ANALYSIS OF AT-SEA JUVENILE STELLER SEA LION LOCATION DISTRIBUTION FOR GROUNDFISH FISHERY BIOLOGICAL OPINION 2009
January 2010

INTRODUCTION

Analyses of Steller sea lion (*Eumetopias jubatus*) at-sea locations prepared for consideration in Biological Opinions assessing potential impacts of Bering Sea and Gulf of Alaska groundfish fisheries on endangered and threatened stocks of Steller sea lions in Alaska have used data obtained from satellite telemetry deployments since 2000 and pooled among individuals. An analysis prepared for the March 2003 addendum to the October 2001 Biological Opinion (NMFS 2003) was based on 63 instrument deployments by NMML during 2000-2003, and was expanded in 2006[1] to include data from a total of 116 deployments by the National Marine Mammal Laboratory (NMML) and the Alaska Department of Fish and Game (ADFG) during 2000-2005. Those analyses determined the frequency of locations associated with diving to >4 m (as an indicator of possible foraging behavior) within 0-10 nm, 10-20 nm, and >20 nm of the nearest listed rookery or haul-out by pooling the locations obtained from all individuals. While that analysis showed a distribution of locations among those categories and indicated some age, seasonal and regional differences, it did not account for individual contribution to the overall distribution (for example, whether an individual sea lion provided 1 or over 100 locations), or explore individual variability particularly with respect to the critical habitat distance bins.

Here the same data were used but the locations associated with diving to >4 m were considered by individual. For each individual cumulative frequency distributions were calculated in 1-nm bins to show the proportion of locations by distance to the nearest listed site (rookery or haulout). This perspective provides a better understanding of individual variability not captured in the previous analysis, and by inspection of the distance distributions provides an indication to the extent 10 nm and 20 nm distance bins encompass potential foraging locations of juvenile sea lions in the western stock geographic region of Alaska.

METHODS

Satellite-linked dive recorders (SLDRs) were deployed on juvenile Steller sea lions as described in Loughlin et al. (2003), Raum-Suryan et al. (2004), Fadely et al. (2005) and Pitcher et al. (2005). Methods used for location processing, filtering, and combining with dive data were described in NMFS (2003) and the May 2006[1] update and are briefly summarized here. This analysis used locations filtered from Service-Argos calculated position fixes obtained from SLDRs deployed on 116 Steller sea lions during 2000-2005 by NMML and ADFG (Table 1). These locations were then error-checked and combined with dive behavior data collected and summarized into 6-hr periods by the SLTDRs. After error-checking location and dive records, further processing associated the 6-hr binned diving data to related at-sea locations. Because it is not possible to definitively determine which locations were associated with foraging, a metric of diving to depths greater than 4 m (>4 m) was chosen as a conservative index that would also deemphasize aggregations of position fixes near shore associated with travel in and out of hauling sites. Thus further filtering removed locations that were not associated with diving to >4 m within a 6-hr time period. A total of 65,150 locations from all 116 animals were extracted from the database for processing. Of those initial locations 50,709 locations were removed

[1] NMML update to NMFS Alaska Regional Office, Juneau, AK, May 2006.

because they were location class (LC) B (14,587 or 22.39%), did not fit the dive >4 m criteria (12,335 or 18.39%), were on-land locations (9,281 or 14.25%), were determined invalid due to duplicity, time of transmission, poor quality (LC Z) or were calculated prior to deployment (6,703 or 10.29%), were determined to be dry at the time of transmission (5,307 or 8.15%), or due to other error-checking (2,496 or 3.83%). For this analysis, the remaining 14,441 (22.17% of the original 65,150) locations were considered by individual sea lion. Cumulative frequencies as proportions of the total locations for an individual were determined by summing the number of locations within progressive 1-nm distance bins (e.g., 0-1 nm, 1-2 nm, etc.) to the nearest listed haulout or rookery, regardless of the trip origin or destination location. The distance of a location to a listed site is not necessarily equivalent to the distance of the same location to shore.

Groups compared in this analysis were season (summer: April-September; winter: October-March) and age class (3-10 months and >10 months) as conducted in the May 2006 analysis, except that in May 2006 ages were categorized based on the estimated age at capture and for this analysis we used the estimated age at time of location fix. Because some deployments on individual sea lions spanned both age categories, this adjustment provides a better indication of age-related behaviors. Estimated age at time of position fix was determined by calculating the elapsed time between date of capture and date of position fix, then adding to the estimated age of the sea lion at capture assuming a median pup birth date of June 12. Estimated ages of sea lions ranged from 3-28 months old, but locations were predominantly from 9-13 month old sea lions. Estimated ages for the 3-10 month age class in summer were 3.3-10 months, and in winter 3.6-9.6 months. For the >10 month age class, the summer age range was 10.0-27.3 months, and winter 15.6-27.9 months.

Also novel to this analysis was grouping locations associated with diving to >4 m within 11 analytical zones (Figure 1), similar to other analyses conducted for the current Biological Opinion. Locations associated with diving to >4 m were assigned to analytical zones 1-10, the Steller Sea Lion Conservation Area (SSLCA), or the northwestern/northeastern Bering Sea (NWBS/NEBS) spatially in ArcGIS. In the cases where individual sea lions travelled among multiple zones, cumulative frequencies of distance to listed site were calculated for an individual within each unique zone entered. Thus, proportions of location distances by animal were standardized by the total number of locations for an individual within the maximum distance achievable within a specific zone. For the zone-stratified analysis, locations received outside of any analytical zone were excluded.

Tabular comparisons among seasons and age classes (Table 2) or analytical zones (Table 3) are presented as the number of sea lions within the group of interest that had at least half (50%), three-quarters (75%) or all (100%) of their locations associated with diving to >4 m within 10 nm and 20 nm of a listed haul-out or rookery as three measures of inclusiveness. For group-stratified analyses only sea lions with at least 10 locations within a group were included.

RESULTS AND DISCUSSION

Season/age-class patterns

Of the 116 sea lions with filtered locations associated with diving to >4 m, 14 were excluded due to not having at least 10 locations within any age class-season combination. In the May 2006 analysis, most (78-95%) locations associated with diving to >4 m occurred within 10 nm of a

listed site when collectively grouped by age category and season. Individual-based results of this analysis are consistent with that finding in that most individuals had at least 75% of their dive locations within 10 and 20 nm range to a listed site (Table 2, Figure 2), but not all diving locations of any individual sea lion were encompassed by those boundaries for any age-season combination. For sea lions 3-10 months old, all diving locations in summer for about two-thirds of the individuals (25/39) were within 10 nm and for four-fifths (32/39) of the individuals within 20 nm (Table 2). In winter, about half of the 3-10 month-old individuals diving locations were entirely within 10 nm, and three-quarters of the individuals entirely within 20 nm. This age class is the most likely to be wholly or partially dependent upon maternal care, yet not all individuals displayed similar patterns. Of the 39 sea lions in summer, 5 displayed a pattern of progressive use with more >4 m diving locations within the 10-20 nm range (Figure 2).

Sea lions >10 months old tended to have more locations more distant from a listed site than 3-10 month olds, reflected by lower cumulative proportion of locations ≤10 nm from a listed site in both seasons (Figure 2, Table 2). In contrast to the 3-10 month old age group, only one third of the >10 month old sea lions had all of their dive locations within 10 nm of a listed site, and two-thirds of the sea lions had all of their diving to >4 m within 20 nm (Table 2). In winter there was only a sample size of 13 sea lions greater than 10 months old, but of those only one had all diving locations within 10 nm, and half had all locations within 20 nm (Table 2).

Analytical zone patterns

This analysis does not estimate habitat use or selection, but does provide an indication to what extent potential foraging activity by individual sea lions is encompassed within 10 nm and 20 nm ranges of critical habitat. Of the 116 sea lions with filtered locations associated with diving to >4 m (Table 1), 103 had at least 10 locations within a unique zone that were used to generate individual cumulative distance distributions. Of those animals, 81 had locations within a single zone, 13 within two zones, 7 within three zones, and 2 within four zones. No locations were recorded in the NWBS, and only one was attributed to the NEBS. Two animals had locations outside of any delimited analytical zone (Table 1), thus 64 locations obtained from two sea lions (7620 and 7621) in the western Aleutian Islands were excluded (Table 1, Figure 1). The distribution of sea lion capture sites was not uniform across the analytical zones; no sea lions were captured and instrumented in zones 1, 2, 7, or 8. However, sea lions entered those zones areas from other areas and in Zones 1, 2 and 8 were male sea lions only (Table 1).

