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Estimation of the abundance of the spinner dolphin *Stenella longirostris* using photo identification technique in Samadai Reef, Red Sea, Egypt

Ahmed M. Shawky*[1], Magdy A. Alwany[2], Saad Zakaria[2], and Salah G. El-Etreby[2]
Marine Department, Faculty of Sciences, Suez Canal University, Ismailia, Egypt

ABSTRACT

Dolphins were photographed for individual identification purposes in Samadai reef, Marsa Alam, Red Sea between January 2012 and March 2013. In this study, 255 spinner dolphin *Stenella longirostris* were identified with a mean identification rate of 45%. Photo-identification analysis provided a population size range of 567 to 637 for spinner dolphins utilizing Samadai daytime for resting and socializing. From the 255 identified dolphins, 33 individuals (12.9%) were re-sighted for 4-8 times and 131 individuals (51.4%) were only observed once. The discovery curve indicated the continuous entrance of new animals to Samadai reef, which increased between May and December.
Keywords: spinner dolphins, *Stenella longirostris*, Samadai Reef, Red Sea, photo ID, population size.

INTRODUCTION

The spinner dolphin *Stenella longirostris* are pantropical animals, they occur in all tropical and subtropical waters around the world between roughly 40°N and 40°S (Jefferson *et al*., 2008). Spinner dolphins are among the most common cetaceans in the Red Sea (Notarbartolo *et al*., 2007). During the day time, these cetaceans often use inshore island habitats for resting and social interactions (Karczmarksi *et al*., 2005). Hawaii, French Polynesia, Brazil and Egypt have all reported populations of the spinner dolphins (Norris *et al*., 1994; Poole, 1995; Silva *et al*., 2005; Notarbartolo *et al.*, 2008). Samadai is a small reef off the coast of southern Egypt, where tourists in increasing numbers congregate daily to swim with the resting dolphins, creating a situation which is seemingly beyond control (Notarbartolo, 2003). Growing concern that the dolphins would abandon the reef as a result of the disturbance was brought to the attention of the Egyptian management authorities, and they responded by suspending all access to Samadai Reef in December 2003. A provisional management plan was prepared immediately, based on precaution and on the scant knowledge available at that time. In January 2004 the reef was again opened to visits, but only under tight control and within the conditions set down in the management plan.

Group size varies with habitats, with open ocean populations occurring in groups of several hundred to a thousand individuals (Norris *et al.*, 1994; Reeves *et al*., 2002; Silva-Jr *et al.*, 2005). Photographic identification (photo-ID) has been used successfully to identify individuals within cetacean populations for more than thirty years. Photo-ID is only useful when the individuals of a population are reliably marked, but the method is sensitive to both the degree of marking and the quality of the photographs (Gowans and Whitehead, 2001; Friday *et al.*, 2008). Abundance estimates determined from photo-ID rely on the ability to determine the proportion of marked individuals within the population. The use of photo-ID techniques implies that individuals are considered to be associated if they are photographed within the same group during an encounter (Karscmarski *et al*., 2005). The residence rate of individuals is measured by calculating identification rates, which represent the probability that an individual identified at any particular time will be identified again (Whitehead, 2001).

In the present study, photo identification technique was employed to estimate the abundance of the only dolphin species (*Stenella longirostris*) in Samadai Reef.

MATERIALS AND METHODS

Study Area:

Samadai Reef is located along the Egyptian coast of the Red Sea in the vicinity of Marsa Alam city at approximately 24° 59' 15" N, 34° 59' 53" E, four nautical miles (7.5 km) away from the nearest harbor of Tondoba bay (Figure 1). The reef has the shape of a horseshoe, forming a shallow lagoon. Lagoon depths range from 3-7m at the northern part, to 12-15m in the rest of the lagoon. The bottom is mainly sandy with some scattered patches of coral reef colonies.

Photo identification

Spinner dolphins, like many other small cetaceans, can be identified by the unique shapes and markings of their dorsal fins and / or other body parts (Würsig and Würsig 1977; Würsig and Jefferson, 1990). All dolphins were photographed at a distance at which the dorsal fin filled at least one quarter of the frame in the camera's viewfinder, irrespective of obvious marks (notches, coloration, etc.) and whether or not an individual was already photographed (Karscmarski *et al*., 2005).

