

AERIAL SURVEYS OF HARBOR SEALS IN SOUTHERN BRISTOL BAY, ALASKA, 1998-1999

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INTRODUCTION

The National Marine Fisheries Service (NMFS) currently recognizes three stocks of harbor seals in Alaska, including a Bering Sea stock that includes all seals north of Unimak Pass (Hill and DeMaster 1999). The current population trend of harbor seals in the Bering Sea is unknown, though Jemison *et al.* (2001) report increasing population trends for Nanvak Bay (northwest Bristol Bay) during both the pupping (9.2%/year) and molting (2.1%/year) periods from 1990-2000. Based on a 1995 aerial survey conducted by NMFS, a total mean count of 8,740 was reported for the Bering Sea with the large majority (~85%) of seals along the north side of the Alaska Peninsula (Withrow and Loughlin 1996). Pitcher (1986) conducted an aerial survey along the north side of the Alaska Peninsula in June 1985, and reported lower counts than obtained in the late 1960s and mid 1970s. Withrow and Loughlin (1996) reported an annual rate of decline of 3.5% between 1975 and 1995 for the north side of the Alaska Peninsula, based on counts collected during the pupping period in 1975-77, 1985, 1990 and during the molting period in 1991 and 1995. Their counts were not adjusted for the effects of covariates (e.g., time of day, date) that are known to influence the number of seals hauled (Frost *et al.* 1999, Small *et al.* 2001, Jemison and Pendleton 2001, Jemison *et al.* 2001). Tide height likely has a greater influence on counts along the north side of the Alaska Peninsula, where seals haul out on open sandbars that become covered with water relatively quickly during a rising tide. In 1975 and 1976, pupping period (June) counts obtained at a mean tide height of +4 feet were three times higher than molting period (August) counts at a mean tide height of +11 feet (Everitt and Braham 1980, Withrow and Loughlin 1996). Everitt and Braham (1980) noted an inverse relationship between tide height and the number of harbor seals hauled out, and although molting period counts could be less than pupping period counts independent of tide height, such large differences have not been observed at Tugidak Island (Jemison and Pendleton 2001) or Nanvak Bay (Jemison *et al.* 2001).

Thus, although counts collected since 1975 along the north side of the Alaska Peninsula indicate a possible decline in harbor seal numbers in Bristol Bay, the population trend should be considered equivocal until the influence of covariates on those counts is determined. In addition, as Bristol Bay is an area of sympatry for harbor and spotted seals (*Phoca larga*) and the two species cannot be visually distinguished from one another when counts are obtained, available counts may include an unknown proportion of spotted seals.

The Alaska Department of Fish and Game (ADF&G) established an aerial survey route in 1998 to collect annual counts of seals along the north side of the Alaska Peninsula to estimate population trend once a series of annual counts have been obtained. This chapter describes the

surveys conducted in 1998 and 1999, including the counts obtained for those two years and a preliminary comparison with the NMFS 1995 survey.

METHODS

During the 1995 NMFS Bristol Bay survey (Withrow and Loughlin 1996), the largest concentrations (range of mean counts: 191 to 3,155) of seals were observed along the north side of the Alaska Peninsula from Port Moller northeast to Kvichak Bay (Fig. 1). West of Kvichak Bay, no seal haulouts were found until west of the Nushagak Peninsula, and mean counts at these northern Bristol Bay sites were < 100, except for Nanvak Bay (436) where a land-based harbor seal monitoring program exists. Thus, two potential trend survey routes were possible, based on the spatial distribution of haulout sites and logistical constraints: Nanvak Bay east to the Nushagak Peninsula, and Port Moller northeast to Kvichak Bay. The latter route along the north side of the Alaska Peninsula was chosen for the ADF&G trend survey route because it contained the large majority of seals in Bristol Bay, and could be surveyed by one observer based out of King Salmon. Additionally, the Nanvak Bay site represents approximately 50% of the seals in northern Bristol Bay, and will likely continue to be monitored with land-based counts.