Cumulative distributions of proportions are shown for individuals among Zones 1-10 and the SSLCA as lines representing the value for each histogram distance bin (Figure 3). Patterns varied greatly by region (Figure 3, Table 3), consistent with the May 2006 analysis. Not evident in the earlier analysis however was the extent of regional and individual variation (Figure 3). Locations associated with diving to >4 m by individuals in zones 1-2 and 8 showed much greater proportions of locations outside of 20 nm to a listed site than did sea lions among other analytical zones (Figure 3, Table 3). The 20 nm distance from a listed site encompassed all locations associated with diving to >4 m for all animals in Zone 6 only (Table 3). No animals in Zones 1 or 2 had more than 75% of their locations within 10 or 20 nm of a listed site, and only one sea lion had at least 50% of locations within 20 nm (Table 3, Figure 3). Of the three animals in Zone 1, one did not have any locations associated with diving to >4 m within 20 nm of a listed site. In other zones, most or all sea lions have at least 75% of their diving locations encompassed within

10 and 20 nm buffers (Table 3). Over all the zones, just under a third of the sea lions had 100% of their locations associated with diving >4 m within 10 nm,

To further explore patterns in distances to nearest listed sites of locations associated with diving to >4 m by individuals relative to 10 and 20 nm critical habitat boundaries, the smallest distance bin that encompassed at least 95% of an individual's dive locations was identified and rank ordered by distance (Figure 4). Of the 135 individual distributions (Table 2, Figure 3), the distance bin that enclosed at least 95% of locations was ≤10 nm for 80 individuals, between 11-20 nm for 29 individuals, and >20 nm for 26 individuals (Figure 4). These locations showed a monotonic increase in rank through 10 nm without clear breaks or jumps among distance bins (Figure 4). As expected from plots of individual distributions (Figure 3) there were considerable regional differences (Figure 5). Distance bins inclusive of 95% of diving locations for individuals fell outside of 20 nm in analytical zones 1, 2 and 8 (Figure 5), reflecting the broad distance ranges of diving locations displayed by sea lions in those areas. Sea lion age also influenced the distance encompassing 95% of diving locations (Figure 6). Most sea lions ≤10 months-old in summer (estimated ages 9.6-10 months) and winter (estimated ages 3.6-9.6 months) exhibited 95% of their diving locations within 10 nm of the nearest listed site (summer 32 of 39 sea lions, winter 48 of 59 sea lions). However, distances encompassing 95% of the dive locations for sea lions 10 months-old and older in summer (10-26.2 months old) and winter (15.6-21.6 months old) were more broadly distributed with only 40 of 85 sea lions in summer and 3 of 13 sea lions in winter having the 95% location distance within 10 nm of a listed site (Figure 6). These patterns are consistent with those found in the 2006 update analysis that showed more locations outside of critical habitat occurred in the central/western Aleutian Island area and in summer by the >10 month old age group.

LITERATURE CITED

Fadely, B.S., Robson, B.W., Sterling, J.T., Greig, A. and Call, K.A. (2005) Immature Steller sea lion (*Eumetopias jubatus*) dive activity in relation to habitat features of the eastern Aleutian Islands. Fisheries Oceanography, 14, 243-258.

Loughlin, T.R., Sterling, J.T., Merrick, R.L., Sease, J.L. and York, A.E. (2003) Diving behavior of immature Steller sea lions (*Eumetopias jubatus*). Fish B-Noaa, 101, 566-582.

NMFS. 2003. Addendum to the Endangered Species Act-Section 7 Consultation, Biological Opinion and Incidental Take Statement of October 2001. NMFS, Alaska Region, Protected Resources Division.

Pitcher, K.W., Rehberg, M.J., Pendleton, G.W., Raum-Suryan, K.L., Gelatt, T.S., Swain, U.G. and Sigler, M.F. (2005) Ontogeny of dive performance in pup and juvenile Steller sea lions in Alaska. Can J Zool, 83, 1214-1231.

Raum-Suryan, K.L., Rehberg, M.J., Pendleton, G.W., Pitcher, K.W. and Gelatt, T.S. (2004) Development of dispersal, movement patterns, and haul-out use by pup and juvenile Steller sea lions (*Eumetopias jubatus*) in Alaska. Mar Mammal Sci, 20, 823-850.

Table 1. Distribution of 14,441 Steller sea lion telemetry positions associated with diving to >4 m by 116 individuals among analytical zones (as shown in Figure 1; SSLCA = Steller Sea Lion Conservation Area, NEBS = North Eastern Bering Sea, Out = outside of any zone). Shaded cell indicates zone in which sea lion was captured.

					Analytical Zone												
ID	Deploy date	Sex	Capture age (mo)	Capture location	1	2	3	4	5	6	SSLCA	7	8	9	10	NEBS	Out
6115	9-Mar-01	M	9	Sea Otter									1	146			
6124	2-Aug-01	F	14	Cape Chiniak, Kodiak										109			
6283	6-Mar-01	M	9	Long Island, Kodiak										55	31		
6284	6-Mar-01	F	9	Long Island, Kodiak										4			
6285	7-Mar-01	F	9	Long Island, Kodiak										110			
6286	9-Mar-01	M	9	Sea Otter										245			
6287	9-Mar-01	M	9	Sea Otter										198			
6288	10-Mar-01	M	9	Sea Otter										329			
6289	12-Mar-01	M	9	Long Island, Kodiak										202			
6290	12-Mar-01	M	9	Long Island, Kodiak										86			
6291	12-Mar-01	M	9	Long Island, Kodiak										150			
6292	12-Mar-01	M	9	Long Island, Kodiak										169			
6293	13-Mar-01	F	9	Long Island, Kodiak									2	261			
6294	13-Mar-01	M	9	Long Island, Kodiak										349			
6295	29-Feb-00	F	9	Turf Pt. Seguam Is.					50								
6296	29-Feb-00	F	9	Turf Pt. Seguam Is.					36								
6297	29-Feb-00	F	9	Turf Pt. Seguam Is.					44								
6298	29-Feb-00	M	9	Turf Pt. Seguam Isl.				51	67								
6299	9-Mar-00	F	9	Aiktak						6		26					
6300	9-Mar-00	M	9	Aiktak							86	17					
6301	12-Mar-00	M	21	Long Island, Kodiak										165			
6302	12-Mar-00	M	9	Long Island, Kodiak										104			
6303	26-Feb-01	M	21	Reef Bite							20						
6304	1-Mar-01	F	9	Aiktak								76					
6305	1-Mar-01	F	9	Ugamak								136					
6306	3-Mar-01	F	21	Rocks off Tigalda						3	27	6					
6307	3-Mar-01	M	9	Rocks off Tigalda						16	24	78					
6308	3-Mar-01	F	9	Aiktak					5	36	67	56					

Table 1, continued.

					Analytical Zone												
ID	Deploy date	Sex	Capture age (mo)	Capture location	1	2	3	4	5	6	SSLCA	7	8	9	10	NEBS	Out
6309	3-Mar-01	F	9	Aiktak						2	3	69					
6310	3-Mar-01	F	9	Aiktak						13	21	141					
6311	4-Mar-01	F	21	Billingshead, Akun						1	29						
6312	4-Mar-01	F	9	Billingshead, Akun							3						
6466	13-Nov-01	F	5	Ugamak								19					
6475	12-Mar-02	M	9	Aiktak						13	72	105					
6647	5-Mar-02	M	9	Two Headed Rock, Kodiak										30			
6966	7-Aug-01	M	14	Two Headed Rock, Kodiak									2	34			
6967	8-Aug-01	F	14	Two Headed Rock, Kodiak										57			
7467	28-Feb-02	M	9	Cape Chiniak, Kodiak									27	217			
7468	2-Mar-02	M	9	Long Island, Kodiak									68	352			
7469	2-Mar-02	M	9	Long Island, Kodiak							3	2	2	92			
7471	3-Mar-02	M	9	Long Island, Kodiak										115			
7473	3-Mar-02	F	9	Long Island, Kodiak										75			
7474	4-Mar-02	F	9	Long Island, Kodiak										194			
7476	5-Mar-02	F	24	Two Headed Rock, Kodiak									2	41			
7478	5-Mar-02	M	9	Two Headed Rock, Kodiak										13			
7479	5-Mar-02	M	9	Two Headed Rock, Kodiak										62			
7481	10-Mar-02	F	9	Basalt Rock						4		96					
7482	11-Mar-02	F	9	Aiktak							2	125					
7483	11-Mar-02	M	9	Aiktak						80	75	144				1	
7484	11-Mar-02	M	9	Aiktak						8	2	134					
7485	11-Mar-02	M	9	Aiktak							6	96					
7486	11-Mar-02	M	9	Aiktak						3	2	130					
7487	11-Mar-02	F	9	Aiktak						2	45	10					
7488	12-Mar-02	M	9	Aiktak						16	7	153					
7489	12-Mar-02	F	9	Aiktak						2	6	107					
7576	17-Sep-01	F	3	Cape Morgan, Akutan						4	4						
7578	17-Sep-01	F	3	Cape Morgan, Akutan							5						
7585	6-Nov-01	F	5	Bull Head, Glacier Is.											43		
7586	6-Nov-01	M	17	Bull Head, Glacier Is.											232		
7589	7-Nov-01	F	17	Bull Head, Glacier Is.											183		

Table 1, continued.

