2017-2018 Summary: Breeding Ecology of Saltmarsh Sparrows (*Ammodramus caudacutus*) in Narragansett Bay, Rhode Island.

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INTRODUCTION. On June 16, 2016, DER photographed a color-banded Saltmarsh Sparrow during bird survey work at Jacob's Point salt marsh in Warren, RI. Subsequent capture of the banded bird revealed a female sparrow that had been color-banded in Pinellas County, Florida, on October 31, 2015[1]. This discovery prompted further exploratory work at Jacob's Point which supported its selection as our study site. In May of 2017 we initiated a comprehensive, multi-year field study of Saltmarsh Sparrow breeding ecology and survivorship at this 19-ha salt marsh (Figs. 1 and 2). Principal objectives of this research are to (1) determine habitat characteristics associated with nest-site selection, (2) monitor the reproductive success of the population including the impact of monthly flooding tides on nest success, (3) via mark-recapture efforts determine rates of inter-annual mortality, and (4) apply our findings to predict impacts of various magnitudes of sea level rise (to as fine a degree as 2 cm) on the near- and long-term survival of Saltmarsh Sparrows in Narragansett Bay, RI. This report presents the results of our fieldwork through the first two breeding seasons (2017 and 2018) of a proposed five-year study.

STUDY AREA. Jacob's Point is a 14-ha salt marsh bordering the east shore of the Warren River on upper Narragansett Bay (Figs 1 and 2). The marsh is owned by the Warren Land Conservation Trust which has graciously granted our research team access to the site for the five-year study period. A narrow sand/upland-barrier ridge separates the marsh from the bay. Tidal waters enter the estuary via two tidal channels that breach the ridge and flow east and south, respectively, into the marsh interior. The extreme southern segment of the marsh is separated from the larger wetland by an elevated road-bed constructed in the 1930s. Tidal flow is maintained to this southern tract via three, 1.5-m culverts running north-south beneath the road-bed along the courses of the original marsh channels.

Vegetation. The Jacob's Point marsh is dominated by "salt meadow" communities of the high marsh. The salt meadow grassland is comprised of stands or mixed communities of *Spartina patens* (salt marsh hay), *Distichlis spicata* (spike grass), and *Juncus gerardi* (black grass). In the eastern one-half of the marsh, and south of the road-bed, the salt meadow community intergrades with the shrubby plant, high tide bush (*Iva frutescens*) in areas of relatively high marsh-surface elevation. *Iva* occurs in dense clumps with sparse grassy growth beneath, or in salt-meadow dominated patches with scattered *Iva* plants or clumps. *Iva* is also present as a band of dense, shrubby habitat along marsh-upland edges. Salt marsh cordgrass *(Spartina alterniflora)* occurs in two forms at Jacob's Point: (1) a tall form (>1 m) grows within the regularly-flooded intertidal zone along the upper elevations of creek- and ditch banks ("low marsh"); and (2) a shorter form (<1 m), "high-marsh cordgrass", which grows in small patches on the high marsh where it intergrades with the salt meadow grasses.

METHODS.

Trapping and marking. During 2017, we set mist-nets during 19 days between 23 May and 7 August; in 2018, we set nets during 17 days between 25 May and 7 August. In both years, nets were set in arrays to capture roaming adults, primarily (1) perpendicular to tidal channels where they foraged, and (2) near nests to capture attending females. We used one 12-m net, and from one to six, 6-m nets. All adult Saltmarsh Sparrows received a USGS-issued aluminum band plus a unique combination of three colored bands (one on the leg with the aluminum band, and two on the opposite leg). Nestlings were banded with aluminum bands only during 2017. In 2018 we banded nestlings with a combination of an aluminum band on one leg, and one colored band on the other leg, such that there was a unique two-band combination per brood (nest).