Photo identification (Photo-ID) at Samadai Reef was conducted during underwater observations over 17 sightings from January 2012 until March 2013 with a minimum of 1 and a maximum of 4 sightings per month.

* *Corresponding author: ahmedshawky_7@hotmail.com*

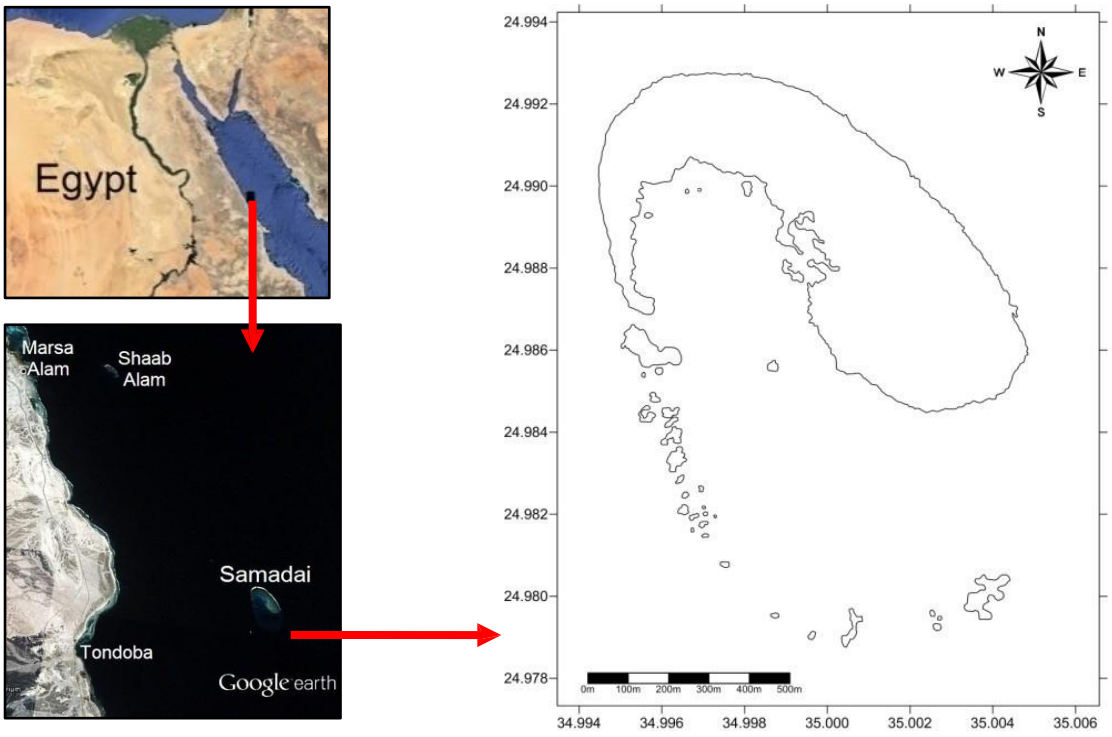


Figure (1): Map and satellite image of Samadai Reef

The animals were photographed with a digital camera; model Canon Power Shot A630, 8 Megapixels. Photos should to be perpendicular to the dorsal fin. Identification of individuals was based primarily on the pattern of notches on the dorsal fin. Although various other mark types (e.g., scratches and scars) were always assessed, they were infrequent on spinner dolphins. Only the notches on the dorsal fin in conjunction with the overall shape of the fin were used to identify individual dolphins.

To determine whether identifiable individuals had been sighted more than once, the photographs were systematically checked against each other by simultaneous projection using two slide projectors side by side. If a dorsal fin was not positively matched with a previously identified fin, it was considered as a new individual (Karczmarski and Cockcroft, 1998).

A photo-ID catalogue for the identified dolphins was organized according to the position and number of notches on the dorsal fin. Photographs of the highest quality for each individual from each encounter were included into an individual sighting history catalogue and each identified individual was given an ID code (Östman *et al*., 2004 and Karscmarski *et al*., 2005). Occasionally, a new photograph allowed for two different tracings to be matched to the same dorsal fin and the two tracings were assigned to the same individual (Östman *et al*., 2004). The more recently assigned code was added to a list of retired ID codes. A discovery curve was conducted to follow up the continued addition of new individuals to the population.