					Analytical Zone												
ID	Deploy date	Sex	Capture age (mo)	Capture location	1	2	3	4	5	6	SSLCA	7	8	9	10	NEBS	Out
7592	8-Nov-01	F	5	NE Haulout, Perry Is.											492		
7593	8-Nov-01	M	17	NE Haulout, Perry Is.											428		
7594	8-Nov-01	F	17	NE Haulout, Perry Is.											311		
7595	8-Nov-01	M	17	NE Haulout, Perry Is.											407		
7600	9-Nov-01	M	5	NE Haulout, Perry Is.											169		
7602	11-Nov-01	F	5	NE Haulout, Perry Is.											165		
7603	11-Nov-01	F	5	NE Haulout, Perry Is.											523		
7620	7-Apr-02	M	9	Bay of Waterfalls, Adak Is.	151	29	12	2									17
7621	7-Apr-02	M	9	Bay of Waterfalls, Adak Is.	23	16	17	13									47
7823	26-Jul-02	F	24	Cape Chiniak, Kodiak										61			
7824	26-Jul-02	M	12	Cape Chiniak, Kodiak										183			
7825	29-Jul-02	M	12	Two Headed Rock, Kodiak										34			
7827	29-Jul-02	M	12	Two Headed Rock, Kodiak										32			
7829	30-Jul-02	M	24	Two Headed Rock, Kodiak										53			
7830	1-Aug-02	F	12	Marmot Is.										156			
7831	2-Aug-02	F	24	Marmot Is.										25			
7832	2-Aug-02	M	24	Marmot Is.										24			
8237	3-Nov-01	M	17	Two Headed Rock, Kodiak									40	156			
8238	13-Nov-01	F	5	Ugamak						3	1	94					
8239	14-Nov-01	F	17	Aiktak						2	32	36			1		
8243	25-Feb-03	F	9	Long Island, Kodiak										260			
8244	27-Feb-03	M	9	Long Island, Kodiak										291			
8246	27-Feb-03	M	9	Long Island, Kodiak						2		49	24	238			
8247	27-Feb-03	M	9	Long Island, Kodiak										287			
8248	1-Mar-03	F	9	Cape Ugat, Kodiak									1	50			
8249	2-Mar-03	F	9	Cape Ugat, Kodiak									3	239			
8251	6-Mar-03	M	9	Rocks off Tigalda						29		134					
8253	7-Mar-03	M	9	Aiktak								133		1			
11210	23-Aug-00	M	14	The Needle, PWS											7		
11211	24-Aug-00	F	26	The Needle, PWS											8		
11212	23-Apr-00	F	10.5	Glacier Island, PWS											7		

Table 1, continued.

ID	Deploy date	Sex	Capture age (mo)	Capture location	Analytical Zone 1	2	3	4	5	6	SSLCA	7	8	9	10	NEBS	Out
11214	24-Apr-00	M	10.5	Glacier Island, PWS											8		
11215	24-Apr-00	F	10.5	Glacier Island, PWS											4		
11216	25-Apr-00	F	10.5	Glacier Island, PWS											22		
11217	25-Apr-00	M	10.5	Glacier Island, PWS											2		
11218	25-Apr-00	M	10.5	Glacier Island, PWS											4		
11219	25-Apr-00	F	10.5	Glacier Island, PWS											2		
11220	26-Apr-00	F	22.5	The Needle, PWS											22		
11221	28-Apr-00	F	22.5	Point Elrington, PWS											23		
11222	22-Aug-00	F	14	Glacier Island, PWS											10		
11223	23-Aug-00	F	14	The Needle, PWS										5			
11246	19-Apr-05	F	10	Silak Is.				117	1								
11247	19-Apr-05	F	10	Silak Is.				52									
11248	20-Apr-05	M	10	Little Tanaga Is.				39									
11249	22-Apr-05	M	10	Lake Point, Adak			10	94									
11250	22-Apr-05	M	10	Lake Point, Adak			5	38									
11251	22-Apr-05	M	10	Lake Point, Adak			8	154									
11252	22-Apr-05	M	10	Lake Point, Adak			14	22									
11253	22-Apr-05	F	10	Lake Point, Adak			86	31									
11255	24-Apr-05	F	10	Ship Rock, Kanaga			27										
11256	25-Apr-05	M	10	Ship Rock, Kanaga			196										
11257	25-Apr-05	M	10	Ogalala Pt., Kagalaska	1		2	54									
11258	25-Apr-05	F	10	Ogalala Pt., Kagalaska				37									
11260	2-May-05	M	11	Lake Point, Adak	1		2	239									
11261	2-May-05	M	11	Lake Point, Adak	88	104	76	39									
11262	2-May-05	F	11	Lake Point, Adak			27	2									
				Total locations with diving to >4 m:	264	149	482	984	203	245	542	2172	172	6059	3104	1	64
				Sea lions with diving to >4 m in zone:	5	3	13	16	6	20	23	26	11	45	24	1	2
				Sea lions tagged in zone:	0	0	2	15	4	29	0	0	0	43	23		

Table 2. Number of juvenile Steller sea lions with greater than 50%, 75%, or all of their locations associated with diving to >4 m contained within 10 and 20 nm distances to nearest listed haul-out or rookery stratified by season (summer: April-September, winter: October-March) and age class. Taken from the cumulative distributions shown in Figure 2.

			10 nm			20 nm		
Season	Age class	Individuals	≥50%	≥75%	100%	≥50%	≥75%	100%
Summer	3-10 mo	39	36	35	25	37	36	32
	>10 mo	77	71	65	24	74	69	51
Winter	3-10 mo	59	58	55	30	59	59	44
	>10 mo	13	13	11	1	13	13	7

Table 3. Number of Steller sea lions with greater than 50%, 75%, or all of their locations associated with diving to >4 m contained within 10 and 20 nm distances to nearest listed haul-out or rookery. Zones are analytical zones as shown in Figure 1.

		10 nm			20 nm		
Zone	Individuals	≥50%	≥75%	100%	≥50%	≥75%	100%
1	3	0	0	0	1	0	0
2	3	0	0	0	0	0	0
3	8	6	5	5	8	6	5
4	14	13	12	7	13	13	10
5	4	4	4	3	4	4	3
6	7	7	7	4	7	7	7
SSLCA	11	11	8	1	11	10	8
7	24	22	21	10	23	22	13
8	4	1	0	0	2	2	0
9	42	41	40	9	42	40	28
10	15	14	13	0	15	15	7

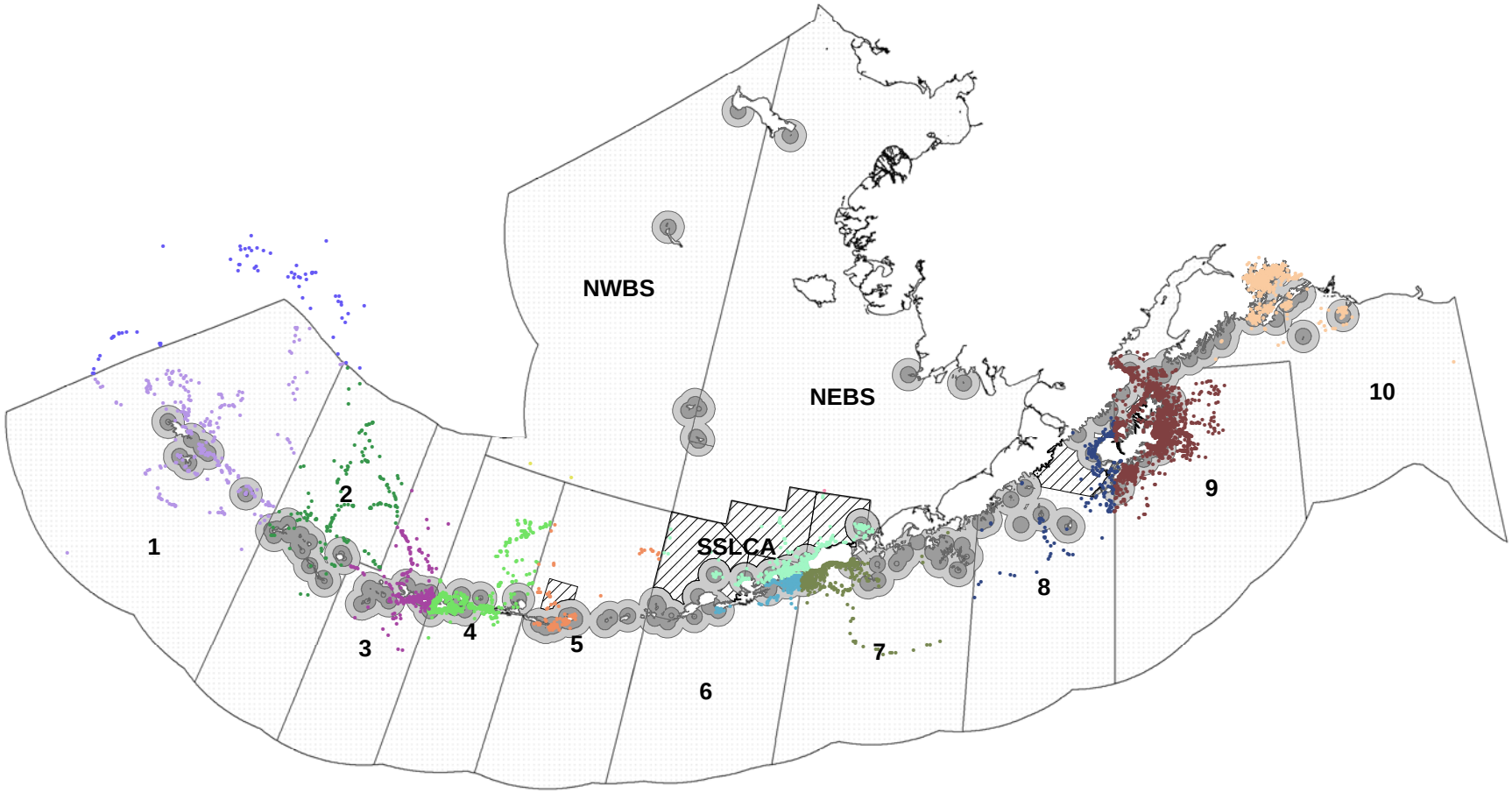


Figure 1. Telemetry locations associated with diving to >4 m by 116 Steller sea lions during 2000-2005, shown with analytical zone boundaries (NWBS = Northwest Bering Sea; NEBS = Northeast Bering Sea; SSLCA = Steller Sea Lion Conservation Area).

