

## Supplementary information

# Continuous Radar Tracking Illustrates the Development of Multi-destination Routes of Bumblebees

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## Supplementary table

**Supplementary Table S1: Details of six bees**

|  | <b>Bee 1</b>  | <b>Bee 2</b>         | <b>Bee 3</b>         | <b>Bee 4</b> | <b>Bee 5</b> | <b>Bee 6</b> |
|--|---|----------------------|----------------------|--------------|--------------|--------------|
| Dates tracked                                | 16/09/14<br>21/09/14                                    | 17/09/14<br>18/09/14 | 25/09/14<br>26/09/14 | 28/09/14     | 03/10/14     | 28/09/15     |
| No foraging bouts                            | 47  | 51                   | 61                   | 6            | 27           | 9            |
| Location of feeder array                     | 1   | 1                    | 2                    | 2            | 2            | 2            |
| Volume sucrose solution per feeder (μl)      | 18 (bouts 1-13)<br>19 (bouts 14-21)<br>20 (bouts 22-47) | 20                   | 16                   | 20           | 19.5         | 14           |
| Trapline sequence                            | 1-2-3-4-5   | 5-4-2-3-1            | 5-1-2-3-4            | N/A          | 5-1-2-4      | N/A          |
| First bout in which trapline appeared        | 34  | 24                   | 17                   | N/A          | 20           | N/A          |
| Largest number of consecutive trapline bouts | 4   | 5                    | 12                   | N/A          | 3            | N/A          |
| Total number of trapline bouts               | 15  | 17                   | 26                   | N/A          | 6            | N/A          |

## Supplementary figures

### **Supplementary Figs S1-S201: Flight paths of every flight made at feeder array by six bees.**

Each figure represents a single foraging bout by one bee. Bee ID, flight number, date of recording and the duration of each flight are shown on each figure. Nest position is represented in each panel by an open circle and the positions of the feeders by closed circles. Scale bars represent a distance of 25m. a) Flight path of the bee during each bout. Consecutive radar observations of the bee's location are joined by straight lines. The foraging bout is broken down into 'legs', each of which encompasses the portion of the flight path which began when the bee left a feeder or nest and ended when it came within 5m of another feeder or the nest. Each leg is represented by a different colour. Any leg during which the bee travels further than 50m from all the feeders it has previously visited is defined as 'exploration' and represented by a dashed line. b) Heat map showing the probability that the bee passed over each part of the landscape during each bout, as estimated from the radar tracks using a Brownian bridges technique (described in Methods). Each pixel represents an area 5 x 5m.