Nest measurements. When a nest was deemed inactive we collected a set of data including a standard set of photographs of the nest and nest-site, the height in millimeters of the nest from substrate-to-rim, the plant species supporting and immediately surrounding the nest—ranked by dominance per species—

[1] The distance traveled by that female—approximately 2,000 km (1,243 miles), represents the longest documented migration of an individual Saltmarsh Sparrow (J. Greenlaw, pers. comm., June 22, 2016).

and the distance to the nearest *Iva frutescens* plant. We preserved the elevation of each nest by driving a 40-50-cm stake (the "elevation stake") into the peat such that the top of the stake was flush with the nest-rim.

Tidal elevation. Prior to the 2018 breeding season we placed a tide gauge in a low-lying area of the high marsh. The gauge consists of a 1.5" x 96" (3.8 cm x 244 cm) slotted angle-rod driven ~ 1.5 m into the mineral soil underlying the marsh peat. Nested in the angle, and extending from the marsh surface ~ 1.5 m to the gauge top is a 2.5-cm wide oak stake. A metric tape is attached to the stake along one exposed surface; the adjacent surface is chalked such that a flooding tide leaves a water-mark at the level of peak amplitude. The gauge is read by measuring from the top of the steel bar down to the chalk mark (Figure 3).

Nest-rim and substrate elevations. On September 29, 2018, we used a CST/berger Horizontal/Vertical Rotary Laser Level and rod to measure elevations of nests relative to local bench marks. A laser-beam sensor was moved up and down the graduated rod until the beam was intercepted, at which time the measurement was taken. Measurements were taken while the rod was placed (1) on top of each nest elevation stake (2018 only), (2) on the marsh substrate beneath each nest, and (3) on top of the tide gauge (steel bar). For presentations in this paper, elevations are presented as cm above the lowest-lying point of the high marsh.[2] These measurements will later be converted to cm above mean sea level.

RESULTS.

Mark and recapture.

During the 2016, 2017, and 2018 breeding seasons, we captured and banded 88 adult Saltmarsh Sparrows, 63 nestlings, and one fledgling (Table 1). Of the 88 adults captured, 38% (41% of 51 adults captured in 2017, and 31% of 32 adults captured in 2018) were females (Table 2). None of the nestlings or fledglings captured in 2016 or 2017 were recaptured in subsequent years.

Table 1. Captures of sparrows by age class and year.

Band year	2016 No. (%)	2017 No. (%)	2018 No. (%)	Total No. (%)
Adult	5 (71)	51 (54)	32 (63)	88 (58)
Fledgling	0 (0)	1 (1)	0 (0)	1 (1)
Nestling	2 (29)	42 (45)	19 (37)	63 (41)
Total	7 (100)	94 (100)	51 (100)	152 (100)

Table 2. Captures of adult sparrows by sex and year.

Band year	2016 No. (%)	2017 No. (%)	2018 No. (%)	Total No. (%)
Female	2 (40)	21 (41)	10 (31)	33 (38)
Male	3 (60)	30 (59)	22 (69)	55 (62)
Total	5 (100)	51 (100)	32 (100)	88 (100)

[2] A transect was established across the span of the marsh, running East-West, and substrate elevation measurements were taken at the edge and interior of each habitat patch bisected by the transect. The lowest-lying point on the high marsh occurred in a patch of medium-height *S. alterniflora* adjacent to a ditch near the western edge of the marsh.

During 2018, we recaptured 12 (54%) of 21 adult-female, and 13 (43%) of 30 adult-male sparrows captured in 2017. Two of the males recaptured in 2018 were also recaptured in 2017 after having been captured as adults during June of 2016.

Nest-site vegetation [to be completed].

Nests were placed in three generalized site-types: (1) salt meadow… (2) salt meadow/cordgrass… (3) High tide bush…

Nest Success.