On the first two days of the 1998 survey (14 and 15 Aug), the entire coastline from Port Moller to Egegik Bay was searched for additional haulouts not reported by Withrow and Loughlin (1996) during their 1995 survey. In the Port Moller area, harbor seals could potentially haulout in three distinct bays: Nelson Lagoon, Port Herendeen, and Port Moller. Next, the coastline was surveyed to the northeast, with extensive searches in each of the following five areas: Seal Island, Port Heiden, Cinder River, Ugashik Bay, Egegik Bay (Fig 1). In each area, seals could potentially haulout on any of the numerous available sandbars, and thus a specific geographic area was delineated that would be searched during each future survey. For Seal Island and Cinder River, the areas were relatively small compared to the other three larger bays, and the search area included all the sandbars near deeper water at low tide suitable for use as a haulout. The search areas for the three larger bays were as follows: Port Heiden, the entire bay to the mouth of the Meshik River; Ugashik Bay, the entire bay south to an east-west line at the mouth of both the Ugashik and King Salmon Rivers; and Egegik Bay, the entire bay to an east-west line from the town of Egegik across the mouth of the Egegik and King Salmon Rivers.

Kvichak Bay was not surveyed until 20 August 1998 when 3 haulouts were located, and then twice again on the last day of the 1998 survey (21 August) during the morning and evening low tides when no additional haulouts were found; counts from the evening survey are reported because the tide was lower, providing more available haulout substrate and the weather was poor (fog and rain) during the morning survey. The area west of Kvichak Bay to the east side of the Nushagak Peninsula was searched during the morning survey, and no seals were observed hauled out. Based on the location of the 3 haulouts, the search area for Kvichak Bay was determined to be the Deadman Sands area south of Halfmoon Bay, and the area encompassed by a ~10km radius outside of the mouth of the Naknek River. The location of each haulout site for the entire survey area was recorded using the Global Positioning System (GPS) aboard the survey aircraft.

The typical flight plan was to leave King Salmon and fly overland ~2 hr directly to the Port Moller area, arriving ~15 minutes prior to low tide. The timing of peak low tide is progressively later in the day moving from southwest to northeast, such that with a ~30 minute break at Port Heiden each area could be surveyed near peak low tide. The survey aircraft used in 1998 and 1999 was a

twin engine Grand AeroCommander, which has high-wings providing a safe and stable platform with excellent downward and lateral visibility. Surveys were flown at an altitude of 200-300 m unless weather conditions required lower altitudes. After locating hauled out harbor seals, the aircraft circled the site and a visual count was obtained of all seals (including those in the water near haulouts) followed by 35mm color slide photographs (ASA 400) taken with an 80-200mm zoom lens for groups of >10-15 seals. The time was recorded when seals at each site were counted, such that the tide height at each site during the survey could later be estimated based on the nearest tide station. Wind speed, air temperature, and sky conditions were also recorded at each site. Five to seven replicate surveys were attempted in both 1998 and 1999, with each site surveyed unless prohibited by poor weather. Seal numbers were later counted from projected slide images on a white surface.

The survey aircraft was chartered from Anchorage in 1998 and 1999, and sections of Lake Iliamna were surveyed in route to King Salmon in 1998 and in route back to Anchorage in 1998 and 1999. Based on observations from Mathisen and Kline (1992), the majority of time during the initial survey on 13 August 1998 was spent at the east end of the lake where there is a higher concentration of islands possibly suitable for haulouts. Starting at the east end of the lake, an extensive search was made west to 154°30'W including the numerous small islands around Porcupine, Flat, Seal, and Triangle islands. West of 154°30'W, the south shore of the lake was surveyed west to Big Island, but not inside Intricate and Kakhonak bays. From Big Island, the small group of islands to the northwest, ~7 km from the north shore were surveyed before heading to King Salmon. On 22 August, the area around Rabbit Island southeast of the town of Iliamna was searched prior to surveying the haulouts occupied (LI01-LI07) on 13 August. On 23 August 1999, the islands outside of Kakhonak and Intricate bays were searched in addition to LI01-LI07.

RESULTS AND DISCUSSION

Thirty-four of 41 occupied haulouts located along the north side of the Alaska Peninsula during 1998 and 1999 were designated as trend survey sites (Table 1). Sixteen sites were located in the greater Port Moller area, yet the large majority of haulouts and seals were relatively close to the open water of Bristol Bay in eastern Nelson Lagoon and northern Port Moller (n = 11 sites). Due to the extensive amount of time required to reach the five haulouts located furthest into the three extensive bays, and the few seals observed there, they were not included in the trend route; haulout location and counts for specific sites are listed in Appendix I. Approximately 35 seals were observed in the water at the mouth of the Bear River (56°08.66'N 160°27.29' W), ~20 km northeast of Port Moller, on 21 August 1998, but this site was not included in the trend route. One haulout site in Port Heiden (PH26, 56°51.01'N 158°50.26'W; site number from NMFS 1995 survey) was surveyed on 14, 15, and 17 August, with counts of 16, 13, and 0 seals, respectively; this site was not included in the trend route. Two trend sites were located at Seal Island, four in Port Heiden, two at Cinder River, five in Ugashik Bay, seven in Egegik Bay, and three in Kvichak Bay (Table 1).