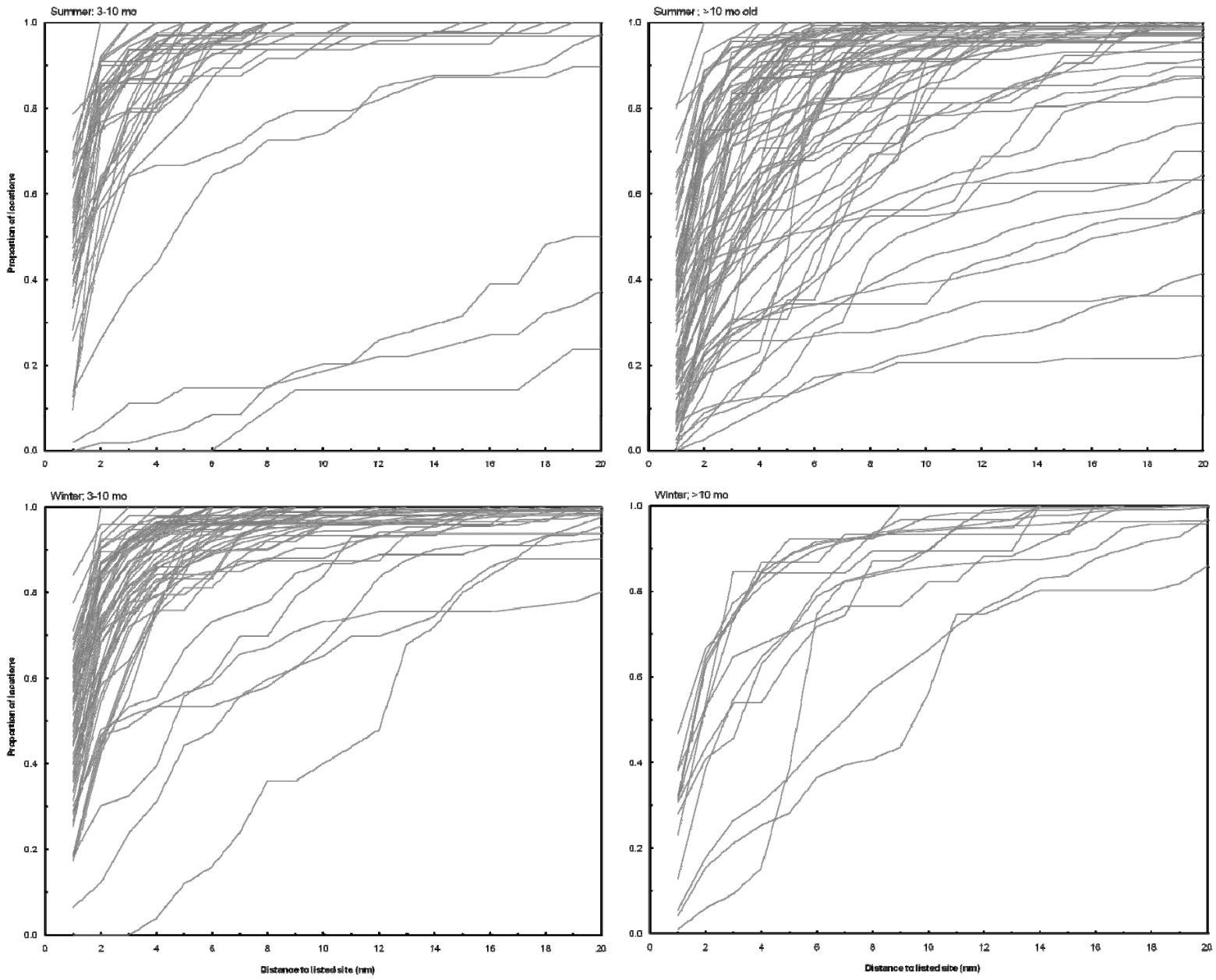

Summer: 3-10 mo
Summer ; >10 mo old
Winter; 3-10 mo
Winter; >10 mo
Proportion of locations
Distance to listed site (nm)
0.0
0.2
0.4
0.6
0.8
1.0
0
2
4
6
8
10
12
14
16
18
20

Figure 2. Cumulative distributions of distance (up to 20 nm shown only) to nearest listed site by individual of juvenile Steller sea lion locations associated with diving to >4 m in summer (April-September) for 3-10 month (n = 39) and >10 month olds (n = 77), and in winter (October-March) for 3-10 month (n = 59) and >10 month olds (n = 13).

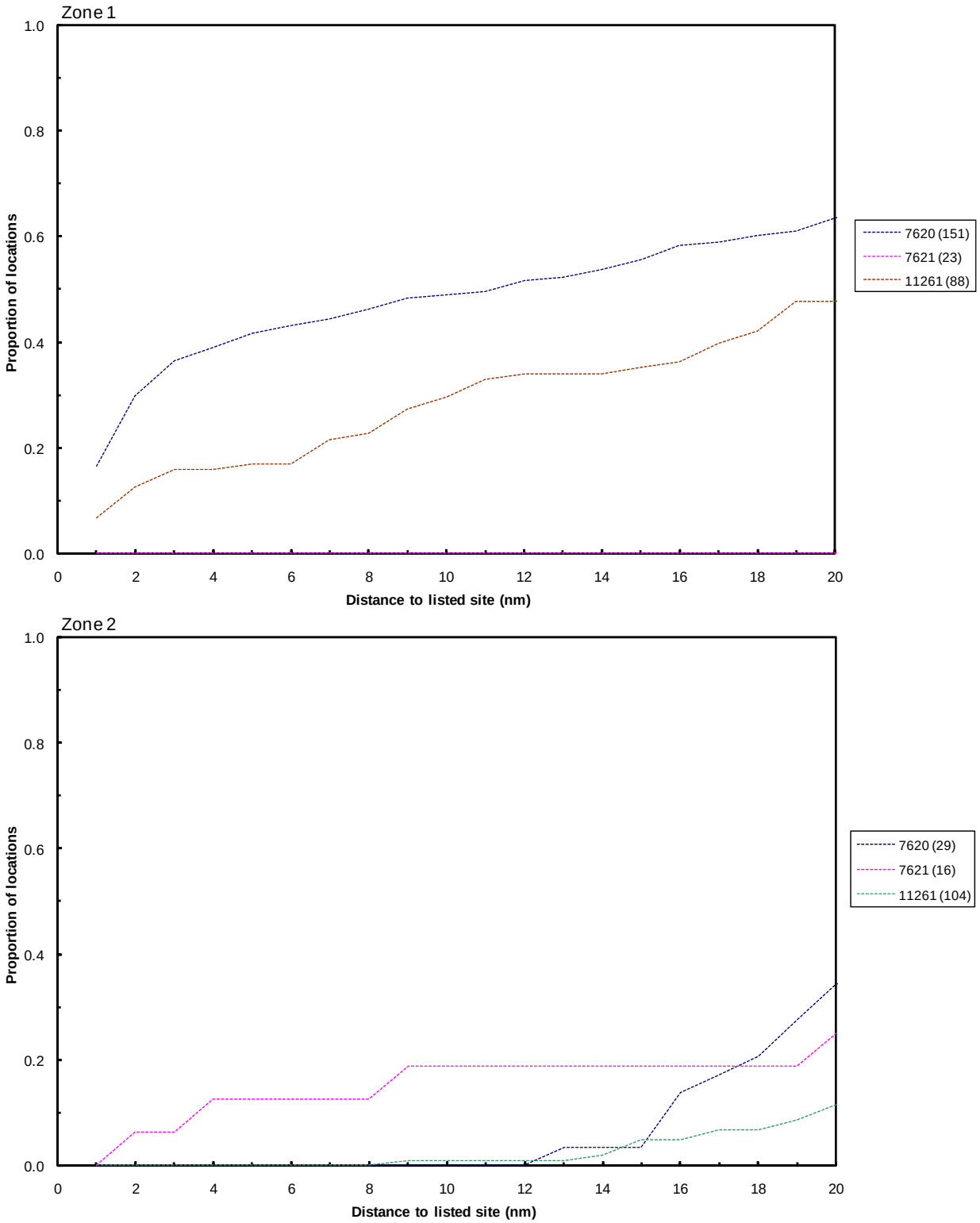


Figure 3. Cumulative distribution of locations associated with dives to >4 m by analytical zone (shown in Figure 1) for distances up through the 19-20 nm bin. Legend indicates animal identifier and number of locations.