During 2017 we found 24 nests, 21 of which had live contents (eggs or nestlings) when found; during 2018 we found 32 nests, 27 of which had live contents. The first-egg date in 2018 was May 22 (not determined in 2017). Nesting ended on August 20 in 2017 and August 10 in 2018. Nests found empty are not included in our summaries and analyses of nest success. A total of 172 eggs and 101 nestlings were documented in the 48 active (2017/2018) nests. Of the 101 nestlings, 61 were banded, 30 of which were among 34 total fledglings (Table 3). Observations made in both years confirmed that small numbers of young had fledged from nests we had not found.

Table 3. Nestling statistics

Band year	2017 *n*	2018 *n*	Total *n*
Total eggs	75	97	172
Total nestlings	48	53	101
Nestlings banded	42	19	61
Nestlings fledged	13	21	34
Banded nestlings fledged	13	17	30

Six (29%) of 21 nests monitored during 2017 were successful (fledged one or more young) vs. 9 of 27 (33%) during 2018. In 2017, eleven (53%) of the 21 nests monitored lost contents to predation, vs. five (18%) of 27 nests in 2018; in 2017, 38% (8 of 21) had one or more nestlings destroyed by flooding tides, vs. 2018 when over one-half (14 of 27) of nests exhibited such losses. Data on nest and tidal elevations reveals that in both years many of the nests that were depredated would likely have been lost to flooding had they survived to the time of encroachment of flooding new-moon high tides.

Table 4. Fates of nests by year.

Nest fate	2017 No. (%)	2018 No. (%)	Total No. (%)
All nestlings fledge	2 (10)	5 (19)	7 (15)
Partial success: tidal flood	3 (14)	2 (7)	5 (10)
Partial success: predation	1 (5)	2 (7)	3 (6)
All nestlings depredated	10 (48)	3 (11)	13 (27)
All nestlings drown: tidal flood	5 (24)	12 (44)	17 (35)
All nestlings drown: storm flood	0 (0)	1 (4)	1 (2)

Nest abandoned	0 (0)	2 (7)	2 (4)
Total	21 (100)	27 (100)	48 (100)

Renesting

Twenty-two color-banded females attended 40 (19 in 2017, 21 in 2018) of the 48 total active nests. Eight of those 22 females nested in both 2017 and 2018. In 2017, four females laid eggs in two nests, with one of those renesting attempts following a successful nest (one fledgling). In 2018, (1) two females had two nests; both renesting attempts followed a successful nest (two and four fledglings), and (2) two females had three nests. One of those two females laid clutches of four eggs in each of three nests with no young fledging, the other laid clutches of three, five, and four eggs, respectfully, in her three nests, with only one nestling fledging from that female's second nest (Appendix A). Thus, across the two years, four color-banded females were documented as double-brooded, and two of those females (LY PX, XB BB) laid first eggs in new nests 15 and 10 days, respectively, after their young from a previous nest fledged (Table 5).

Table 5. Nest chronologies of double-brooded females.

Female	Nest-1 fledge date[a] (no. fledged)	Nest-2 discovery date (contents)	Nest-2 estimated first-egg date	Nest-2 last date active (contents)	Nest-2 fate	Notes
YL XB	6-21-17 (1)	7-7-17 (2 eggs)	N/A	7-14-17 (2 eggs, female flush)	0 fledge, depredated 7-16-17	
RO XB	6-12-18 (2)	7-21-18 (4 eggs)	7-20-18	8-3-18 (3 yg)	0 fledge, depredated 7-5-18	First Nest-2 hatchling 7-31-18.
LY PX	7-11-18 (1)	7-28-18 (4 eggs)	7-26-18	8-4-18 (4 eggs)	0 fledge, depredated 8-6-18	3 eggs flooded out of first nest of season 6-13-18.
XB BB	7-15-18 (4)	7-31-18 (3 eggs)	7-25-18	8-10-18 (3 yg)	0 fledge, 3 yg drowned 8-10-18	First nest-2 hatchling 8-6-18.

[a] Date of fledging for the first *successful* nest of year.

