermeasure is possible. These cells are left blank in the lower table because there are no open water periods in those months.

[14] WWF-Canada calculations, Appendix A, Column X. S.L. Ross's Tables 5, 6, 11, and 12 showed that there would essentially be 100% ice cover and no response possible from late December through May; therefore, this table reflects an essentially 100% response gap that time. These percentages take into account industry's statement that containment and recovery would play no significant role in the response to a large spill.

[15] S.L. Ross, Tables 8, 10, 14, and 16. S.L. Ross's study only examined, in detail, the response gap during June – through November.

We draw your attention in particular to the following results:

1. Not surprisingly, the monthly response gaps (solid lines on the accompanying graphs) are greater than the response gaps for open water periods alone (dashed lines). The differences are in some instances quite large. For example, the response gap for June in the near and far offshore Beaufort Sea are 66% and 82% respectively, as compared to the 20% reported for both by S.L. Ross for open water periods only.

2. The differences between the monthly response gap estimates and those for periods of open water only are generally more pronounced in the Beaufort Sea, reflecting the comparatively lower percentages of open water conditions there. They are less pronounced in the Davis Strait, where open water conditions prevail much of the summer.

3. Arctic environmental conditions severely limit the percentage of time when an oil spill response is possible. Monthly response gaps during June through November range from 44% to 84%, and approach 100% during December through May.

4. The response gap for spills less than 100 bbl, where containment and recovery could be used (Appendix A, Column W), is almost the same as the response gap for large spills, where Industry reports this countermeasure is not typically feasible (Column X). The response gap in the near offshore Beaufort depicted above (comparing the solid black lines for the two graphs), for example, differs only marginally and only in August. This problem indicates the need for improved mechanical response tools and techniques for the Arctic to improve containment and recovery capability for large oil spills.

5. Aerial dispersant applications for large spills could provide some limited benefit after August for both the Beaufort Sea and Davis Strait (compare Appendix A, columns H and Y or, for example, the solid black curves with the dotted blue curve in the graphs above), reducing the late season response gaps. Unfortunately, the estimated response gaps in the autumn are very large, exceeding 80%, even when dispersants are included amongst the permissible countermeasures.

6. S.L. Ross' study did not include wind chill in the response gap analysis.[16] S.L. Ross assumes that all Tier III response would be conducted using large vessels with crane deployment of equipment by operators in climate-controlled cabs; however, this would not be true of all countermeasures (e.g. ISB and dispersant application), nor would this be true of smaller vessels and tactics used for containment and recovery in the near offshore environment. If wind chill limitations are included, the response gap is actually larger than S.L. Ross predicts.

[16] S.L. Ross, p. 5

7. Response gap estimates for near offshore Beaufort Sea *in situ* burning and containment and recovery are the same (Table 7), however, response operating limits established in Table 2 and 3, indicate that *in situ* burning should be possible more often than containment and recovery, if *in situ* burning is possible up to 3/10th ice cover whereas containment and recovery is limited to 1/10th ice cover.

8. The main difference between the dispersant response operating limits (Table 4) and *in situ* burning and mechanical containment and recovery (Tables 2 and 3) is S.L. Ross's assumption that dispersant application is favorable up to 5/10th ice cover, considerably expanding its period. All the other variables give a slight advantage to dispersants, as long as some wave action is present for mixing.

   Using Tables 2-4, S.L. Ross computes the time that each counter measure is possible (e.g. Table 7) and then the time at least one countermeasure is possible (e.g. Table 8).

   Table 7 shows that *in situ* burning and containment and recovery are favorable 70% of the time in June, whereas, dispersants are only favorable 60% of the time, which is inconsistent with the advantage shown in Table 4. Then Table 8 shows that at least one countermeasure is favorable in June 80% of the time, yet none of the countermeasures are more than 60-70% favorable.[17] Similar issues are found in Tables 8, 10, 14, and 16 for the months of June - August. Additional explanation is warranted to explain the results in these tables.

