Beaufort Sea Play 13: Brookian Unstructured Eastern Topset

Geological Assessment:
GRASP UAI: AAAAABAV
Play Area: 4,745 square miles
Play Water Depth Range: 5 – 150 feet
Play Depth Range: 2000 –7000 feet
Play Exploration Chance: 0.5040

Play 13, Brookian Unstructured Eastern Topset, Beaufort Sea OCS Planning Area, 2006 Assessment, Undiscovered Technically-Recoverable Oil & Gas			
Assessment Results as of November 2005			
Resource Commodity (Units)	**Resources ***		
	F95	**Mean**	**F05**
BOE (Mmboe)	116	639	1,575
Total Gas (Tcfg)	0.065	0.336	0.758
Total Liquids (Mmbo)	104	579	1,440
Free Gas** (Tcfg)	0.043	0.211	0.449
Solution Gas (Tcfg)	0.022	0.126	0.309
Oil (Mmbo)	102	570	1,422
Condensate (Mmbc)	2	9	19
* Risked, Technically-Recoverable			
** Free Gas Includes Gas Cap and Non-Associated Gas			
F95 = 95% chance that resources will equal or exceed the given quantity			
F05 = 5% chance that resources will equal or exceed the given quantity			
BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas			
Mmb = millions of barrels			
Tcf = trillions of cubic feet			

Table 1

Play 13, the "Brookian Unstructured Eastern Topset" play, contains just under 3% of the Beaufort Sea Province hydrocarbon endowment (mean of 639 Mmboe). The overall assessment results for play 13 are shown in table 1. Liquid hydrocarbons compose 90% of the endowment. Table 5 reports the detailed assessment results by

commodity for play 13.

Table 3 summarizes the volumetric input data developed for the *GRASP* computer model of Beaufort Sea play 13. Table 4 reports the risk model used for play 13. The location of play 13 is shown in figure 1.

Play 13 includes the deltaic-topset facies of the Tertiary Sagavanirktok Formation and equivalent facies of the Upper Cretaceous Colville Group. It is located north of the Barrow arch and south of the hinge line fault zone east of the eastern stratigraphic limit of the Nanushuk Group (generally east of the Colville River delta). Excellent reservoir-quality sandstones occur within the Sagavanirktok Formation in most coastal wells and we expect similar reservoir sequences to also extend offshore. The Canning Formation, Pebble Shale, Hue Shale, lower Kingak shale, and the Shublik Formation are variable to rich oil source rocks that lie within the projected oil window and underlie the play sequence across most of the play area. The play sequence is sparsely faulted. Most of the prospects are expected to be stratigraphic traps or small-offset fault traps. Seals are likely to be a risk factor for many of the prospects because of the abundance of sandstone within the play sequence.

Oil was discovered offshore at Hammerhead (reserves not published) and Kuvlum (reserves not published) and in the correlative play onshore at West Sak and Ugnu (combined contain 23 Bbl in place heavy oil (Petroleum news Vol 10 No. 2)). In Harrison Bay, the Phoenix well tested oil from a sandstone in the Colville Group.

The presence of adequate seal, closure and source are the primary risk factors for this play.

Play 13, Brookian Unstructured Eastern Topset, Beaufort Sea OCS Planning Area, 2006 Assessment, Conditional BOE Sizes of Ten Largest Pools			
Assessment Results as of November 2005			
Pool Rank	BOE Resources *		
	F95	Mean	F05
1	53	348	1069
2	24	144	370
3	12	85	213
4	8	56	142
5	5	41	104
6	4	31	80
7	3.4	25	64
8	2.9	20	53
9	2.6	17	45
10	2.3	15	39
* Conditional, Technically-Recoverable, Millions of Barrels Energy-Equivalent (Mmboe), from "PSRK.out" file			
F95 = 95% chance that resources will equal or exceed the given quantity			
F05 = 5% chance that resources will equal or exceed the given quantity			
BOE = total hydrocarbon energy, expressed in barrels-of-oil-equivalent, where 1 barrel of oil = 5,620 cubic feet of natural gas			