Spatial Distribution of nests

Nests of female Saltmarsh Sparrows were clustered in four discrete activity centers, three of which were used in both 2017 and 2018 (Fig. 4). This pattern represents a non-random selection of nest-site locales among the tracts of salt-marsh habitat available at Jacob's Point. In future analyses we will attempt to identify characteristics of these activity centers that make them attractive to nesting sparrows, to include: substrate elevation, vegetative composition at the nest site, number of females on active nests within 5 m of the nest site at time of nest initiation, and proximity of nests to *Iva* plants.

Vertical distribution of nests and flooding tides.

Substrate elevations at active Saltmarsh Sparrow nest sites for which data were available (18 nests, 2017; 26 nests, 2018) ranged from 1.2 - 27.0 cm above the lowest point on the high marsh (mean = 11.9 cm, ± 5.9). The height of 25 nest rims above the underlying substrate ranged from 6.5 – 14 cm (mean = 10.3 cm ± 1.8), and the elevation (relative to the lowest point on the high marsh) of 23 nest rims for which data was available in 2018 ranged from 12.6 – 37.6 cm (mean = 22.3 cm ± 6.6). Thus, the rims of all nests for which data were available were placed within a 25-cm vertical space across the 14-ha study area (Fig. 5). The upper reaches of that vertical range were regularly exceeded by flooding new-moon spring tides

which occur approximately every 28 days during the breeding season in the Northeast. During the 2018 breeding season our tide gauge recorded the peak elevation of 14 marsh-flooding tides that occurred on, or before, the day of the highest tide per cycle (five during the new-moon cycle in June, five in July, and four in August). The peak elevation of the August 2018 new-moon event (38.8 cm) exceeded the elevation of all of the 23 nests for which elevation was measured in 2018, and the peak elevations of the June and July events exceeded the elevation of all but 3 and 2 of the 2018 nests, respectfully. The mean elevation of the 14 flooding tides (33. 6cm ± 8.1) exceeded the elevations of 20 (96%) of the 23 nests-rims (Figs. 5, 6). Damage to eggs and chicks began as early as four nights prior to the peak tide (June), and for each of the three monthly flooding events, no nests remained active after the day of the peak tide. During 2018, seven of the 14 flooding tides (four during June, two during July, and one in August) fully or partially destroyed the eggs and chicks in active nests.[3]

Fall migration. Observations after the 2017 nesting season revealed that two males color-banded at Jacob's Point on 27 May and 10 July, respectively, remained on the marsh till at least 27 September when they were photographed foraging on the seed-bearing stems of low-marsh *S. alterniflora* along creek-banks in the western marsh segment. During 2018 a more concerted effort was made to identify spring/summer residents that delayed departure from their Jacob's Point breeding grounds. DER monitored *S. alterniflora* habitats at the marsh for 51 consecutive days between 1 September and 21 October. Between one and seven Saltmarsh Sparrows (mode = three) were found during 20 mornings between 6 September and 16 October. These Saltmarsh Sparrows shared the *S. alterniflora* habitats with Nelson's Sparrows on several days during this late-summer/early-fall period. Color-banded Saltmarsh Sparrows—i.e. members of the Jacob's Point breeding population—were detected on five days:

- 6 Sep: two adult males banded in 2018.
- 12 Sep: three males banded as adults in 2018, two 2018 fledglings.
- 20 Sep: one 2018 fledgling.
- 4 Oct: one adult male banded in 2017.
- 15 Oct: one adult male banded in 2018.

We conclude that all females and most males in our study population depart Jacob's Point for their wintering grounds during the month of August, while a smaller number of males linger into early fall where they (1) mix with southward-bound Saltmarsh and Nelson's Sparrows stopping over at Jacob's Point, and (2) persist at least in part on the seeds of *S. alterniflora*.

Other results.

During the 2017 breeding season, video of females attending nestlings was captured by KC at two nests, approximately 20 min per nest. A color-banded male visited one of the nests; we speculated that this male was seeking to find and copulate with the attending female.