Discussion

The scope of this exercise was limited to re-calculating response gaps to account for the presence of both open water and ice-cover conditions during the proposed drilling season (June-November) based on the July 12, 2011 S.L. Ross Response Gap Report. Any critical evaluation of S.L. Ross' methodology, including their account of operating limits for the three countermeasure options, would apply equally to these results.

There are a number of limitations to the gap response methodology that are worth mentioning, not because they diminish the value of the approach, but because they dictate what can and cannot be learned from this kind of study:

[17] An 80% estimate could be possible if the response operating limit range varied widely for all three countermeasures, but in this case, S.L. Ross predicts that the dispersant operating range encompasses the same range as ISB and mechanical response and slightly beyond.

1. The response gap estimates are specific to the countermeasures assessed in the study only. If, as S.L. Ross suggests, there are other tactics that could be deployed when these measures cannot be used, new conclusions could arise from a study of such alternatives.

2. Environmental conditions suitable for the deployment of countermeasures are just one link in a chain of requirements that ultimately determines the effectiveness of an oil spill response. An important factor that cannot be overlooked in the wake of the Deepwater Horizon incident is that some fraction of crude oil released from a subsea blowout or leak can remain suspended in the water column or settle, where it is inaccessible to all three of the studied countermeasures. Among other determining variables are logistic requirements, which affect the feasibility, speed and potential scale of deployment, and finally the effectiveness of the countermeasures when deployed under a range of conditions. Since response operating conditions deemed marginal are not included in the response gap, an effective response is not guaranteed even when it can be tried.

3. Caution is warranted when combining the range of conditions under which one or more countermeasures is possible. For example, a hypothetical alternative countermeasure that could often be deployed during periods of ice-cover could reduce the apparent response gap, but do little to improve the effectiveness of an oil spill response if it was relatively ineffective.

4. A response gap study does not provide the information needed to assess whether a delayed response is feasible. Specifically, it provides no information on the likelihood that conditions that initially prevent response operations will be followed by conditions that permit them soon enough in relation to the changing condition of the oil and for long enough to address the response need. When a response must be deferred through the winter season and resumed in the spring or summer, limitations on tracking, finding the oil months later, and attempting to recover weathered oil pose serious additional challenges.

<u>Areas for Additional Work:</u>

The report prepared for the NEB was designed to assess primary oil spill countermeasure operating limitations and focused on response options relevant to a significant offshore spill.

An immediate area for additional work would be an investigation of the feasibility of responding to oil spills during ice cover during the proposed drilling season with the alternative tactics mentioned in the S.L. Ross report. Such a study should be designed to assess the response gap

for the alternatives in the context of logistic constraints on the feasibility of deploying them and the relative efficiency of such measures in relation to the primary countermeasures.[18]

A further refinement would be a study focused on the response gap for nearshore spills.

Conclusion

The response gap report by S.L. Ross is an important effort to quantify one of the more important factors that will determine oil spill response performance in Canada's offshore Arctic: the oil spill response gap. Their analysis shows that spill response would not be possible much of the time for open water periods during June through September, worsening in October and November and becoming essentially impossible December through May. When their analysis is extended to include ice-covered periods during the proposed drilling season, the response gap for these three primary countermeasures is substantially larger. Additional limitations noted in our comments above would increase the size of the response gap.

Environmental conditions in the Beaufort Sea and Davis Strait severely limit the percentage of time when an oil spill response would be possible. This is a sobering result that must be factored into any assessment of the potential consequences of a blowout or spill at these locations. The very large gaps in October and November should be factored in to the drilling operating season decision making process.

Acknowledgements

We would like to acknowledge helpful reviews by Layla Hughes (WWF-US), Rod Downey (WWF-UK) and Susan Harvey, Harvey Consulting, LLC.

[18] *In situ* burning in ice conditions, for example, requires thicker slicks to enable ignition and is less efficient than burning in open water. S.L. Ross, 2003.