Fig S1

Bee 1, Bout 1, 16/09/2014  
Duration: 00:26:58

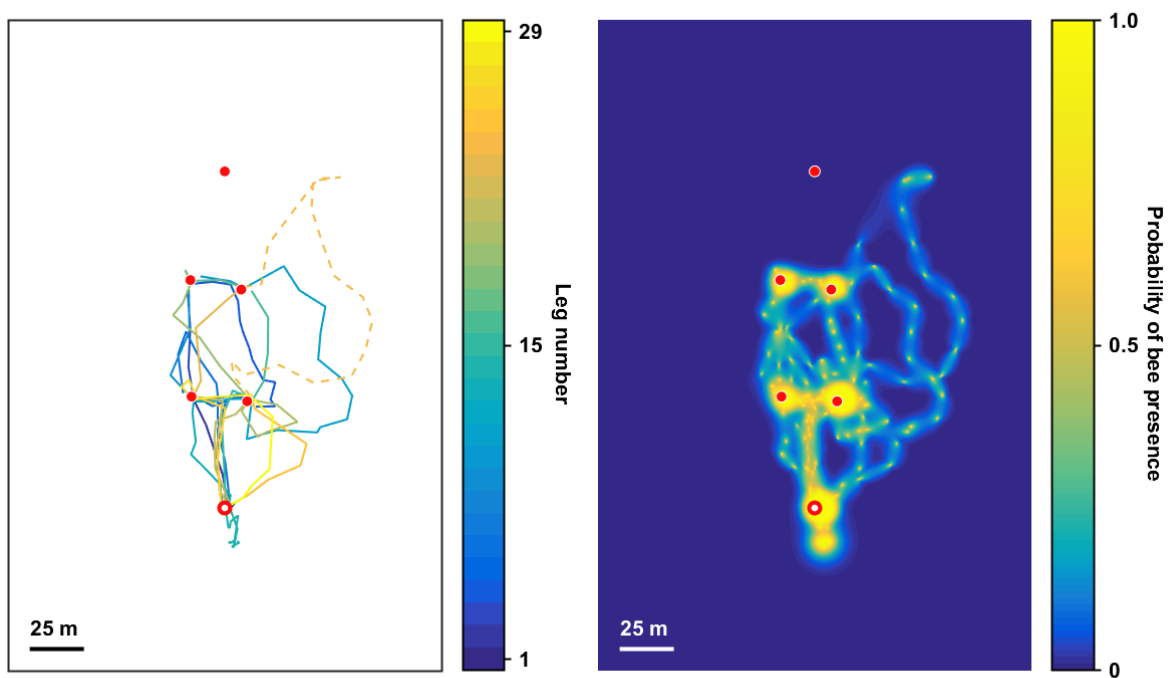




Fig S2

Bee 1, Bout 2, 16/09/2014  
Duration: 00:16:48