[3] A later draft of this report will include content on the relationships of nest success with nest-site vegetation, nest-site and nest elevation, and time-of-season; and the relationship of nest elevations with nest-site vegetation.


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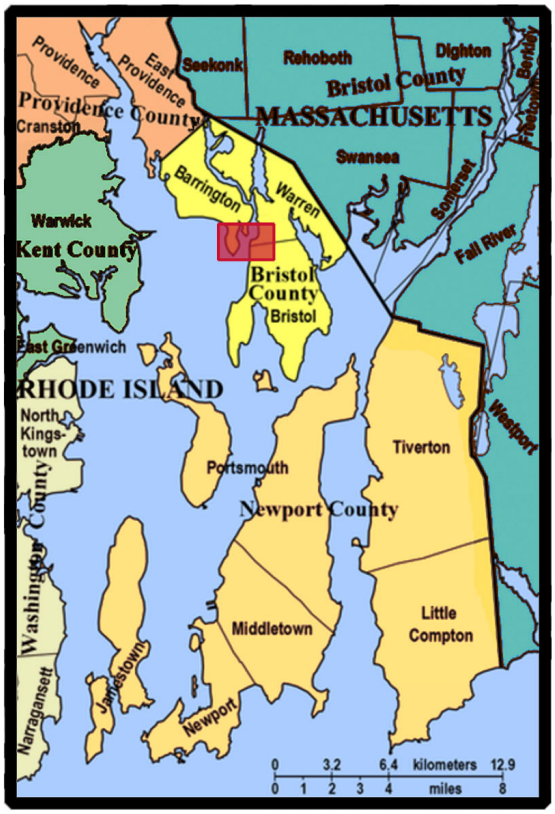

FIGURE 1. Locus, within Narragansett Bay, RI, of the aerial photograph shown in Fig. 2, below. Locus is delineated by the red-shaded rectangle.

FIGURE 2. The Jacob's Point salt marsh study area is delineated in red. See Fig. 1 for locus of this figure within Narragansett Bay, RI.

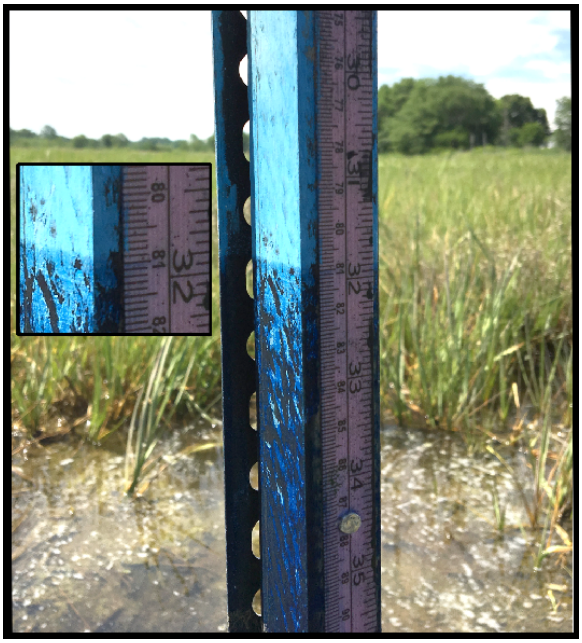

Figure 3. Gauge used for measuring peak-tide elevations at Jacob's Point salt marsh. Pictured is a reading of 80.9 cm from the zero point at top of steel rod.

Figure 4. Clustering of Saltmarsh Sparrow nests at Jacob's Point Salt Marsh. Purple ovals delineate nest clusters from 2017; orange ovals from 2018. The overlapping areas illustrate the high degree

of preference for certain marsh tracts for nest placement both within and between years. The hashed purple circle south of the road represents the site of a suspected nest in 2017.