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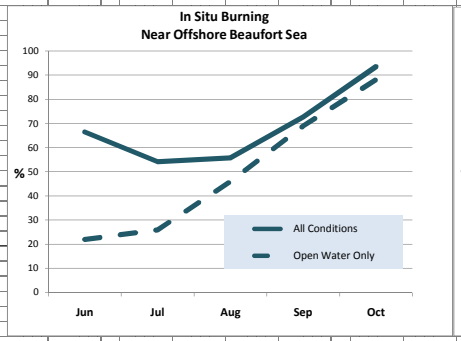
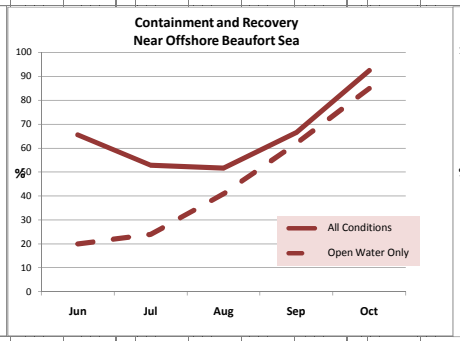
APPENDIX A

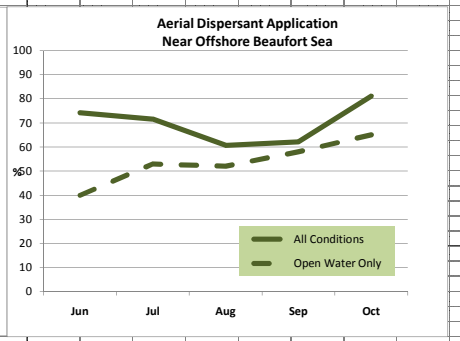
Near Offshore Beaufort

			Individual Countermeasures														Combined Countermeasures									
	Month	% of time with open water	In Situ Burning				Containment and Recovery				Aerial Dispersant Application				At Least One Countermeasure Option Favourable During Periods of Open Water	At Least One Countermeasure Option Favourable or Marginal During Periods of Open Water	No Countermeasure Option Possible									
			% of Open Water Periods			% of Time	% of Open Water Periods			% of Time	% of Open Water Periods			% of Time	% of Open Water Periods					% of Time						
			Fav.	Marg.	Not Possible		Fav.	Marg.	Not Possible		Fav.	Marg.	Not Possible		One or More Fav.	One or More at Least Marg.	< 100 bbl	> 100 bbl	< 100 bbl	> 100 bbl						
		O	$F_i \mid O$	$M_i \mid O$	$N_i \mid O$	N_i	$F_c \mid O$	$M_c \mid O$	$N_c \mid O$	N_c	$F_d \mid O$	$M_d \mid O$	$N_d \mid O$	N_d	$(F_i \vee F_c \vee F_d) \mid O$	$(F_i \vee F_c \vee F_d) \mid O \vee (M_i \vee M_c \vee M_d) \mid O$	$(N_i \wedge N_c \wedge N_d) \mid O$	$(N_i \wedge N_d) \mid O$	$N_i \wedge N_c \wedge N_d$	$N_i \wedge N_d$						
Jun	43	70	8	22	66	70	10	20	66	60	0	40	74	80	80	20	22	66	66						
Jul	62	67	7	26	54	66	10	24	53	46	0	53	71	77	77	23	26	52	54						
Aug	82	45	9	46	56	46	13	41	52	48	0	52	61	60	60	40	46	51	56						
Sep	88	20	11	69	73	21	17	62	67	41	2	58	62	42	44	56	58	61	62						
Oct	54	5	7	88	94	5	9	85	92	32	3	65	81	32	35	65	65	81	81						