In 1998, six replicate surveys were conducted from 14-21 August in each of the seven main survey areas, excluding Kvichak Bay, which was surveyed twice on 20 and 21 August (Table 2). Surveys were flown each of the seven days between 16 and 22 August 1999, though counts could not be obtained at some areas because of poor weather the first three days (Table 2). Mean counts for each major survey area were calculated as the sum of daily counts (total count for all sites surveyed within an area) divided by the number of survey days. Counts were not available for all sites within

an area on some days due to poor weather or disturbance, and thus daily counts for an area are not directly comparable due to unequal survey effort across days.

The total mean count was quite similar in 1998 and 1999, at 10,941 and 11,202 seals, respectively. The magnitude and direction of the change in mean counts between years varied among areas (-24% to 105%), yet in both years the largest counts were obtained at Port Moller and Port Heiden, followed by Ugashik and Egegik bays, and then Kvichak Bay, Cinder River, and Seal Island. Counts at individual sites with the main survey areas varied substantially (Appendices II and III), as counts could range from several hundred to less than 50 from one day to the next. A portion of this variation was due to seals using different haulouts within an area, possibly due to disturbance from boats fishing for salmon or natural haulout site selection.

The raw count of 11,202 seals from the 1999 trend survey was 43.4% higher than the count (7,785) obtained by the NMFS during their 1995 range-wide abundance survey. However, the 1999 trend survey was conducted ~3 weeks earlier than the 1995 abundance survey. Assuming a similar relationship of increasing counts with earlier survey dates as quantified in the Prince William Sound covariate based population trend analysis (Frost *et al.* 1999), a comparison between the 1995 and 1999 raw counts indicates, preliminarily, harbor seal numbers were stable for the Bristol Bay trend route area during 1995-1999. However, this crude comparison does not take into account the other covariates that are known to substantially influence the number of seals hauled out; i.e., time of day and time relative to low tide. In addition, tide height may have more influence on counts in Bristol Bay than other areas, as some sandbars used for haulouts may be exposed for relatively shorter periods of time, or not at all, during higher tides. A population trend analysis incorporating the influence of covariates will be performed on counts obtained during four different annual surveys (1995, 1998, 1999, 2000) to determine a current trend estimate for Bristol Bay; the confidence interval for this estimate will likely remain relatively broad until an additional 2-3 annual surveys have been conducted. A subsequent analysis incorporating counts obtained since 1966 needs to be performed to provide a robust long-term population trend estimate.

Harbor seals were hauled out on seven different sites in Lake Iliamna on 13 August 1998, with six sites located near Seal and Triangle Islands; all sites were on sandy or pebble shorelines (Table 3). Seals were hauled at only two sites nine days later on 22 August and at three sites on 23 August 1999. The total raw count on 13 August 1998 was 321 (Table 4), greater than the high count of 137 reported by Mathisen and Kline (1992). Of the seven occupied sites on 13 August, two sites (LI02 and LI04) are likely the same sites where Mathisen and Kline (1992) counted seals in the eastern part of the lake in August 1991. Although they did not report the latitude and longitude of the two sites, one was Seal Island and the picture of this site in their report matched those taken of LI04. The other site was referred to as "S2", Ancillary Island between Seal Island and Triangle Island, which is likely the same as LI02. The other two haulout sites reported by Mathisen and Kline were in the central part of the lake toward Intricate Bay, and referred to as "Th1" and "Th2" for Thompson Island. Site LI07 is near Thompson Island, but the GPS coordinates recorded in 1998 do not match those of either Th1 or Th2 as recorded in the 1992 report. Overall, the raw counts of the number of seals in Lake Iliamna for 1998 and 1999 are higher than those reported by Mathisen and Kline (1992), and the use of haulouts near Triangle and Seal islands in the east and northwest of Intricate Bay in the south central part of the lake appears quite similar.

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Table 1. Locations of 34 harbor seal population trend haulout sites surveyed in 1998 and 1999 along the north side of the Alaska Peninsula in southern Bristol Bay, from Port Moller northeast to Kvichak Bay. The substrate for all trend sites is tidal sandbar.