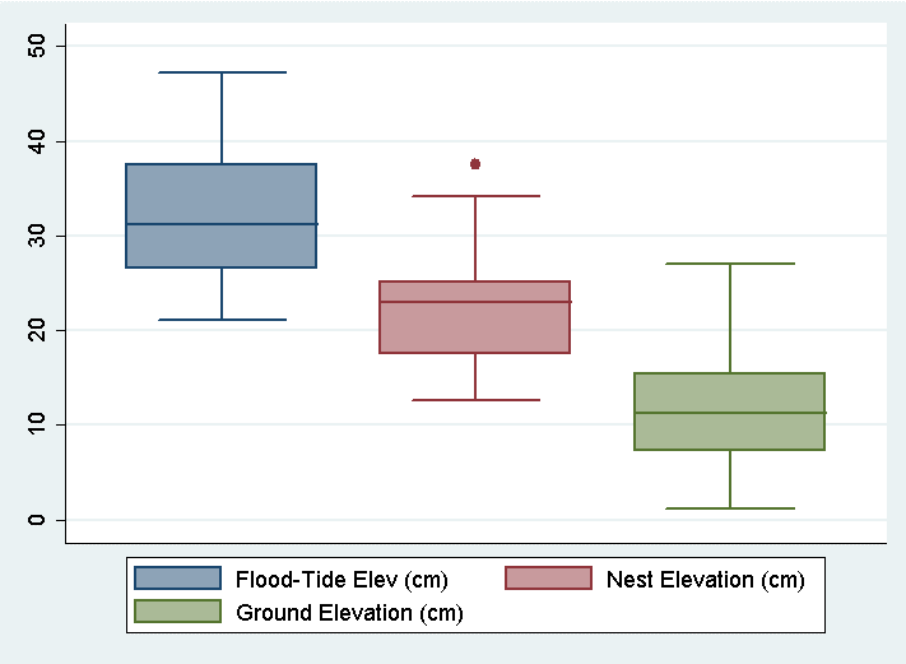

Figure 5. Box plots presenting the elevational distributions (in centimeters) of flooding tides (2018), nest elevations (2018), and the substrate at the nest site (2017 and 2018). Elevations are relative to the lowest elevation on the high marsh (= 0 cm).

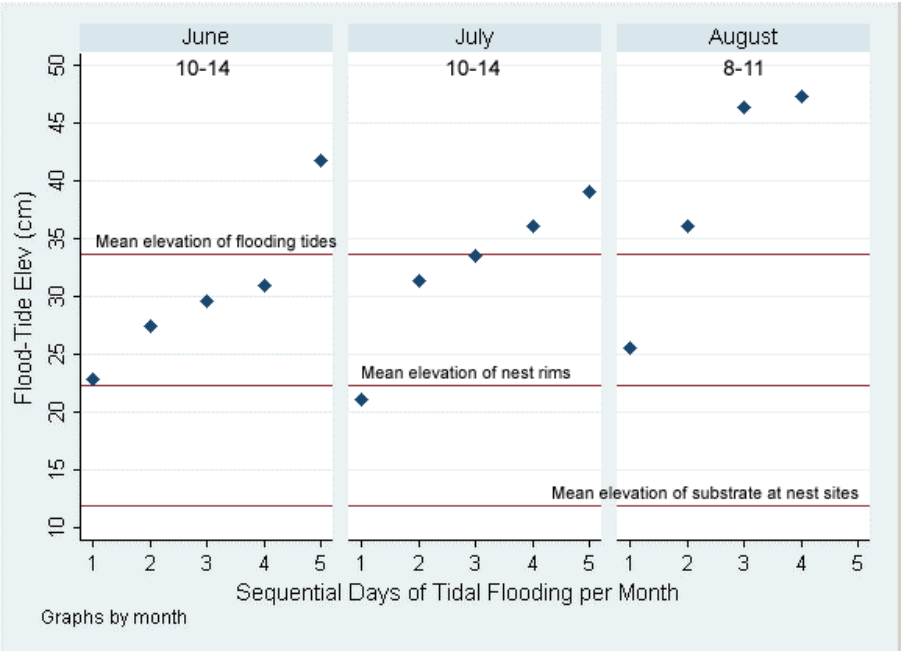

Figure 6. Plots of the elevation of marsh-flooding tides per month. Horizontal lines from top-to-bottom represent mean elevations of flooding tides, nest rims, and substrate at nest sites.