Table 2

A maximum of 19 hypothetical pools is forecast by the aggregation of the risk model and the prospect numbers model for play 13. These pools range in mean conditional (un-risked) recoverable volumes from 5 Mmboe (pool rank 19) to 348 Mmboe (pool rank 1). Pool rank 1 ranges in possible conditional recoverable volumes from 53 Mmboe (F95) to 1,069 Mmboe (F05). Table 2 shows the conditional sizes of the 10 largest pools in play 13.

Table 6 reports statistics for the simulation pools developed in the *GRASP* computer model for play 13. In the computer simulation for the play, a total of 64,471 "simulation pools" were sampled for size.

These simulation pools can be grouped according to the USGS size class system in which sizes double with each successive class. Pool size class 11 contains the largest share (13,711, or 21%) of simulation pools (conditional, technically recoverable BOE resources) for play 13. Pool size class 11 ranges from 32 to 64 Mmboe. The largest pool among the 64,471 simulation pools falls within pool size class 18, which ranges in size from 4,096 to 8,192 Mmboe.

GRASP Play Data Form (Minerals Management Service-Alaska Regional Office)

Basin: Beaufort   **Assessor**: Johnson/Scherr   **Date**: 10/17/2005
Play Number: 13   **Play Name**: Brookian Unstructured Eastern Topset
Play UAI Number: AAAAABAV

Play Area: mi² (million acres)   4745 (3036.9)   **Play Depth Range: feet**   2000   3,600   7000
Reservoir Thermal Maturity: % Ro   **Expected Oil Gravity: °API**   25
     Play Water Depth Range: feet   5   30   150

POOLS Module (Volumes of Pools, Acre-Feet)

Fractile	F100	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Prospect Area (acres)-Model Input	400	900		2400	5000		10000			28000		58000	60000
Prospect Area (acres)-Model Output													
Fill Fraction (Fraction of Area Filled)	0.1	0.14		0.29	0.5		0.76			0.95		0.99	1
Productive Area of Pool (acres)	126	346	530	1078	2376	4538.773/6149.806	5235	7998	10657	16308	26324	36224	39026
Pay Thickness (feet)	13.0	35.6	42.6	57.4	80.0	90.591/48.523	111.5	133.3	150.4	179.9	220.0	499.7	500.0

MPRO Module (Numbers of Pools)

Play Level Chance	1		Prospect Level Chance	0.504		Exploration Chance	0.504

Risk Model	Play Chance	Petroleum System Factors	Prospect Chance
		Presence of Closure	0.8
		Adequate Seal	0.7
		Adequate Preservation	0.9

Fractile	F99	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Numbers of Prospects in Play	7.00	8.14	8.90	10.20	12.00	12.85/2.97	14.00	15.40	16.40	18.00	19.70	20.90	21.00
Numbers of Pools in Play	2	3	4	5	6	6.48/ 2.33	8	9	10	11	12	13	19

Minimum Number of Pools	0	Mean Number of Pools	6.48	Maximum Number of Pools	19

POOLS/PSRK/PSUM Modules (Play Resources)

Fractile	F100	F95	F90	F75	F50	Mean/Std. Dev.	F25	F15	F10	F05	F02	F01	F00
Oil Recovery Factor (bbl/acre-foot)	68	134	150	183	227	239.214/80.085	282	317	343	385	439	479	750
Gas Recovery Factor (Mcfg/acre-foot)	224	438	493	600	747	787.935/ 266.195	929	1045	1131	1273	1453	1587	2490
Gas Oil Ratio (Sol'n Gas)(cf/bbl)	38.0	96.0	112.9	148.0	200.0	221.428/105.929	270.2	317.6	354.3	416.6	500.0	564.7	1051.0
Condensate Yield ((bbl/Mmcfg)	7.60	19.21	22.58	29.61	40.00	44.286/21.197	54.04	63.51	70.85	83.31	99.98	112.90	210.20