Location	Site#	GPS Coordinates	
Port Moller	01	56°00.97' N	161°04.83' W
Port Moller	02	55°59.13' N	161°05.23' W
Port Moller	03	55°59.25' N	160°48.78' W
Port Moller	04	55°58.21' N	160°43.99' W
Port Moller	05	55°57.85' N	160°44.79' W
Port Moller	06	55°55.02' N	160°45.49' W
Port Moller	07	55°53.92' N	160°42.25' W
Port Moller	08	55°53.06' N	160°42.31' W
Port Moller	09	55°53.51' N	160°35.40' W
Port Moller	10	55°51.57' N	160°18.43' W
Port Moller	11	56°00.18' N	160°47.23' W
Seal Island	01	56°40.98' N	159°23.64' W
Seal Island	02	56°42.09' N	159°22.22' W
Port Heiden	01	56°53.95' N	158°47.88' W
Port Heiden	02	56°54.89' N	158°48.21' W
Port Heiden	03	56°55.05' N	158°45.98' W
Port Heiden	04	56°53.29' N	158°45.46' W
Cinder River	01	57°22.35' N	158°05.55' W
Cinder River	02	57°22.39' N	158°05.52' W
Ugashik Bay	01	57°36.06' N	157°44.54' W
Ugashik Bay	02	57°35.47' N	157°41.33' W
Ugashik Bay	03	57°33.36' N	157°36.54' W
Ugashik Bay	04	57°33.04' N	157°37.53' W
Ugashik Bay	05	57°31.98' N	157°35.56' W
Egegik Bay	01	58°12.83' N	157°28.47' W
Egegik Bay	02	58°12.43' N	157°28.19' W
Egegik Bay	03	58°12.46' N	157°27.73' W
Egegik Bay	04	58°13.11' N	157°34.13' W
Egegik Bay	05	58°16.11' N	157°37.04' W
Egegik Bay	06	58°16.74' N	157°36.48' W
Egegik Bay	07	58°17.51' N	157°35.22' W
Kvichak Bay	01	58°39.65' N	157°26.57' W
Kvichak Bay	02	58°41.70' N	157°33.45' W
Kvichak Bay	03	58°44.76' N	157°10.54' W

Table 2. Raw counts by area from the Bristol Bay population trend survey route, 1998 and 1999. Daily counts for different areas (e.g., Cinder River, Egegik Bay) represent the sum of counts for all the individual sites surveyed within that area (Appendix I and II). Daily and mean counts have not been adjusted through a covariate analysis.

AREA	14-Aug	15-Aug	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug	MEAN
1998										
Port Moller	2791	3810		2863	3611		3467	3833		3396
Seal Island	79	263		292	225		374	455		281
Port Heiden	2046	2723		4558	4547		4878	5231		3997
Cinder River	205	360		360	400		208	517		342
Ugashik Bay	1422	1667		1556	573		1038	1243		1250
Egegik Bay	1062	1239		1018	889		1119	1134		1077
Kvichak Bay							572	623		598
1999										
Port Moller			3439	3149		2949	4304	4506	4441	3798
Seal Island			585			66	708	696	524	516
Port Heiden					1445	3346	3898	2989	3440	3024
Cinder River			638		806	497	771	789	696	700
Ugashik Bay			1418		1448	1398	1353	1431	1141	1365
Egegik Bay			1040	942	449	1057	970	1304	958	960
Kvichak Bay			1056	974	1034	633	477	825	883	840

Table 3. Locations and substrate type of harbor seal haulout sites surveyed in 1998 and 1999 in Lake Iliamna, Alaska.

Location	Site#	GPS Coordinates		Substrate
Lake Iliamna	01	59°42.76' N	154°12.83' W	Rocky Islet
Lake Iliamna	02	59°42.87' N	154°23.61' W	Island with sandy shore on W side
Lake Iliamna	03	59°43.33' N	154°25.13' W	Island with sandy shore
Lake Iliamna	04	59°45.07' N	154°26.42' W	Island with sandy shore
Lake Iliamna	05	59°44.96' N	154°26.29' W	Island with sand and gravel shore
Lake Iliamna	06	59°43.92' N	154°29.24' W	Island with sand and gravel shore
Lake Iliamna	07	59°33.53' N	154°51.33' W	Island with sand and gravel shore
Lake Iliamna	08 ^a	59°33.10' N	154°52.50' W	
Lake Iliamna	09 ^a	59°32.30' N	154°56.40' W	Island with sandy shore

^aCoordinates for sites LI08 and LI09 are from Mathisen and Kline (1992); neither of these sites was definitively located in 1998, and only site LI09 was located in 1999.