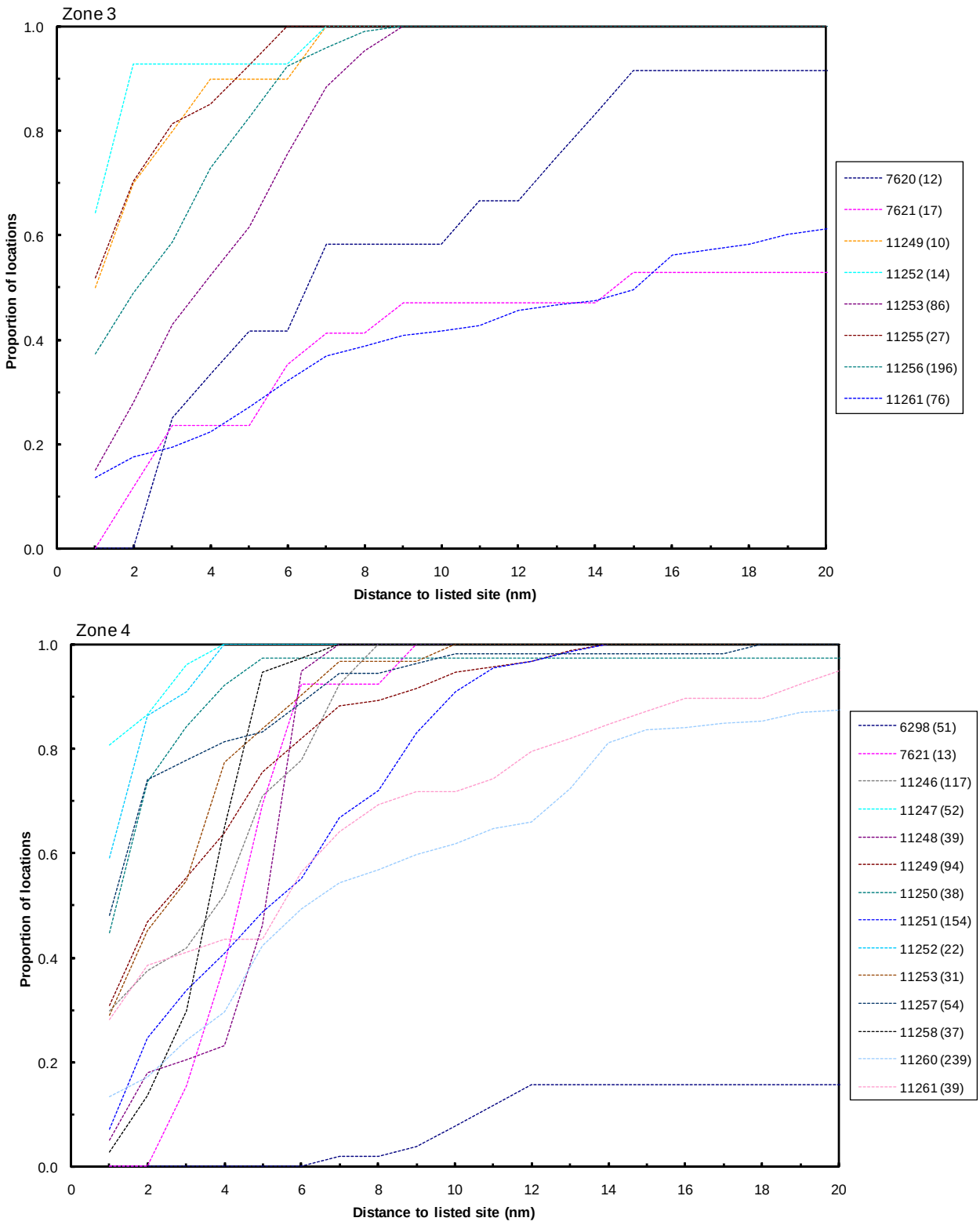
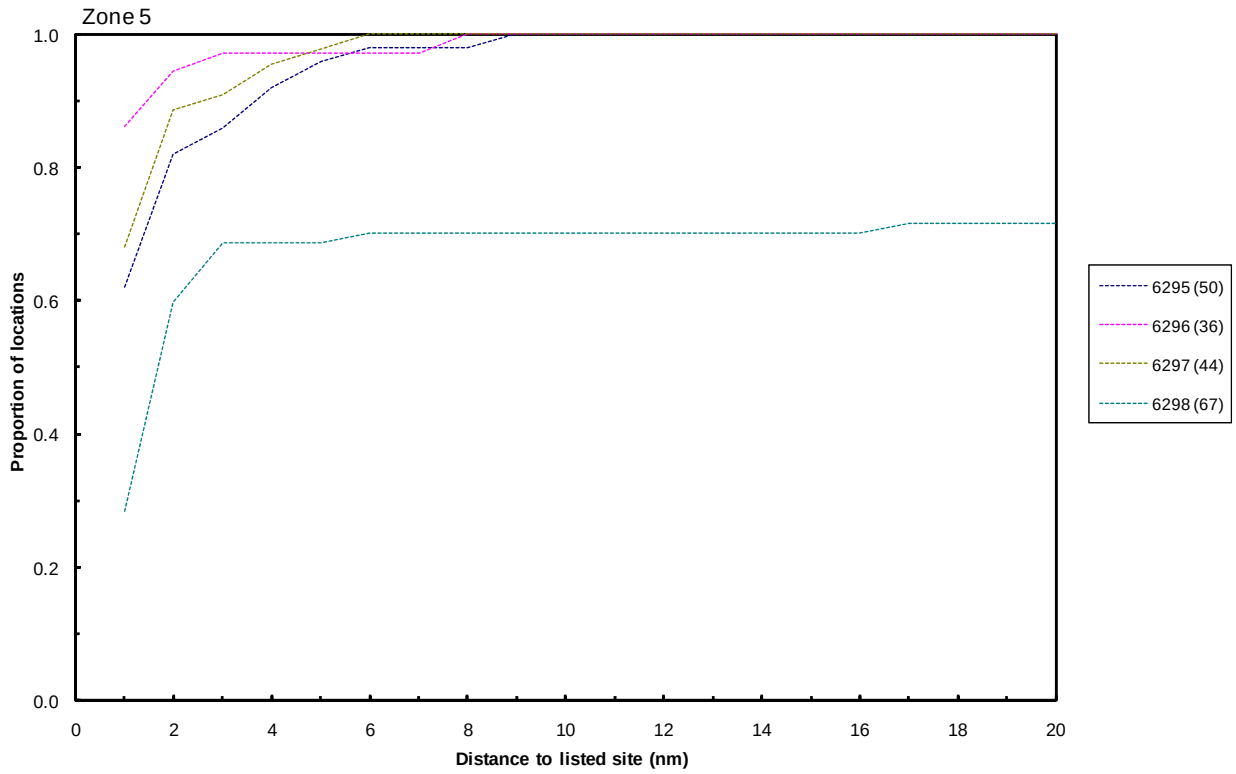


Figure 3, continued.