Pool Size Distribution Statistics from *POOLS* (1,000 BOE): μ (mu)= 10.6870525 σ^2 (sigma squared)= 1.68655383   **Random Number Generator Seed=** 942054

BOE Conversion Factor (cf/bbl)	5620	Probability Any Pool Contains Both Oil and Free Gas (Gas Cap)	0.4
Probability Any Pool is 100% Oil	0.6	Fraction of Pool Volume Gas-Bearing in Oil Pools with Gas Cap	0.25
Probability Any Pool is 100% Gas	0		

Table 3. Input data for Beaufort Sea play 13, 2006 assessment.

<div align="center">

Risk Analysis Form - 2006 National Assessment

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Assessment Province: Beaufort	**Play Number, Name:**	13, Brookian Unstructured Eastern Topset
Assessor(s): Johnson/Scherr	**Play UAI:**	AAAAABAV
Date: 20-Oct-05		

For each component, a *quantitative* probability of success (i.e., between zero and one, where zero indicates no confidence and one indicates absolute certainty) based on consideration of the *qualitative* assessment of **ALL** elements within the component was assigned. This is the assessment of the probability that the minimum geologic parameter assumptions have been met or exceeded.

		Play Chance Factors	**Averge Conditional Prospect Chance[1]**
1. Hydrocarbon Fill component (1a * 1b * 1c)	**1**	*1.0000*	*0.9000*
a. Presence of a Quality, Effective, Mature Source Rock			
Probability of efficient source rock in terms of the existence of sufficient volume of mature source rock of adequate quality located in the drainage area of the reservoirs.	1a	1.00	1.00
b. Effective Expulsion and Migration			
Probability of effective expulsion and migration of hydrocarbons from the source rock to the reservoirs.	1b	1.00	1.00
c. Preservation			
Probability of effective retention of hydrocarbons in the prospects after accumulation.	1c	1.00	0.90
2. Reservoir component (2a * 2b)	**2**	*1.0000*	*1.0000*
a. Presence of reservoir facies			
Probability of presence of reservoir facies with a minimum net thickness and net/gross ratio (as specified in the resource assessment).	2a	1.00	1.00
b. Reservoir quality			
Probability of effectiveness of the reservoir, with respect to minimum effective porosity, and permeability (as specified in the resource assessment).	2b	1.00	1.00
3. Trap component (3a * 3b)	**3**	*1.0000*	*0.5600*
a. Presence of trap			
Probability of presence of the trap with a minimum rock volume (as specified in the resource assessment).	3a	1.00	0.80
b. Effective seal mechanism			
Probability of effective seal mechanism for the trap.	3b	1.00	0.70

Overall Play Chance (Marginal Probability of hydrocarbons, MPhc)	*1.0000*	
(1 * 2 * 3) *Product of All Subjective Play Chance Factors*		

Average Conditional Prospect Chance[1]		*0.5040*
(1 * 2 * 3) *Product of All Subjective Conditional Prospect Chance Factors*		
[1] **Assumes that the Play exists (where all play chance factors = 1.0)**		
Must be consistent with play chance and prospect distribution -- See discussion on Page 3 of Guide		

Exploration Chance	*0.5040*
(Product of Overall Play Chance and Average Conditional Prospect Chance)	

Comments: *See guidance document for explanation of the Risk Analysis Form*

Table 4. Risk model for Beaufort Sea play 13, 2006 assessment.