A rough estimate was carried out for the spinner dolphin's population using the same method used in two earlier studies (Norris *et al*. 1994, Östman, 1994), using the following calculation:

$$\frac{\text{Total Number of Identified Individuals}}{\text{Mean Percent of Individuals identified per school}}$$

RESULTS

Results of the photo-identification are represented graphically in the discovery curve (Figure 2) and summarized in the appendix. They were partially analyzed for the most obviously marked individuals (Table1). In Samadai Reef, 255 individual spinner dolphins were identified (135 females, 115 males and 5 calves). The discovery curve indicates the continuous recurrence of new animals to the study area which increased between May and December 2012 (4-10 sightings). It increased again at the 17th sighting with 14 new individuals (Figure 2). At the first sighting, 87 individuals were identified. A range of 4–28 (SD=±7.4) individuals were newly identified during the remaining 16 sightings (Figure 3).

Figure (4) shows the degree of residency (the frequency of re-sighting of each individual dolphin in the study site). Of the 255 spinner dolphins identified, the majority (51.4%, n=131) were sighted only once. About 56 individuals were sighted more than once (22%), 35 individuals (13.7%) were sighted three times, 16 individuals (6.3%) were sighted

four times, 8 individuals (3.1%) were sighted five times, 6 individuals (2.4%) were sighted six times, two individuals (0.8%) were sighted seven times, while only one individual (0.4%) was sighted eight times.

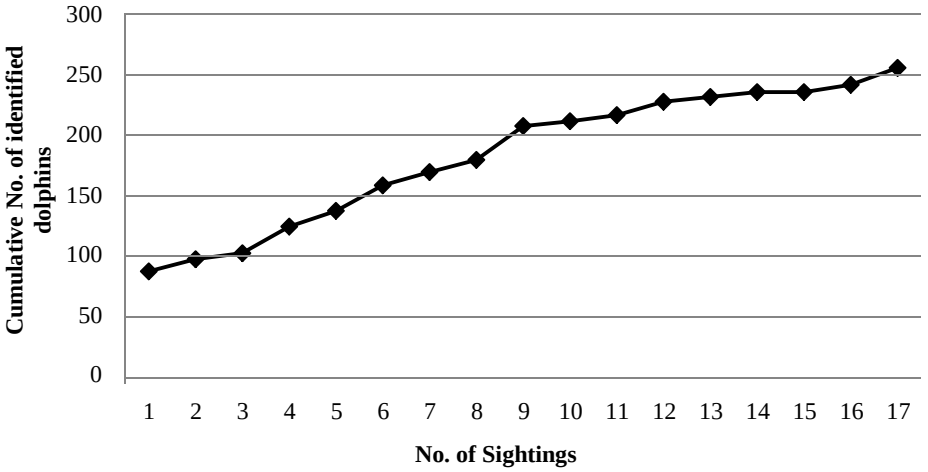


Figure (2): Rate of discovery of spinner dolphins identified per school in Samadai Reef.

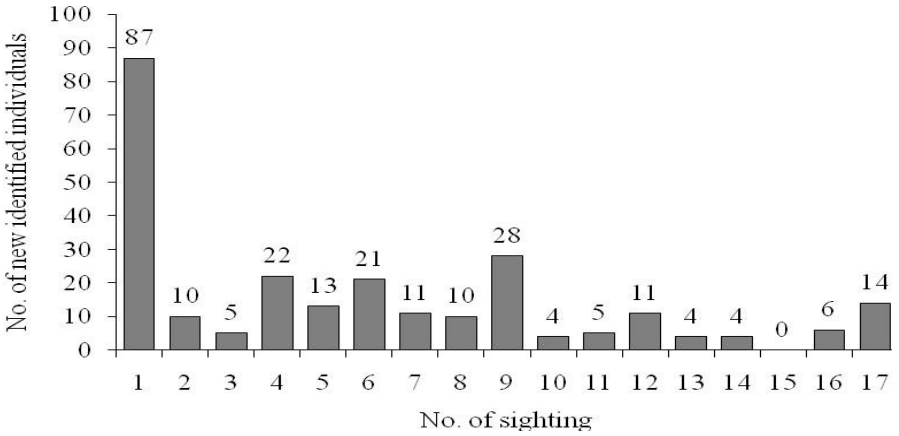


Figure (3): Number of newly identified individuals added to the catalogue after each sighting.