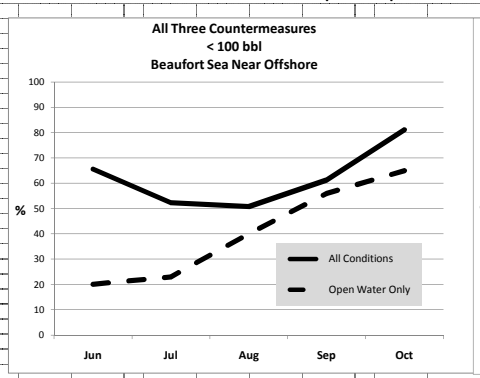
Response Gap for Individual Countermeasures

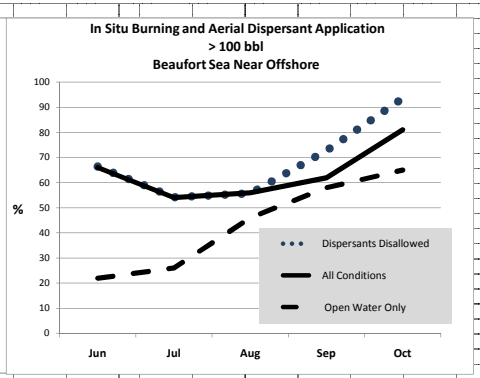






Response Gap for Combined Countermeasures

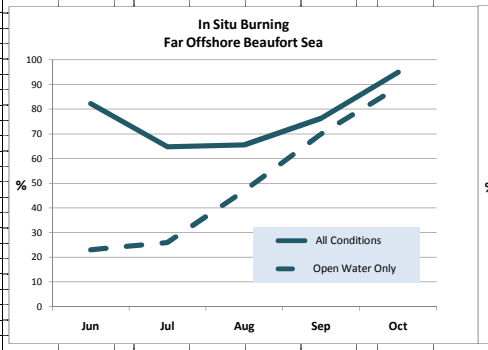


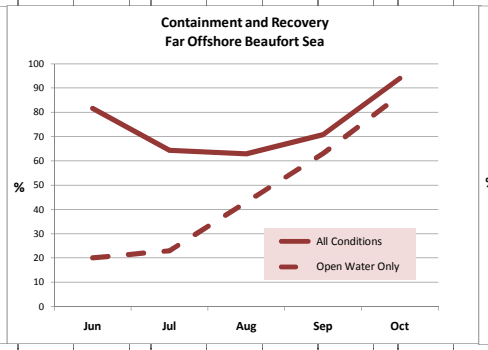


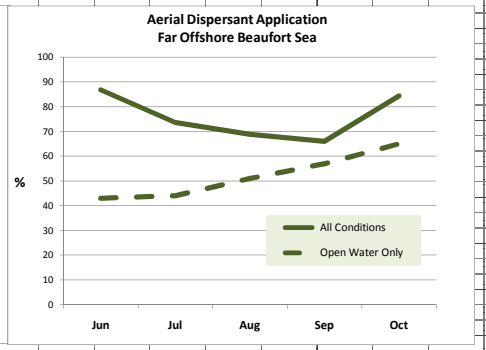
Far Offshore Beaufort

Month	% of time with open water	In Situ Burning: % of Open Water Periods: Fav.	In Situ Burning: % of Open Water Periods: Marg.	In Situ Burning: % of Open Water Periods: Not Possible	In Situ Burning: % of Time	Containment and Recovery: % of Open Water Periods: Fav.	Containment and Recovery: % of Open Water Periods: Marg.	Containment and Recovery: % of Open Water Periods: Not Possible	Containment and Recovery: % of Time	Aerial Dispersant Application: % of Open Water Periods: Fav.	Aerial Dispersant Application: % of Open Water Periods: Marg.	Aerial Dispersant Application: % of Open Water Periods: Not Possible	Aerial Dispersant Application: % of Time	Combined Countermeasures: At Least One Countermeasure Option Favourable During Periods of Open Water: % of Open Water Periods: One or More Fav.	