GRASP - Geologic and Economic Resource Assessment Model - PSUM Module Results
Minerals Management Service - Alaska OCS Region
GRASP Model Version: 8.29.2005)
Computes the Geologic Resource Potential of the Play

Play UAI: AAAAABAV			**Play No.**		**13**		
World	Level	-	World	Level	Resources		
Country	Level	-	UNITED	STATES	OF		AMERICA
Region	Level	-	MMS	-	ALASKA	REGION	
Basin	Level	-	**BEAUFORT**	**SHELF**			
Play	**Level**	**-**	**Play**		**13 Brookian**	**Unstructured**	
Geologist	Peter	Johnson			**Eastern**	**Topset**	
Remarks	Play	13	2005	assessment			
Run Date & Time:		Date	19-Sep-05 Time		13:49:43		

Summary of Play Potential

Product	MEAN	Standard Deviation
BOE (Mboe)	638,840	488,660
Oil (Mbo)	569,710	442,380
Condensate (Mbc)	9,277	12,388
Free (Gas Cap & Nonassociated) Gas (Mmcfg)	210,580	261,420
Solution Gas (Mmcfg)	125,810	107,330

    10000 (Number of Trials in Sample)
    0.9992 (MPhc [Probability] of First Occurrence of Non-Zero Resource)
    Windowing Feature: used

Empirical Probability Distributions of the Products

Greater Than Percentage	BOE (Mboe)	Oil (Mbo)	Condensate (Mbc)	Free (Gas Cap & Nonassociated) Gas (Mmcfg)	Solution Gas (Mmcfg)
100	0	0	0	0	0
99.99	0	0	0	0	0
99	43,997	39,297	625	14,941	7,962
95	115,840	102,370	1,894	43,459	21,605
90	173,260	153,330	2,586	62,967	34,515
85	219,740	194,890	3,449	76,273	44,015
80	258,390	229,040	4,152	92,889	48,720
75	297,440	265,970	3,903	95,325	59,635
70	340,920	302,870	5,112	117,870	67,224
65	381,200	336,680	6,447	141,440	72,540
60	423,560	376,760	6,867	140,520	83,905
55	468,890	415,040	7,085	165,430	97,398
50	515,560	455,350	7,839	189,440	104,870
45	562,990	504,910	7,730	174,360	108,580
40	623,380	560,450	8,444	181,380	124,820
35	685,780	607,470	11,160	252,070	125,300
30	755,700	672,830	10,368	257,960	149,490
25	846,150	750,630	13,887	296,920	161,850
20	944,980	846,410	13,345	299,180	179,780
15	1,076,200	953,650	16,267	382,790	214,640
10	1,251,000	1,115,700	17,610	421,290	240,010
8	1,360,000	1,209,300	19,811	470,310	265,240
6	1,490,700	1,331,600	22,167	472,700	296,750
5	1,575,200	1,421,600	18,676	448,930	309,280
4	1,674,400	1,488,800	24,204	572,080	334,810
2	2,000,300	1,796,000	25,352	604,310	401,580
1	2,362,700	2,138,500	29,957	649,840	441,890
0.1	3,461,500	3,106,800	28,035	513,250	1,322,600
0.01	5,748,600	5,455,500	11,401	301,730	1,281,100
0.001	6,103,600	5,694,000	52,850	1,321,100	683,860

Table 5. Assessment results by commodity for Beaufort Sea play 13, 2006 assessment.