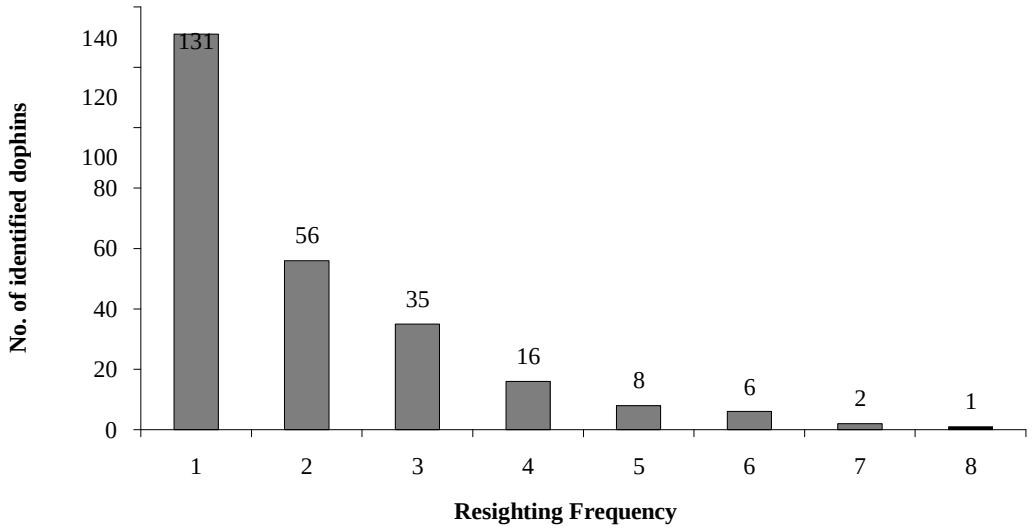
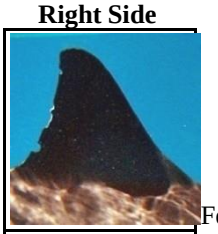
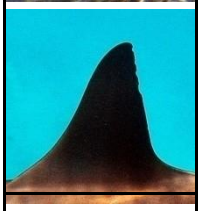
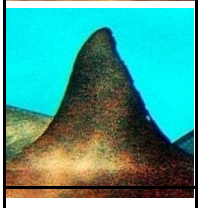
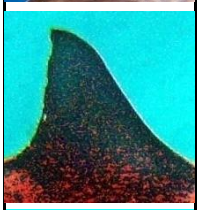
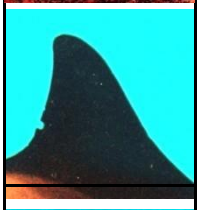
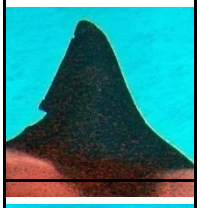


Figure (4): Number of identified individuals of dolphins versus the number of re-sighted.

Table (1): Examples of identified dolphins with reliable notches and scars.

ID	Code	Left Side	Right Side	Sex	Date of First Sighting	No. of Re-sightings
14	A12014			Female	January, 2012	7
39	A12039			Male	January, 2012	5
67	A12067			Female	January, 2012	5
114	E12114			Male	March, 2012	1
122	L1220			Male	December, 2012	2
188	L12188			Female	December, 2012	1
184	L12184			Male	December, 2012	1
241	C13241			Female	March, 2013	1

The percentage of identified individuals was calculated (Mean 45% and SD=± 26.6%), based on school size (Figure 5). For the first nine schools, up to 70% (207 of 255) of individuals were identified (Mean 45%, SD=±26.7%). One school (#8 in Figure 5) contained 130 dolphins, 12 of which were identified. The school that was 100% identified contained only 21 dolphin (Figure 6). By using two slightly different methods to get the mean percentage of individuals identified per school, two different abundance estimates were produced:

(1) By dividing the total number of identified individuals in all school with the sum of all school size estimates, a mean identification rate of 40% was produced. Applying this identification rate to the number of individuals in the photo-ID catalogue (255) provides a population estimate of 637 individual.

(2) By averaging the identification rate for each school, a mean identification rate of 45% is produced, providing a population estimate of 567 individual.