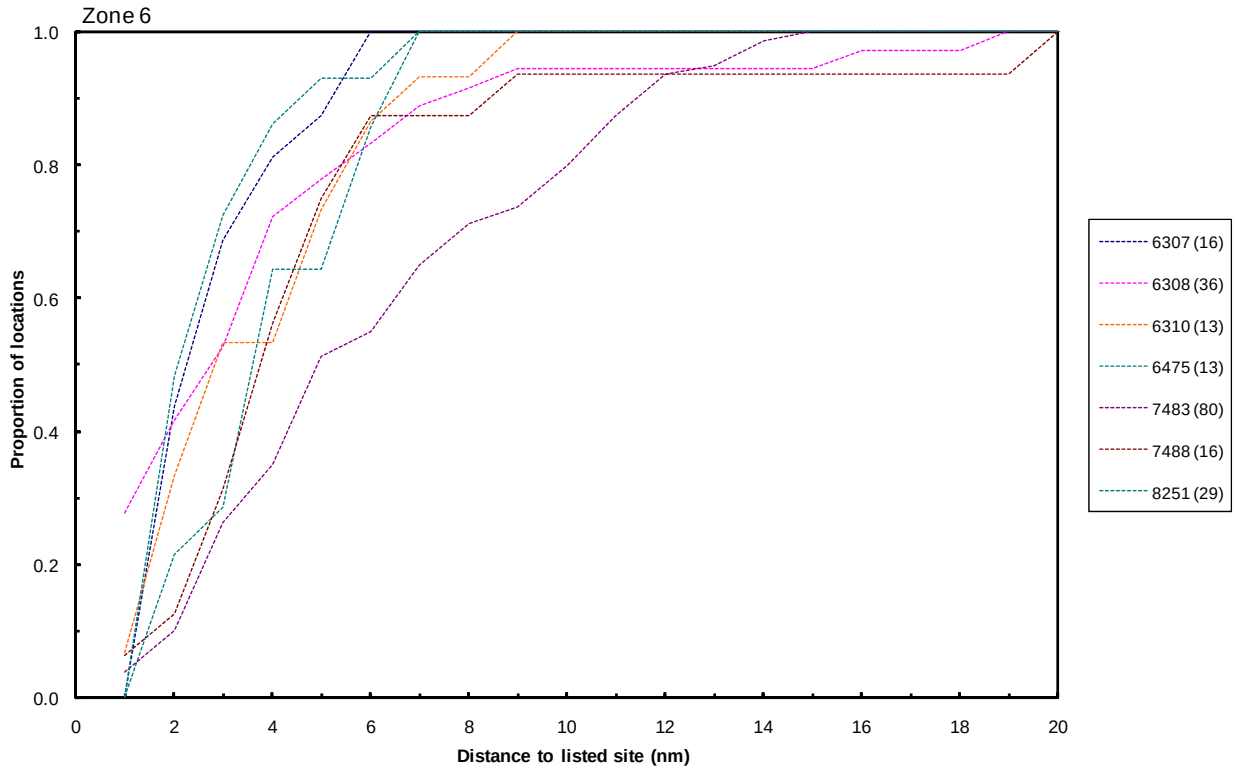
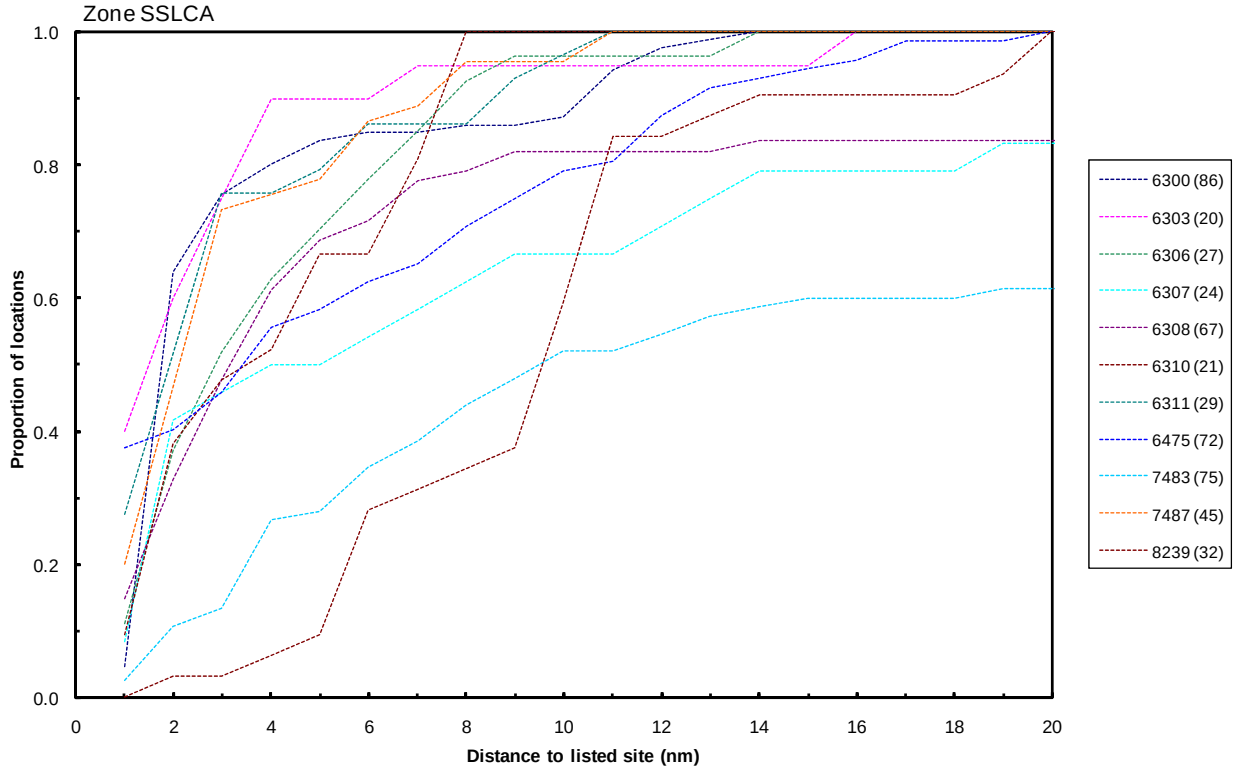


Figure 3, continued.



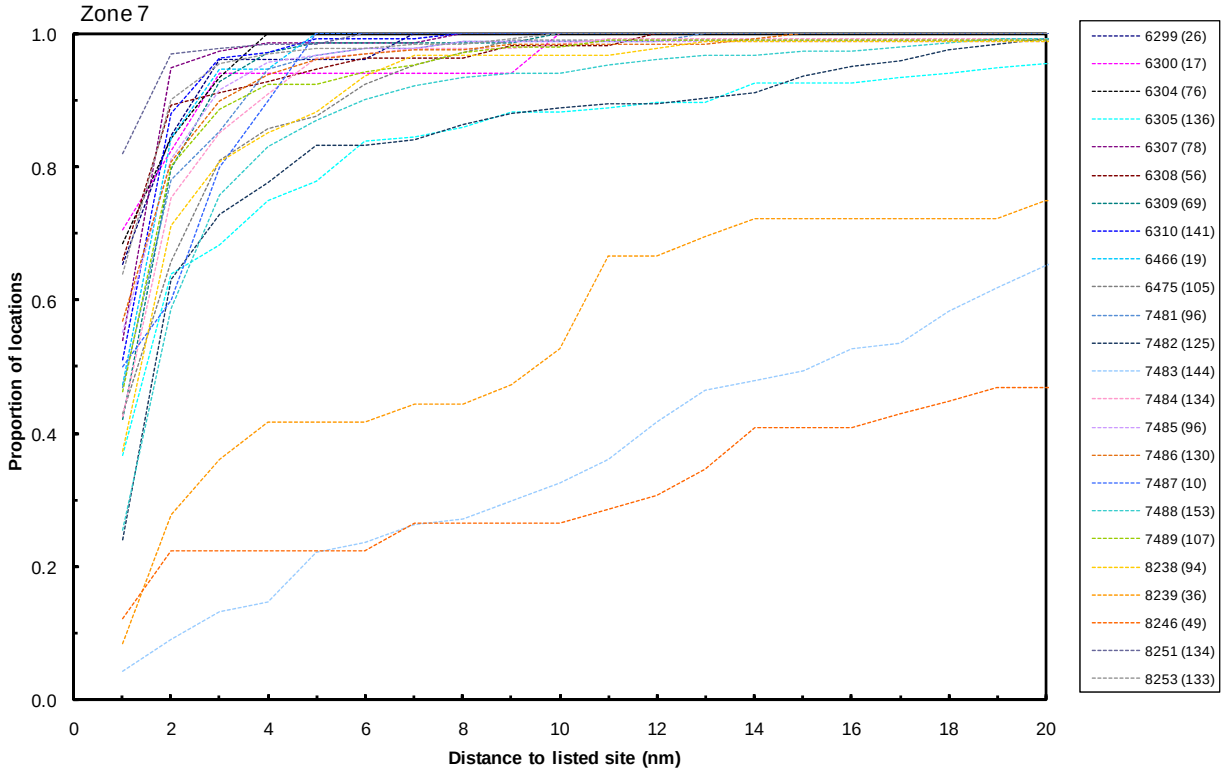


Figure 3, continued.