Class	Min (MMBOE)	Max (MMBOE)	Pool Count	Percentage	Trial Average	Trials w/Pool Avg	Mixed Pool	Oil Pool	Gas Pool	Mixed Min	Mixed Max	Oil Min	Oil Max	Gas Min	Gas Max	Total Min	Total Max	Res Min	Res Max	Total Resource	Average Resource
1	0.0312	0.0625	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
2	0.0625	0.125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
3	0.125	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
4	0.25	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
5	0.5	1	49	0.075686	0.0049	0.004903	24	25	0	1	1	1	1	0	0	1	1	0.551232	0.970524	39.105182	798.064947
6	1	2	466	0.719791	0.0466	0.046633	213	253	0	1	1	1	2	0	0	1	2	1.011817	1.999418	747.102504	1.603224
7	2	4	1689	2.608857	0.1689	0.169018	686	1003	0	1	2	1	3	0	0	1	3	2.001714	3.999193	5225.980000	3.094126
8	4	8	4190	6.471942	0.419	0.419293	1726	2464	0	1	3	1	3	0	0	1	4	4.000758	7.999352	25291.895000	6.036252
9	8	16	7826	12.088166	0.7826	0.783148	3274	4552	0	1	4	1	5	0	0	1	6	8.000893	15.999970	93663.419000	11.968237
10	16	32	11980	18.504503	1.198	1.198839	4868	7112	0	1	5	1	5	0	0	1	7	16.001663	31.998908	280855.305000	23.443682
11	32	64	13711	21.178234	1.3711	1.37206	5397	8314	0	1	5	1	6	0	0	1	9	32.002213	63.993137	632045.177000	46.097672
12	64	128	11495	17.755363	1.1495	1.150305	4472	7023	0	1	4	1	5	0	0	1	7	64.004243	127.995929	1038142.000000	90.312500
13	128	256	7571	11.694289	0.7571	0.75763	3056	4515	0	1	5	1	4	0	0	1	6	128.025447	255.948926	1355325.000000	179.015320
14	256	512	3900	6.024004	0.39	0.390273	1484	2416	0	1	3	1	3	0	0	1	4	256.029726	511.892000	1378215.000000	353.388367
15	512	1024	1492	2.304567	0.1492	0.149305	575	917	0	1	2	1	2	0	0	1	3	512.285807	1022.611000	1033769.000000	692.874756
16	1024	2048	331	0.511268	0.0331	0.033123	120	211	0	1	1	1	2	0	0	1	2	1025.705000	2036.108000	438670.511000	1.325289
17	2048	4096	38	0.058695	0.0038	0.003803	5	33	0	1	1	1	1	0	0	1	1	2059.603000	3033.823000	92437.152000	2.432557
18	4096	8192	3	0.004634	0.0003	0.0003	1	2	0	1	1	1	1	0	0	1	1	4414.658000	5118.466000	13991.149000	4.663716
19	8192	16384	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
20	16384	32768	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
21	32768	65536	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
22	65536	131072	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
23	131072	262144	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
24	262144	524288	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
25	524288	1048576	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.000000	0.000000	0.000000	0.000000
Not Classified			0	0	0	0	Below Class 0	0	0									Below Class 0.000000	0.000000	0.000000	0.000000
	Totals		64741	99.999992	6.4741	6.478635	Above Class 0	0	0									Above Class 0.000000	0.000000	0.000000	0.000000

Min and Max refer to numbers of pools of the relevant size class that occur within any single trial in the simulation.

Min and Max refer to aggregate resources of the relevant size class that occur within any single trial in the simulation.

Number of Pools not Classified: 0
Number of Pools below Class 1: 0
Number of Trials with Pools: 9993