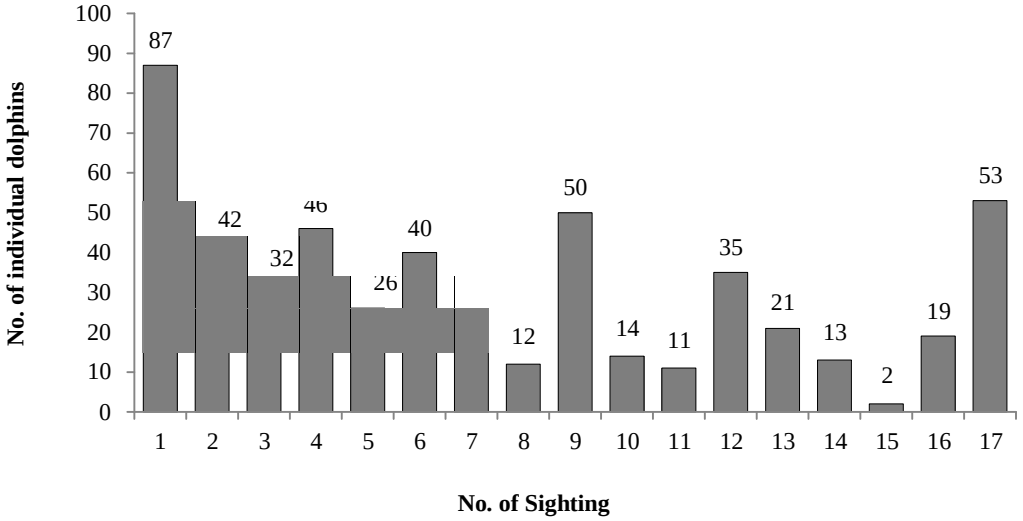


Figure (5): Number of identified spinner dolphins per school.

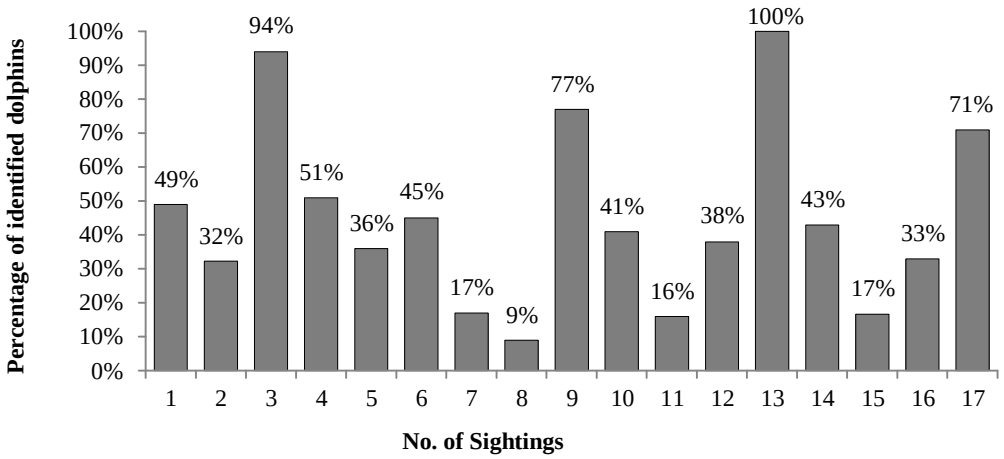


Figure (6): Proportion of identified spinner dolphins per school.

DISCUSSION

The present study gives the first proper estimate of the abundance of spinner dolphins in Samadai Reef. The photo-identification analysis presented here provided a rough population size range of 567 to 637 for spinner dolphins utilizing Samadai Reef for daytime resting and socializing.

The sole study by Notarbaltolo and Coasta (2007) on the local spinner dolphin abundance in Samadai, reported a resident population of 111 individuals, which is considerably lower than the number reported here (255 individuals with a 45% identification rate). This rate of increase in the number of dolphins in Samadai Reef (more than twice the number firstly recorded in 2007) could be due to the conservation measures and the enforcement of the management plan developed by the Red Sea Protectorates. The result that 14 individuals were newly identified at the last (17^{Th}) sighting (Figure 2) points out that the occurrence of new individuals in Samadai Reef is an Ongoing process.