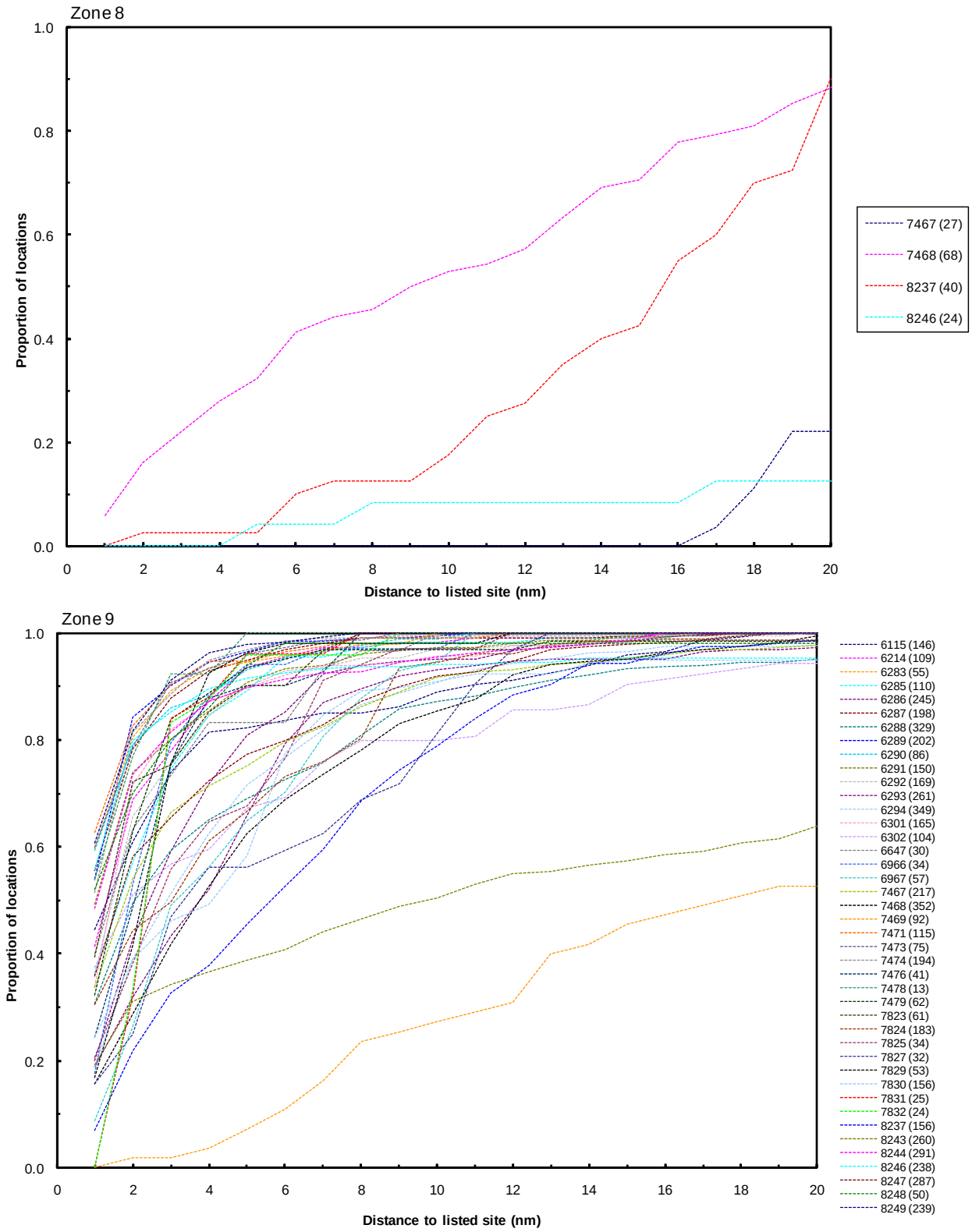


Figure 3, continued.

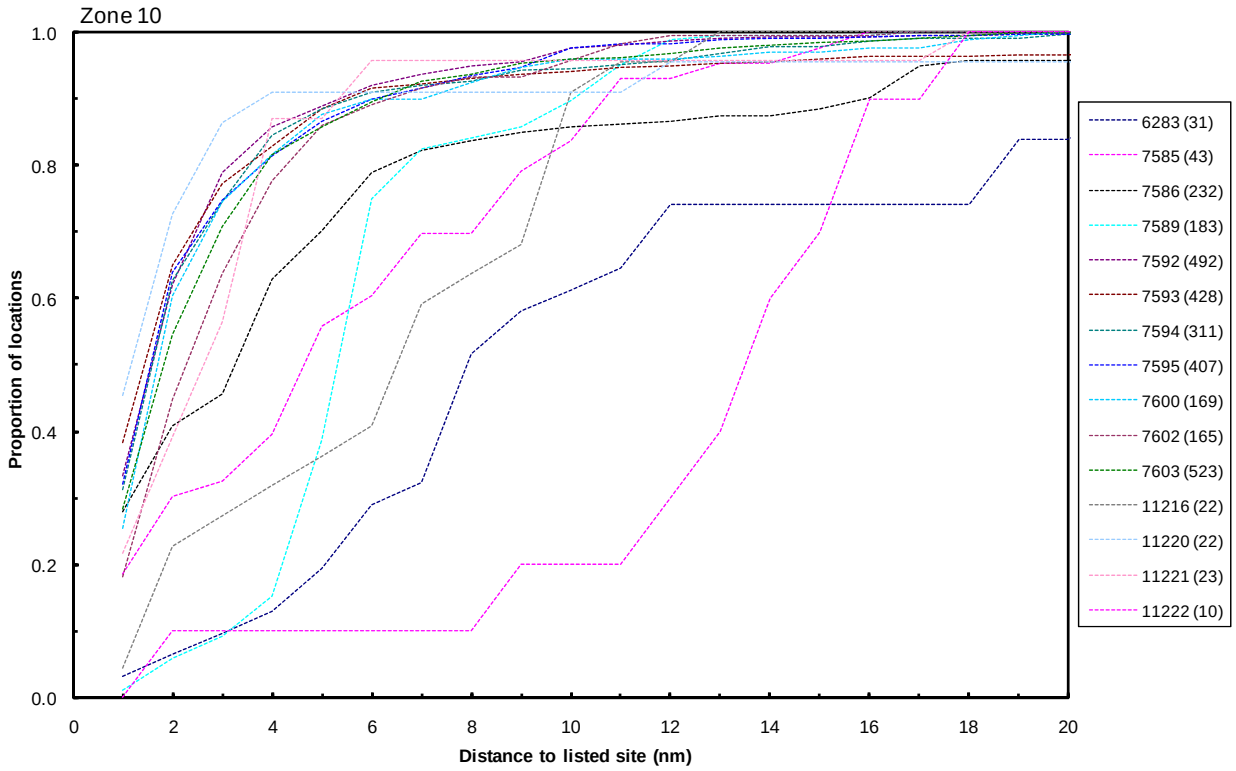


Figure 3, continued.

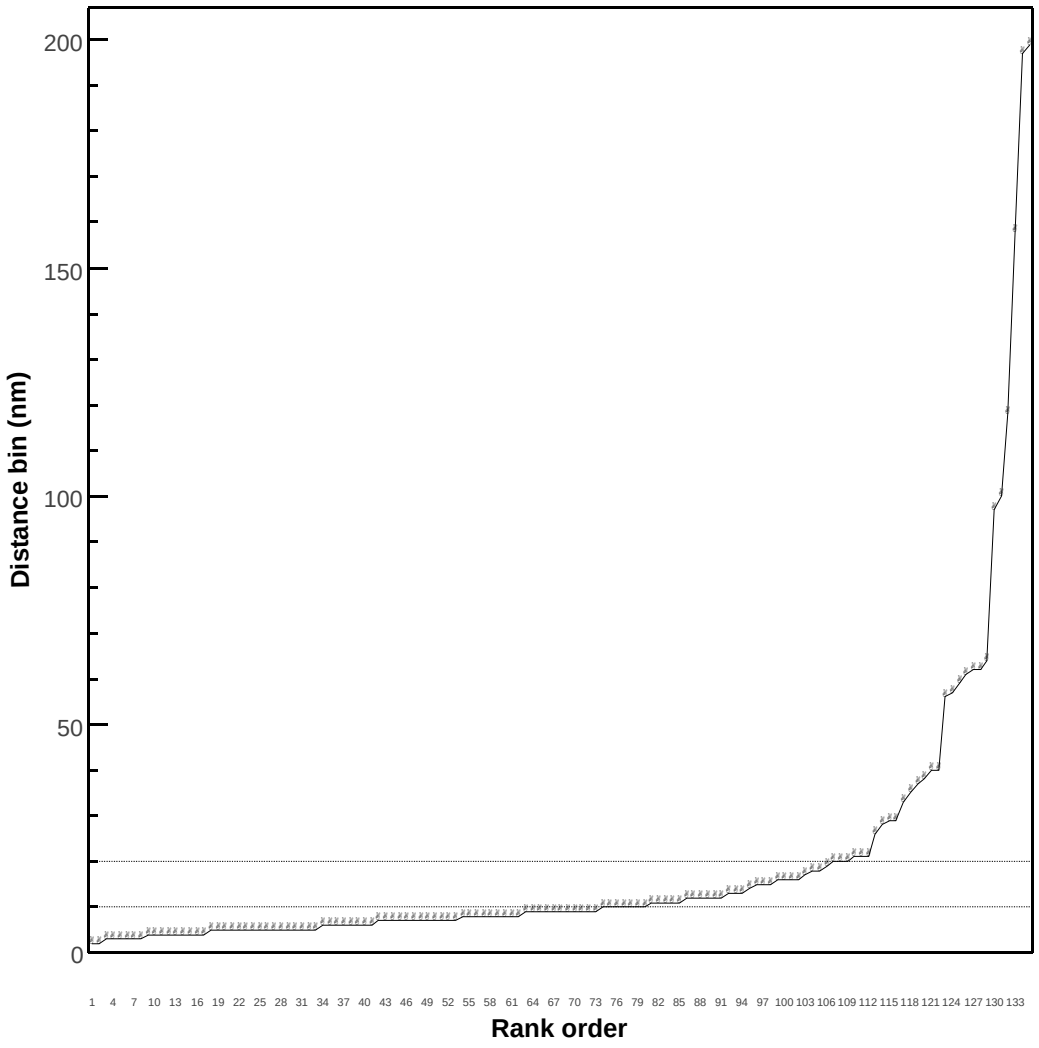


Figure 4. Rank order of the distance bin encompassing at least 95% of the cumulative distribution of distances to the nearest listed site associated with diving to >4 m within all analytical zones for individual juvenile Steller sea lions (*n*=135, Table 3). Horizontal reference lines highlight 10 and 20 nm distances.