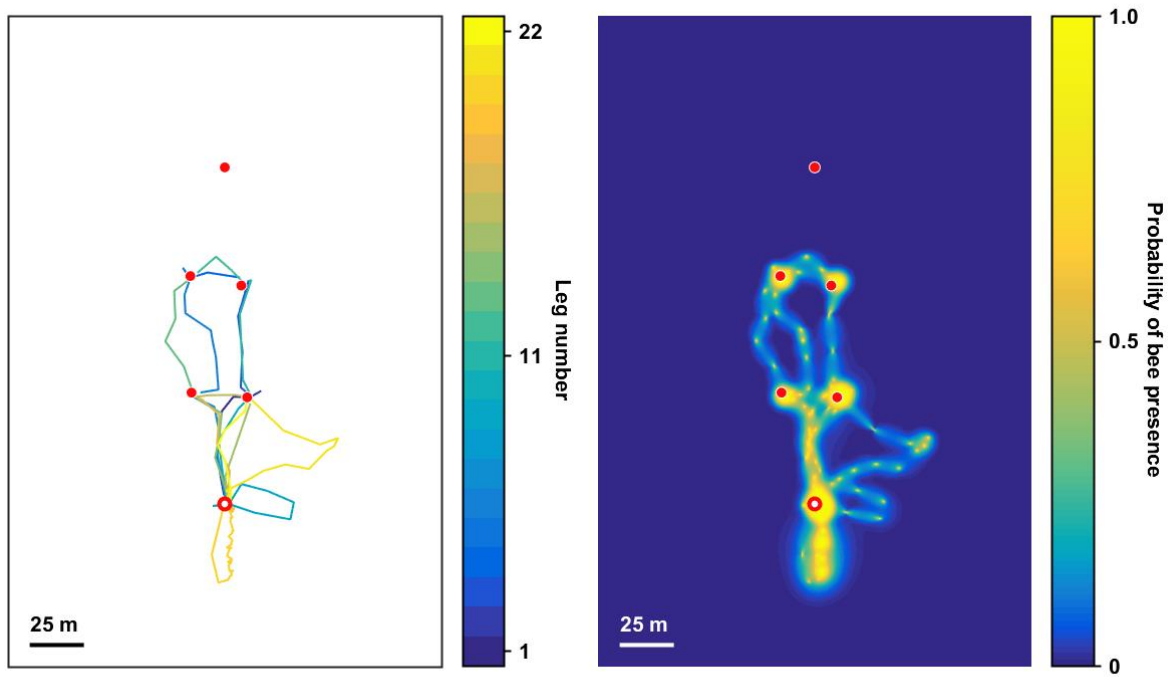


Fig S3

Bee 1, Bout 3, 16/09/2014  
Duration: 00:30:43

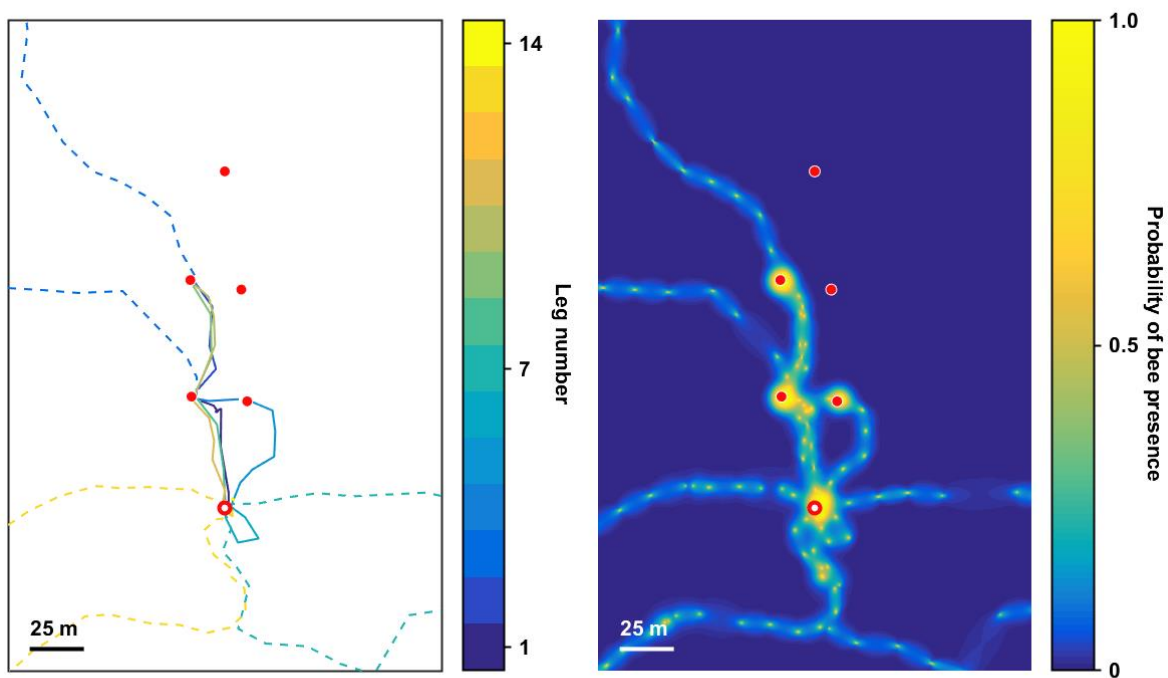


Fig S4

Bee 1, Bout 4, 16/09/2014  