The observation of individuals for short durations seen in the area indicates the existence of a much larger population in the region that makes use of Samadai an occasional basis. This finding is in accordance with the study by Notarbaltolo and Coasta (2007). Over 45% of the animals observed in this study displayed some degree of marking to allow photo-identification. This rate is comparable to Norris *et al.* (1994) (20%) and Östman (1994) (24%). In other studies, it ranged from only 14-15% (at Moorea) in French Polynesia (Poole, 1995) to 53%, (at Midway Atoll) in Hawaii (Karczmarski *et al.,* 2005) and 76 % (at Kure Atoll) in Hawaii (Karczmarski *et al.,* 2005). Webster (2011) reported that only 22% of spinner dolphins of Mauritius were considered sufficiently well marked to be used in photo identification analysis. Furthermore, Chilvers and Corkeron (2002) concluded that associations between individuals within the population make them impossible to identify.

Wilson *et al.,* (1999); Gowans and Whitehead, (2001) reported that the notches and tears on the dorsal fins of the bottlenose dolphins whether natural or due to biting were considered to be long-lasting and therefore mark loss was assumed to be negligible. The authors also stated that only individuals with marks that are judged to be long-lasting and distinctive were included in their calculations. Karczmarski *et al*., (2005) identified larger number of males than females spinner dolphins in Hawaii which reflects the greater distinctiveness of individual marks (larger notches and more severe scars and wounds) among males. The present study identified more females than males in Samadai. This could be attributed the sex ratio of the spinner dolphin population in the study site (3:1 female: male, personal observation).

Accordingly, it was preferable to establish a population estimate using a photo-ID catalogue approaching or exceeding that of Notarbartolo and Coasta (2007) and using a more robust method, such as mark recapture. To accomplish this, the current photo-ID effort should be continued to increase the size of the catalogue and a recapture study should be conducted when the catalogue has grown sufficiently.

CONCLUSION

This study used the photo-ID data collection method and analysis to help with the estimation of the abundance of the spinner dolphins in Samadai Reef. However, further studies are recommended in order to ascertain how much disturbance is taking place in the study site as a result of continued human presence which might have resulted in long-term changes in school size, resting patterns and/or changes in abundance. It is also crucial to collect more data over a long period of time in order to judge the effectiveness of the conservation plan that is currently in action.

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Appendix (1): Residency pattern of the 255 spinner dolphins identified in Samadai.

ID	Year	2012										2013							Total
	Name	Jan			May			Nov		Dec		Jan				Feb	Mar		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1	A12001	X		X			X												3
2	A12002	X	X	X															3
3	A12003	X																	1
4	A12004	X																	1
5	A12005	X																	1
6	A12006	X	X											X					3
7	A12007	X		X		X												X	4
8	A12008	X																X	2
9	A12009	X	X																2
10	A12010	X																	1
11	A12011	X			X													X	3
12	A12012	X	X																2
13	A12013	X	X	X	X		X			X			X					X	8
14	A12014	X	X	X	X					X		X	X						7
15	A12015	X	X	X	X														4
16	A12016	X															X		2
17	A12017	X	X															X	3
18	A12018	X	X					X		X			X						5
19	A12019	X																	1
20	A12020	X		X															2
21	A12021	X				X	X												3
22	A12022	X		X	X														3
23	A12023	X															X		2
24	A12024	X		X															2
25	A12025	X		X	X					X	X								5
26	A12026	X																	1
27	A12027	X		X	X														3
28	A12028	X																	1
29	A12029	X																	1
30	A12030	X	X																2
31	A12031	X																	1
32	A12032	X																	1
33	A12033	X	X	X															3
34	A12034	X			X														2
35	A12035	X																	1
36	A12036	X																	1
37	A12037	X								X									2
38	A12038	X	X	X															3
39	A12039	X					X				X				X			X	5
40	A12040	X		X	X														3