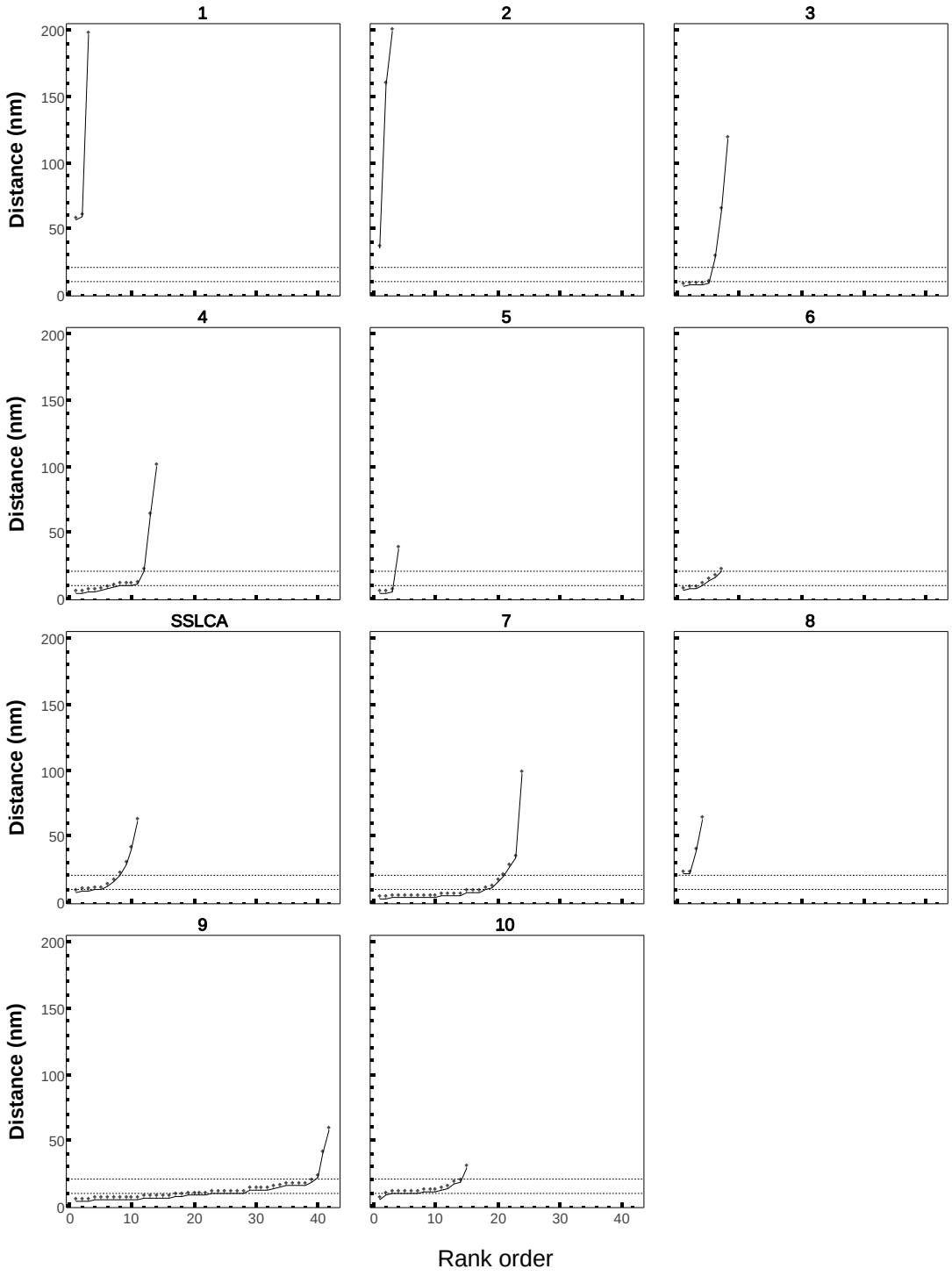


Figure 5. Rank order of the distance bin encompassing at least 95% of the cumulative distribution of distances to the nearest listed site associated with diving to >4 m by analytical zone for individual juvenile Steller sea lions (total *n*=135, Table 3). Horizontal reference lines highlight 10 and 20 nm distances.

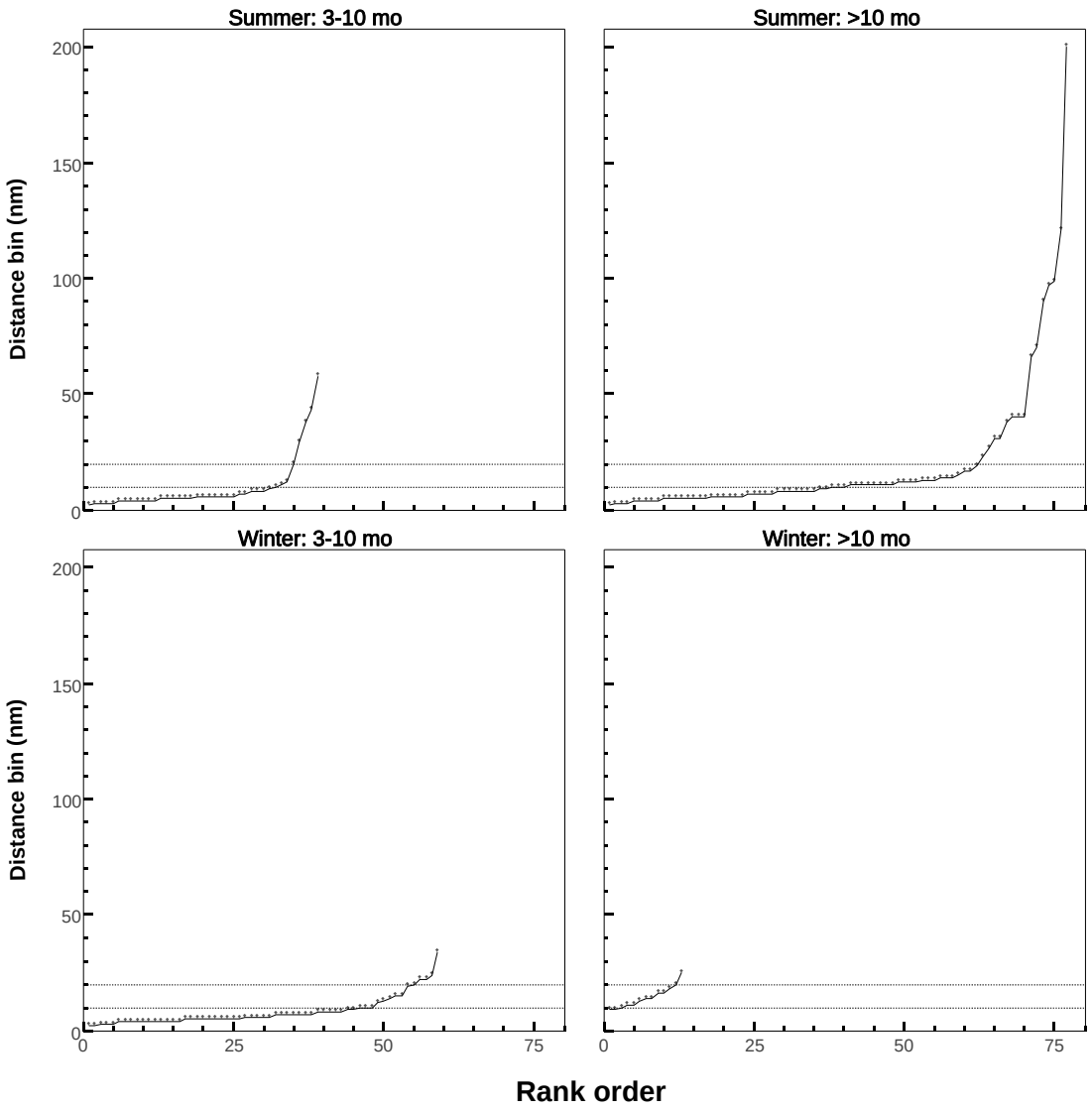


Figure 6. Rank order of the distance bin encompassing at least 95% of the cumulative distribution of distances to the nearest listed site associated with diving to >4 m by season and age class for individual juvenile Steller sea lions (from Table 2, Figure 2). Horizontal reference lines highlight 10 and 20 nm distances.