Combined Countermeasures: At Least One Countermeasure Option Favourable or Marginal During Periods of Open Water: % of Open Water Periods: One or More at Least Marg.	No Countermeasure Option Possible: % of Open Water Periods: < 100 bbl	No Countermeasure Option Possible: % of Open Water Periods: > 100 bbl	No Countermeasure Option Possible: % of Time: < 100 bbl	No Countermeasure Option Possible: % of Time: > 100 bbl
	O	$F_i \mid O$	$M_i \mid O$	$N_i \mid O$	N_i	$F_c \mid O$	$M_c \mid O$	$N_c \mid O$	N_c	$F_d \mid O$	$M_d \mid O$	$N_d \mid O$	N_d	$(F_i \vee F_c \vee F_d) \mid O$	$(F_i \vee F_c \vee F_d) \mid O \vee (M_i \vee M_c \vee M_d) \mid O$	$(N_i \wedge N_c \wedge N_d) \mid O$	$(N_i \wedge N_d) \mid O$	$N_i \wedge N_c \wedge N_d$	$N_i \wedge N_d$
Jun	23	67	10	23	82	67	13	20	82	57	0	43	87	80	80	20	23	82	82
Jul	47	64	11	26	65	63	13	23	64	56	0	44	74	77	77	23	26	64	65
Aug	65	43	10	47	66	43	14	43	63	48	0	51	69	60	60	40	47	61	66
Sep	79	19	11	70	76	21	16	63	71	41	2	57	66	42	44	56	57	65	66
Oct	46	4	7	89	95	4	9	87	94	31	3	65	84	32	35	65	65	84	84

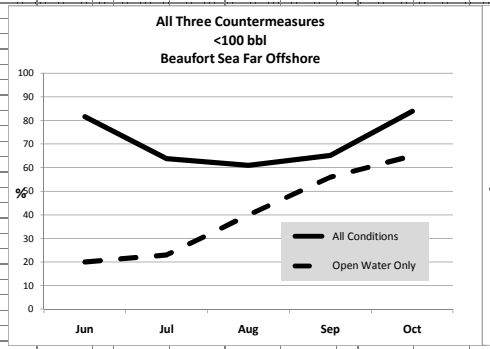
Response Gap for Individual Countermeasures