41	A12041	**X**	**X**		**X**	**X**	**X**										**X**	6
42	A12042	**X**																1
43	A12043	**X**				**X**												2
44	A12044	**X**	**X**															2
45	A12045	**X**															**X**	2
46	A12046	**X**											**X**	**X**			**X**	4
47	A12047	**X**															**X**	2
48	A12048	**X**		**X**	**X**						**X**		**X**	**X**				6
49	A12049	**X**		**X**			**X**											3
50	A12050	**X**																1
51	A12051	**X**				**X**	**X**											3
52	A12052	**X**				**X**												2
53	A12053	**X**	**X**				**X**											3
54	A12054	**X**																1
55	A12055	**X**																1
56	A12056	**X**															**X**	2
57	A12057	**X**															**X**	2
58	A12058	**X**																1
59	A12059	**X**	**X**															2
60	A12060	**X**	**X**	**X**														3
61	A12061	**X**																1
62	A12062	**X**	**X**													**X**		3
63	A12063	**X**	**X**	**X**	**X**		**X**											5
64	A12064	**X**	**X**		**X**	**X**							**X**			**X**		6
65	A12065	**X**	**X**															2
66	A12066	**X**	**X**															2
67	A12067	**X**						**X**				**X**	**X**			**X**		5
68	A12068	**X**	**X**		**X**	**X**											**X**	5
69	A12069	**X**	**X**	**X**													**X**	4
70	A12070	**X**														**X**		2
71	A12071	**X**																1
72	A12072	**X**																1
73	A12073	**X**																1
74	A12074	**X**								**X**			**X**				**X**	4
75	A12075	**X**	**X**														**X**	3
76	A12076	**X**	**X**															2
77	A12077	**X**	**X**															2
78	A12078	**X**		**X**		**X**		**X**										4
79	A12079	**X**																1
80	A12080	**X**		**X**	**X**	**X**												4
81	A12081	**X**	**X**	**X**	**X**		**X**			**X**								6
82	A12082	**X**			**X**					**X**								3
83	A12083	**X**																1
84	A12084	**X**	**X**															2
85	A12085	**X**	**X**	**X**	**X**													4
86	A12086	**X**		**X**	**X**		**X**											4

87	A12087		**X**		**X**			**X**										3
88	A12088		**X**		**X**													2
89	A12089		**X**		**X**													2
90	A12090		**X**	**X**														2
91	A12091		**X**															1
92	A12092		**X**	**X**														2
93	A12093		**X**		**X**	**X**												3
94	A12094		**X**	**X**	**X**	**X**												4
95	A12095		**X**	**X**			**X**						**X**	**X**				**X**	6
96	A12096		**X**							**X**								**X**	3
97	A12097			**X**															1
98	A12098			**X**						**X**	**X**								3
99	A12099			**X**															1
100	A12100			**X**			**X**						**X**						3
101	A12101		**X**		**X**		**X**												3
102	A12102				**X**									**X**					2
103	A12103				**X**														1
104	A12104				**X**														1
105	A12105				**X**			**X**		**X**	**X**	**X**	**X**				**X**		7
106	A12106				**X**														1
107	A12107				**X**														1
108	A12108				**X**														1
109	A12109				**X**		**X**												2
110	A12110				**X**														1
111	A12111				**X**														1
112	A12112				**X**				**X**							**X**			3
113	A12113				**X**					**X**			**X**		**X**			**X**	5
114	A12114				**X**														1
115	A12115				**X**					**X**	**X**			**X**	**X**			**X**	6
116	A12116				**X**														1
117	A12117				**X**														1
118	A12118				**X**														1
119	A12119				**X**		**X**					**X**	**X**						4
120	A12120				**X**	**X**											**X**		3
121	A12121				**X**														1
122	A12122				**X**		**X**												2
123	A12123					**X**													1
124	A12124					**X**													1
125	A12125					**X**				**X**	**X**								3
126	A12126					**X**				**X**									2
127	A12127					**X**													1
128	A12128					**X**													1
129	A12129					**X**													1
130	A12130					**X**													1
131	A12131					**X**	**X**						**X**	**X**					4

132	A12132					**X**													1
133	A12133					**X**													1
134	A12134					**X**													1
135	A12135					**X**													1
136	A12136						**X**			**X**									2
137	A12137						**X**			**X**	**X**						**X**	**X**	5
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143	A12143						**X**												1
144	A12144						**X**												1
145	A12145						**X**							**X**					2
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148	A12148						**X**												1
149	A12149						**X**												1
150	A12150						**X**												1
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163	K12163							**X**											1
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177	L12177									**X**									1

178	L12178									**X**				**X**	**X**			**X**	4
179	L12179									**X**						**X**			2
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181	L12181									**X**									1
182	L12182									**X**									1
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184	L12184									**X**									1
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187	L12187									**X**									1
188	L12188									**X**									1
189	L12189									**X**									1
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192	L12192									**X**									1
193	L12193									**X**									1
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209	M12209											**X**							1
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212	M12212											**X**							1
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