Table 4. Raw counts of harbor seals at haulout sites in Lake Iliamna, Alaska, 1998 and 1999.

Site	13-Aug-98	22-Aug-98	23-Aug-99
LI01	2	0	0
LI02	98	0	35
LI03	11	0	0
LI04	124	194	133
LI05	29	0	0
LI06	9	0	0
LI07	48	24	57
LI09			0
TOTAL	321	218	225

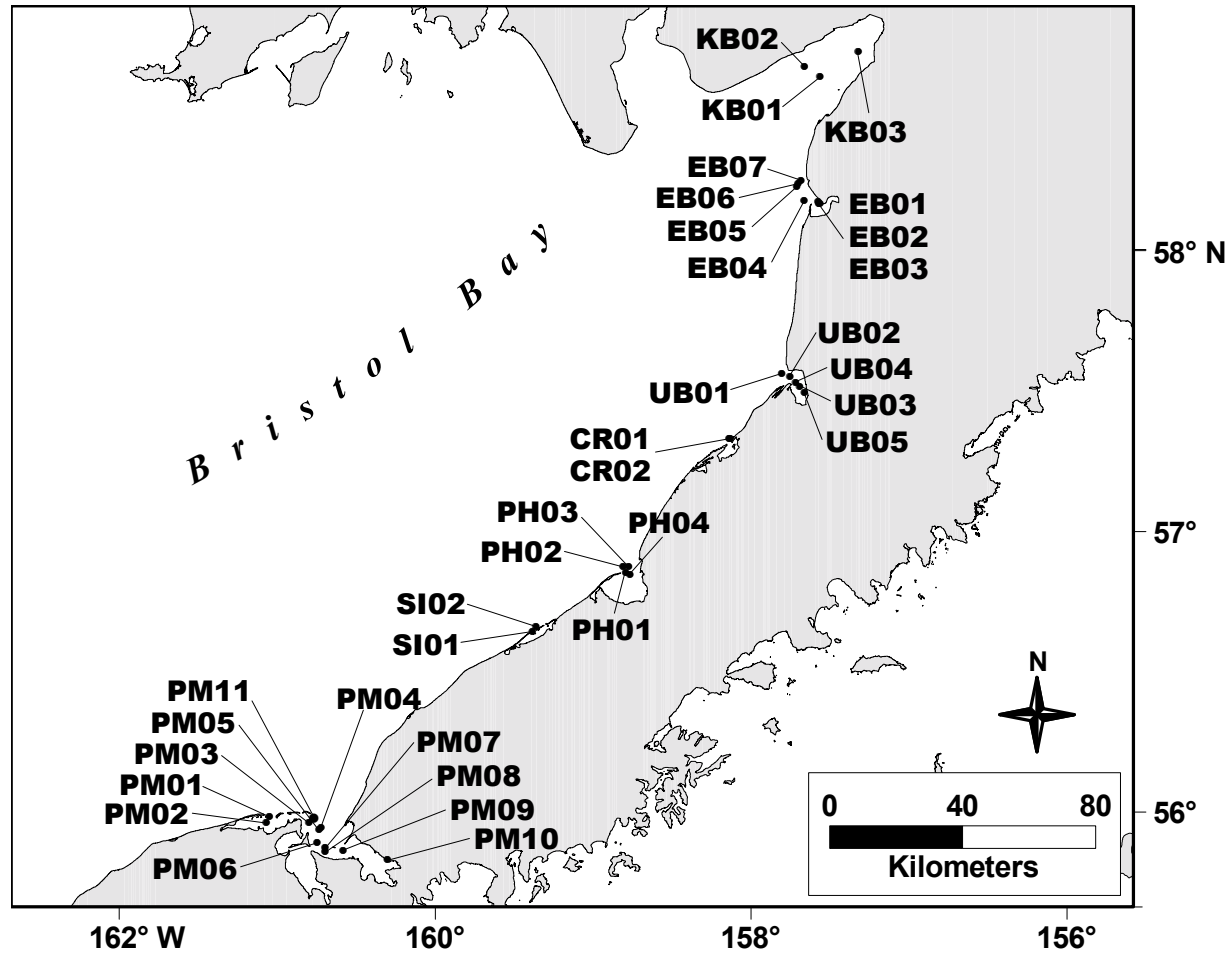


Figure 1. Location of the 34 haulout sites where counts of harbor seals were obtained during aerial surveys in 1998 and 1999 to estimate population trend in southern Bristol Bay, Alaska.