Duration: 00:31:27

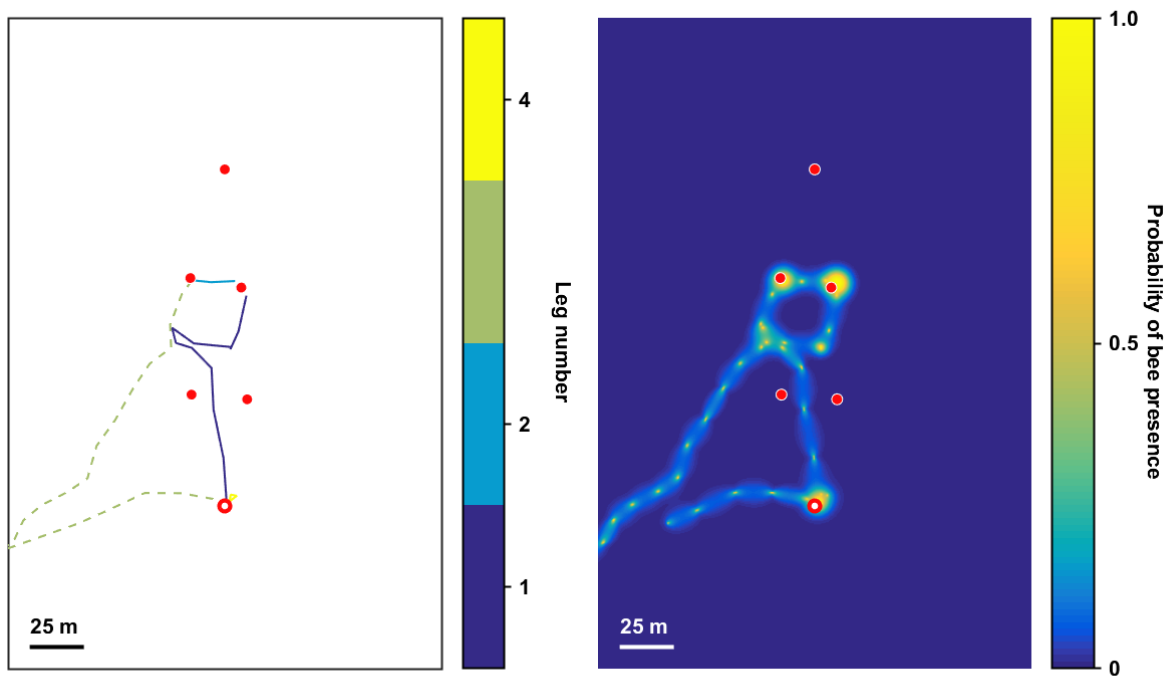


Fig S5

Bee 1, Bout 5, 16/09/2014  
Duration: 00:28:34

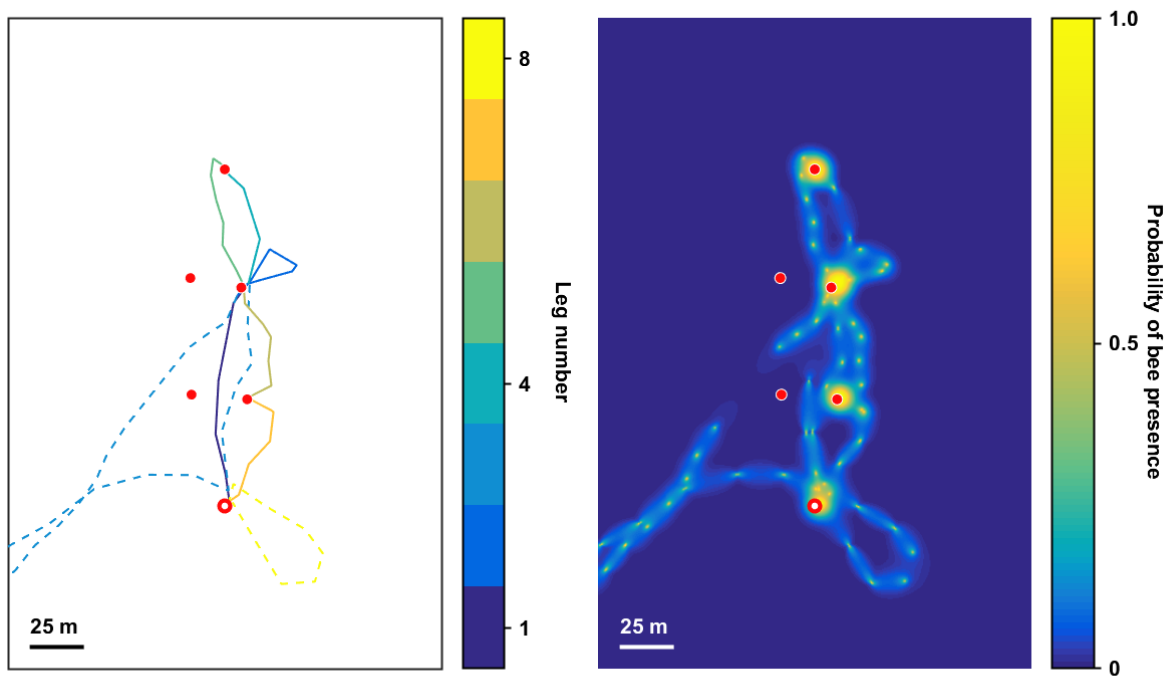


Fig S6