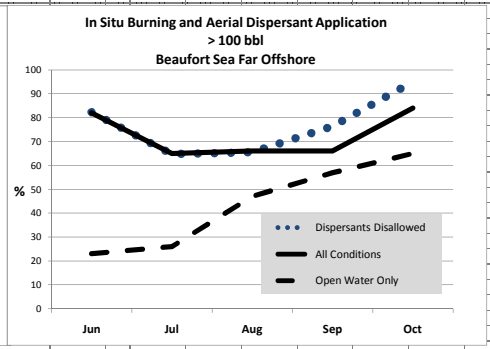






Response Gap for Combined Countermeasures

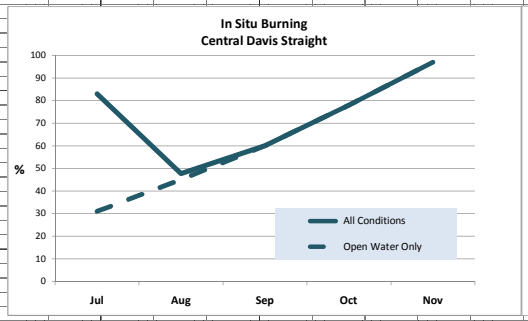


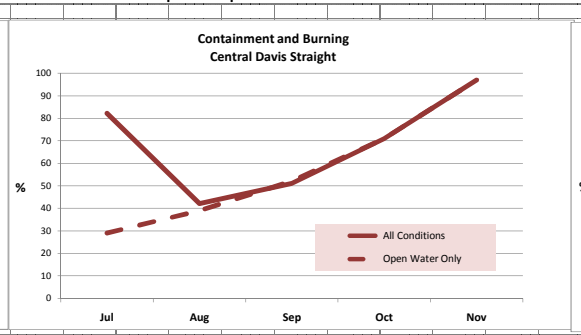


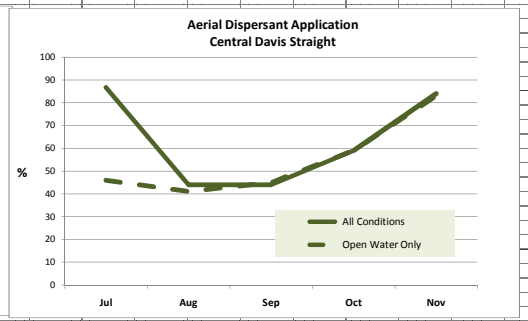
Central Davis Strait

	Month	% of time with open water	In Situ Burning				Containment and Recovery				Aerial Dispersant Application				Combined Countermeasures						
															At Least One Countermeasure Option Favourable During Periods of Open Water	At Least One Countermeasure Option Favourable or Marginal During Periods of Open Water	No Countermeasure Option Possible				
			% of Open Water Periods			% of Time	% of Open Water Periods			% of Time	% of Open Water Periods			% of Time	% of Open Water Periods				% of Time		
			Fav.	Marg.	Not Possible		Fav.	Marg.	Not Possible		Fav.	Marg.	Not Possible		One or More Fav.	One or More at Least Marg.	< 100 bbl	> 100 bbl	< 100 bbl	> 100 bbl	
		O	$F_i \mid O$	$M_i \mid O$	$N_i \mid O$	N_i	$F_c \mid O$	$M_c \mid O$	$N_c \mid O$	N_c	$F_d \mid O$	$M_d \mid O$	$N_d \mid O$	N_d	$(F_i \vee F_c \vee F_d) \mid O$	$(F_i \vee F_c \vee F_d) \mid O \vee (M_i \vee M_c \vee M_d) \mid O$	$(N_i \wedge N_c \wedge N_d) \mid O$	$(N_i \wedge N_d) \mid O$	$N_i \wedge N_c \wedge N_d$	$N_i \wedge N_d$	
	Jul	25	59	9	31	83	36	35	29	82	53	0	46	87	73	73	27	31	82	83	
	Aug	95	40	15	45	48	31	30	39	42	59	0	41	44	63	63	37	41	40	44	
	Sep	100	23	17	60	60	22	27	52	51	54	2	45	44	54	56	44	45	44	44	
	Oct	100	9	13	78	78	9	20	71	71	39	2	59	59	39	41	59	59	59	59	
	Nov	100	0	3	97	97	0	3	97	97	15	1	83	84	15	17	83	83	83	84	

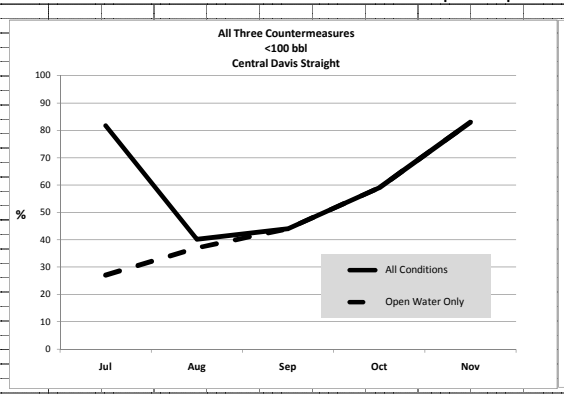
Response Gap for Individual Countermeasures