Appendix I. Location and counts of harbor seals at five haulout sites in the Port Moller area located on 14 August 1998 that were not included as part of the Bristol Bay trend route. Site numbers are those used by the NMFS during their 1995 survey.

Location	Site#	GPS Coordinates		Substrate	Count
Nelson Lagoon	20	55°58.68' N	161°00.50' W	Sandbar	4 ^a
Herendeen Bay	22	55°49.47' N	160°46.27' W	Small Rocky Island	16
Herendeen Bay	23	55°45.77' N	160°41.64' W	Small Rocky Island	85
Herendeen Bay	24	55°45.64' N	160°43.72' W	Small Rocky Island	8
Herendeen Bay	25	55°50.19' N	160°53.35' W	Sandbar	9

^aAdditional counts were obtained on 15 August (n=4) and 17 August (n=0) 1998.

Appendix II. 1998 harbor seal aerial survey counts from the Bristol Bay trend route. Site names refer to the following areas: PM=Port Moller, SI=Seal Island, PH=Port Heiden, CR=Cinder River, UB=Ugashik Bay, EB=Egegik Bay, KB=Kvichak Bay.

SITE	14-Aug	15-Aug	17-Aug	18-Aug	20-Aug	21-Aug
PM01	508	296	340	416	420	337
PM02	472	628	433	764	740	838
PM03	771	830	437	644	502	761
PM04		255	618	660	733	717
PM05	103	883	113	117	214	250
PM06	344	233	344	381	294	352
PM07	38	47	0	0	17	0
PM08	39	32	39	30	42	44
PM09	516	536	482	536	505	534
PM10		70	57	63	0	
SI01	62	69	0	0	0	0
SI02	17	194	292	225	374	455
PH01	955	1606	2529	2391	3386	3180
PH02		15	252	153	290	573
PH03	680	944	1594	1798	1102	1337
PH04	411	158	183	205	100	141
CR01	205	84	0	309	105	17
CR02	0	276	360	91	103	500
UB01	140	119	453	547	213	150
UB02	80	4	174	7	0	0
UB03	201	35	882	1	54	0
UB04	1001	1403	0	0	642	839
UB05		106	47	18	129	254
EB01	26	0	341	0	432	397
EB02	136	0	0	366	0	0
EB03	219	411	0	0	0	0
EB04	95	57	34	39	22	22
EB05		583	269	200	258	470
EB06	586	188	374	284	407	171
EB07						74
KB01					526	558
KB02					4	9
KB03					42	56

Appendix III. 1999 harbor seal aerial survey counts from the Bristol Bay trend route. Site names refer to the following areas: PM=Port Moller, SI=Seal Island, PH=Port Heiden, CR=Cinder River, UB=Ugashik Bay, EB=Egegik Bay, KB=Kvichak Bay.

SITE	16-Aug	17-Aug	18-Aug	19-Aug	20-Aug	21-Aug	22-Aug
PM01	728	310		137	453	366	353
PM02				315	505	605	546
PM03	341	445		479	558	501	560
PM04	867	470		358	540	444	631
PM05	478	652		937	991	1211	1009
PM06	358	417		2	405	434	482
PM07	8	26		25	11	0	8
PM08	53	90		0	46	38	57
PM09	551	683		633	676	689	719
PM10	55	56		63	56	61	61
PM11					63	157	15
SI01	0			0	0	0	0
SI02	585			66	708	696	524
PH01			0	0	0	0	0
PH02			0	46	0	0	0
PH03			1078	2855	3538	2729	3247
PH04			367	445	360	260	193
CR01	638		806	497	771	789	696
CR02	0		0	0	0	0	0
UB01	642		567	562	619	758	373
UB02	0		0	0	0	0	0
UB03	776		809	0	725	25	0
UB04	0		72	836	9	648	768
UB05	0		0	0	0	0	0
EB01	249		0	247	0	24	166
EB02	58	314	0	80	43	18	52
EB03	0	44	328	0	333	354	112
EB04	100	108	121	113	82	85	86
EB05	633	378		47	512	0	246
EB06	0	98		570		823	296
EB07	0	0		0	0	0	0
KB01	1024	945	987	573	429	802	859
KB02	12	18	23	29	18	6	16
KB03	20	11	24	31	30	17	8