Bee 1, Bout 6, 16/09/2014  
Duration: 00:11:46

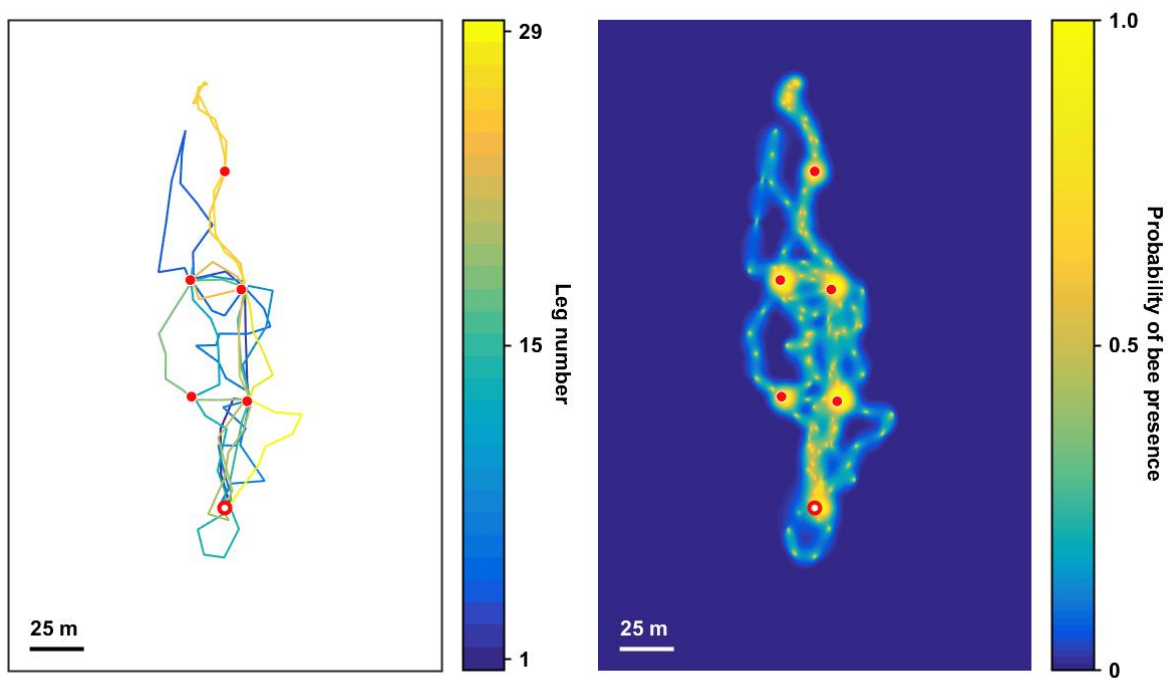


Fig S7

Bee 1, Bout 7, 16/09/2014  
Duration: 00:08:11

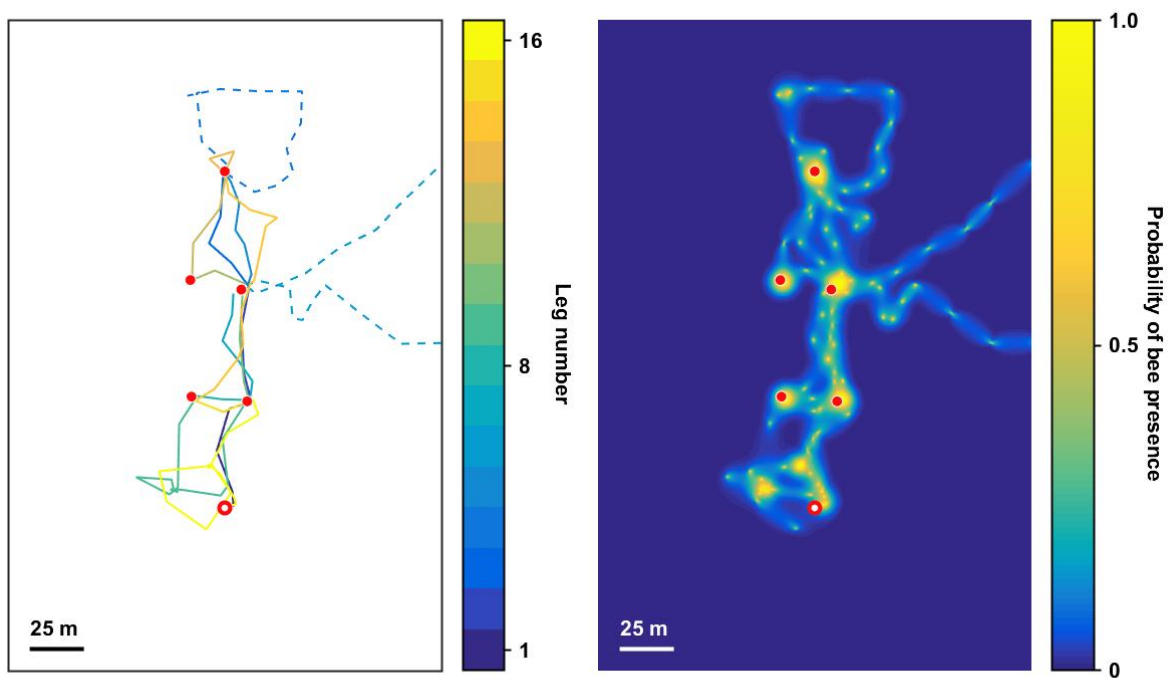