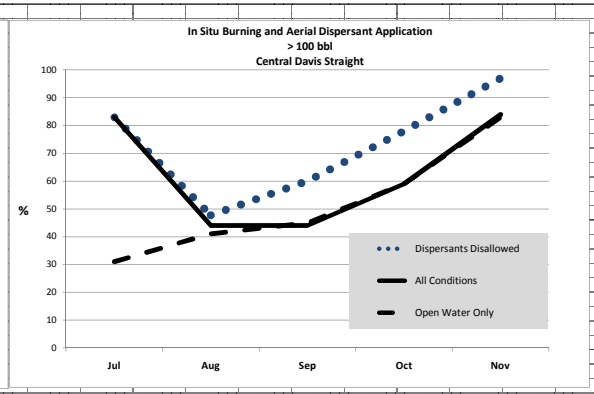






Response Gap for Combined Countermeasures

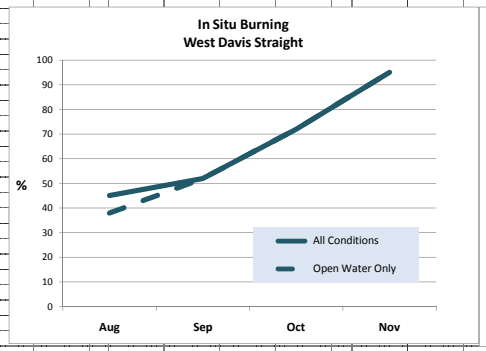


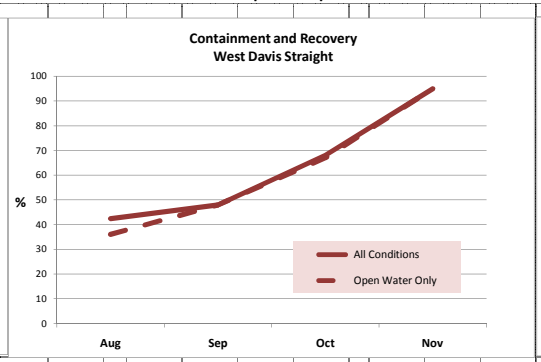


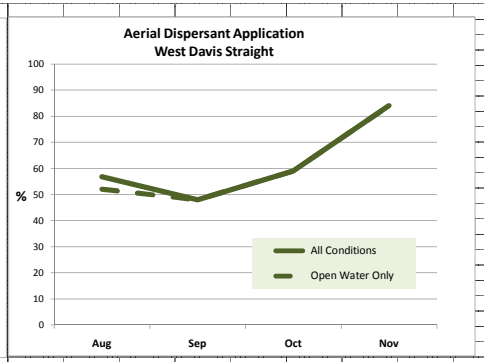
West-Central Davis Strait

			Individual Countermeasure Options														Combined Countermeasures													
	Month	% of time with open water	In Situ Burning				Containment and Recovery				Aerial Dispersant Application				At Least One Countermeasure Option Favourable During Periods of Open Water	At Least One Countermeasure Option Favourable or Marginal During Periods of Open Water	No Countermeasure Option Possible											
			% of Open Water Periods			% of Time	% of Open Water Periods			% of Time	% of Open Water Periods			% of Time	% of Open Water Periods						% of Time								
			Fav.	Marg.	Not Possible		Fav.	Marg.	Not Possible		Fav.	Marg.	Not Possible		One or More Fav.	One or More at Least Marg.	< 100 bbl	> 100 bbl	< 100 bbl	> 100 bbl								
		O	$F_i \mid O$	$M_i \mid O$	$N_i \mid O$	N_i	$F_c \mid O$	$M_c \mid O$	$N_c \mid O$	N_c	$F_d \mid O$	$M_d \mid O$	$N_d \mid O$	N_d	$(F_i \vee F_c \vee F_d) \mid O$	$(F_i \vee F_c \vee F_d) \mid O \vee (M_i \vee M_c \vee M_d) \mid O$	$(N_i \wedge N_c \wedge N_d) \mid O$	$(N_i \wedge N_d) \mid O$	$N_i \wedge N_c \wedge N_d$	$N_i \wedge N_d$								
Aug	90		52	9	38	45	38	26	36	42	48	0	52	57	65	65	35	38	42	45								
Sep	100		33	15	52	52	31	21	48	48	52	0	48	48	55	56	44	48	44	48								
Oct	100		14	14	72	72	14	18	67	68	40	1	59	59	40	42	58	59	58	59								
Nov	100		1	4	95	95	1	4	95	95	16	0	84	84	16	16	84	84	84	84								

Response Gap for Individual Countermeasures







Response Gap for Combined Countermeasures