Table 6. Statistics for simulation pools created in computer sampling run for Beaufort Sea play 13, 2006 assessment.
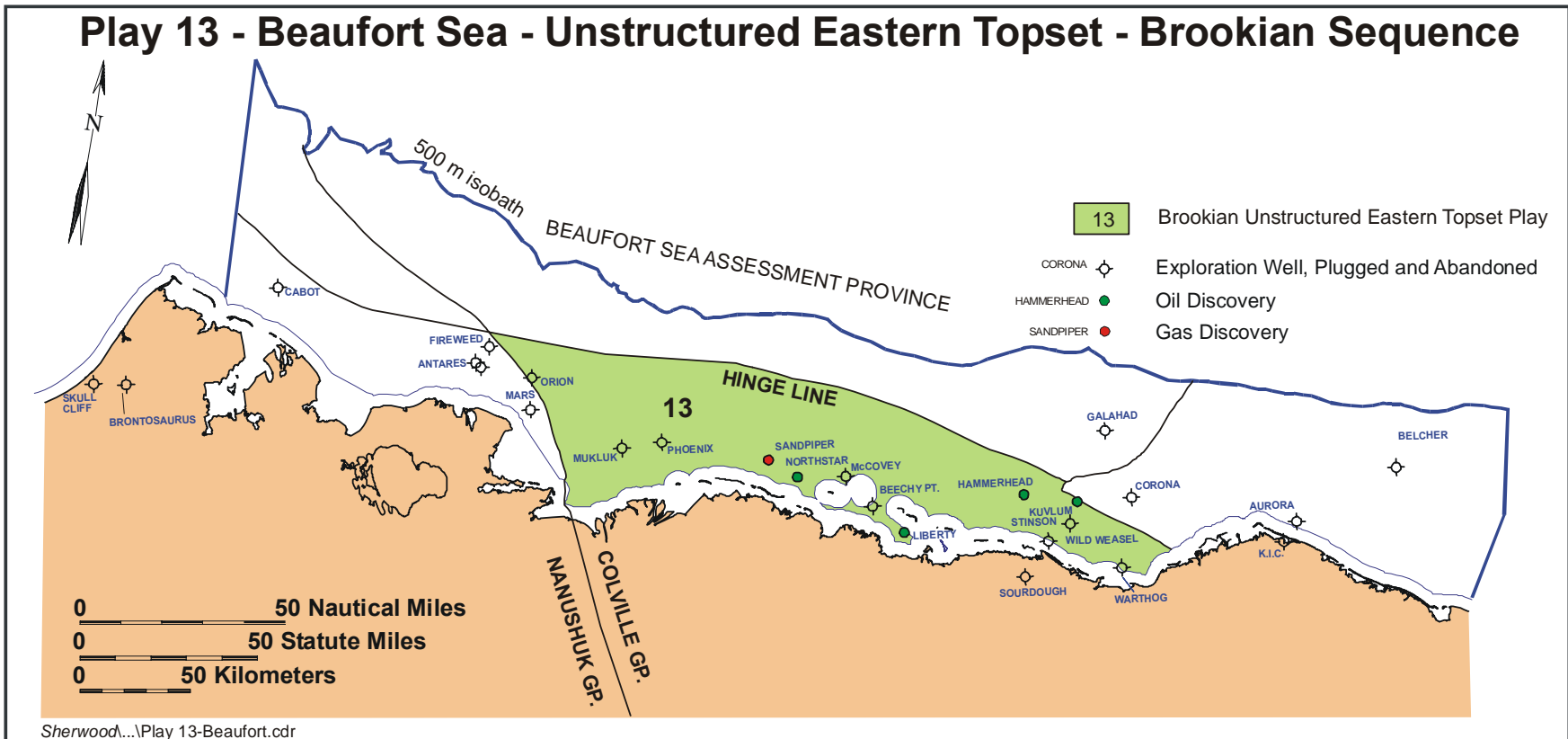
Play 13 - Beaufort Sea - Unstructured Eastern Topset - Brookian Sequence

500 m isobath

BEAUFORT SEA ASSESSMENT PROVINCE

| 13 | Brookian Unstructured Eastern Topset Play |

CORONA ◇ Exploration Well, Plugged and Abandoned

HAMMERHEAD ● Oil Discovery

SANDPIPER ● Gas Discovery

HINGE LINE

13

CABOT

FIREWEED
ANTARES
ORION
MARS
SKULL CLIFF
BRONTOSAURUS
MUKLUK
PHOENIX
SANDPIPER
NORTHSTAR
McCOVEY
BEECHY PT.
HAMMERHEAD
LIBERTY
KUVLUM
STINSON
WILD WEASEL
SOURDOUGH
WARTHOG
GALAHAD
CORONA
AURORA
K.I.C.
BELCHER

NANUSHUK GP.
COLVILLE GP.

0	50 Nautical Miles
0	50 Statute Miles
0	50 Kilometers

Sherwood\...\Play 13-Beaufort.cdr

Figure 1. Map location of Beaufort Sea play 13, 2006 assessment.