Appendix A. Nest contents, success, and chronology of color-banded females, 2017 - 2018.

band_num	colors	nest	attempt	date_found	first_contents	success	numfledg	banded
2051-661-25	RR XB	18-02	1	31may2018	4e	0	0	0
2051-661-29	YY XB	17-14	1	06jul2017	3e	1	1	4
2051-661-29	YY XB	18-04	1	02jun2018	4e	0	0	0
2051-661-32	RO XB	17-02	1	16jun2017	4e	0	0	0
2051-661-32	RO XB	18-06	1	05jun2018	1e 2y	1	2	0
2051-661-32	RO XB	18-26	2	21jul2018	4e	0	0	0
2051-661-33	RG XB	17-01	1	16jun2017	4y	0	0	4
2051-661-33	RG XB	17-19	2	19jul2017	2y	0	0	1
2051-661-33	RG XB	18-11	1	11jun2018	1e 3y	0	0	0
2051-661-34	RBk XB	17-12	1	05jul2017	4e	0	0	0
2051-661-34	RBk XB	17-20	2	01aug2017	4e	1	2	3
2051-661-34	RBk XB	18-09	1	07jun2018	4e	0	0	0
2051-661-34	RBk XB	18-17	2	25jun2018	4e	0	0	0
2051-661-34	RBk XB	18-25	3	19jul2018	4e	0	0	0
2051-661-36	YL XB	17-15	1	07jul2017	4e	1	1	3
2051-661-36	YL XB	17-24	2	07aug2017	2e	0	0	0
2051-661-38	XB OY	17-03	1	16jun2017	4y	1	1	4
2051-661-39	GY XB	17-04	1	20jun2017	3y	0	0	3
2051-661-51	BkY XB	17-18	1	17jul2017	4y	1	4	4
2051-661-51	BkY XB	18-14	1	23jun2018	3e	1	4	4
2051-661-61	YG XB	17-07	1	03jul2017	4e	0	0	0
2051-661-62	BkB XB	17-08	1	03jul2017	4e	0	0	0
2051-661-62	BkB XB	17-23	2	03aug2017	3e	0	0	3
2051-661-63	BkO XB	17-11	1	05jul2017	4e	0	0	3
2051-661-64	BkL XB	17-10	1	10jul2017	4e	0	0	4
2051-661-64	BkL XB	18-10	1	08jun2018	4e	0	0	0
2051-661-66	XB BB	17-16	1	17jul2017	2y	0	0	2
2051-661-66	XB BB	18-19	1	28jun2018	4e	1	4	4
2051-661-66	XB BB	18-28	2	01aug2018	3e	0	0	0
2051-661-85	__ XB	17-17	1	14jul2017	4y	1	4	4
2051-661-99	LL BX	17-22	1	03aug2017	3e	0	0	0
2051-661-99	LL BX	18-01	2	30may2018	4e	1	3	3
2781-738-17	LY PX	18-03	1	01jun2018	3e	0	0	0
2781-738-17	LY PX	18-16	2	24jun2018	5e	1	1	1
2781-738-17	LY PX	18-27	3	28jul2018	4e	0	0	0
2781-738-18	WBk XP	18-08	1	06jun2018	4e	0	0	0
2781-738-28	WO XP	18-15	1	23jun2018	3e	1	1	1
2781-738-45	BkG XP	18-24	1	19jul2018	2e	0	0	0
2781-738-49	XP GrBk	18-30	1	04aug2018	3y	1	2	3
2781-738-51	OO XP	18-32	1	10aug2018	1y	1	2	0