Fig S8

Bee 1, Bout 8, 16/09/2014  
Duration: 00:04:08

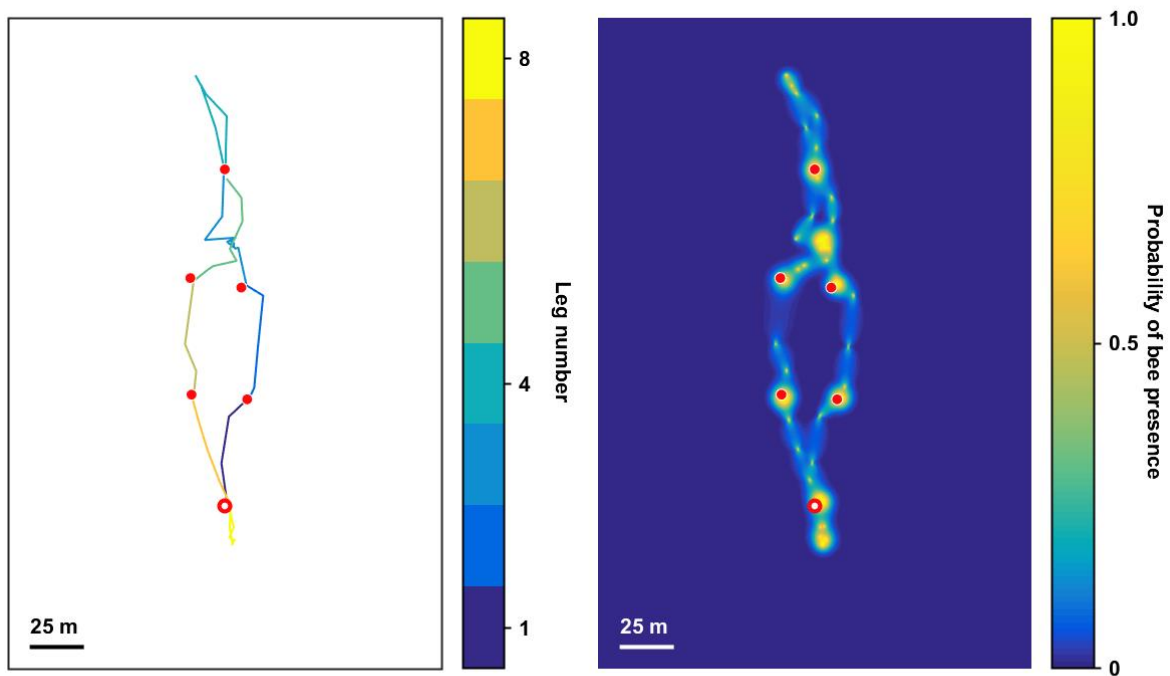


Fig S9

Bee 1, Bout 9, 16/09/2014  
Duration: 00:09:52

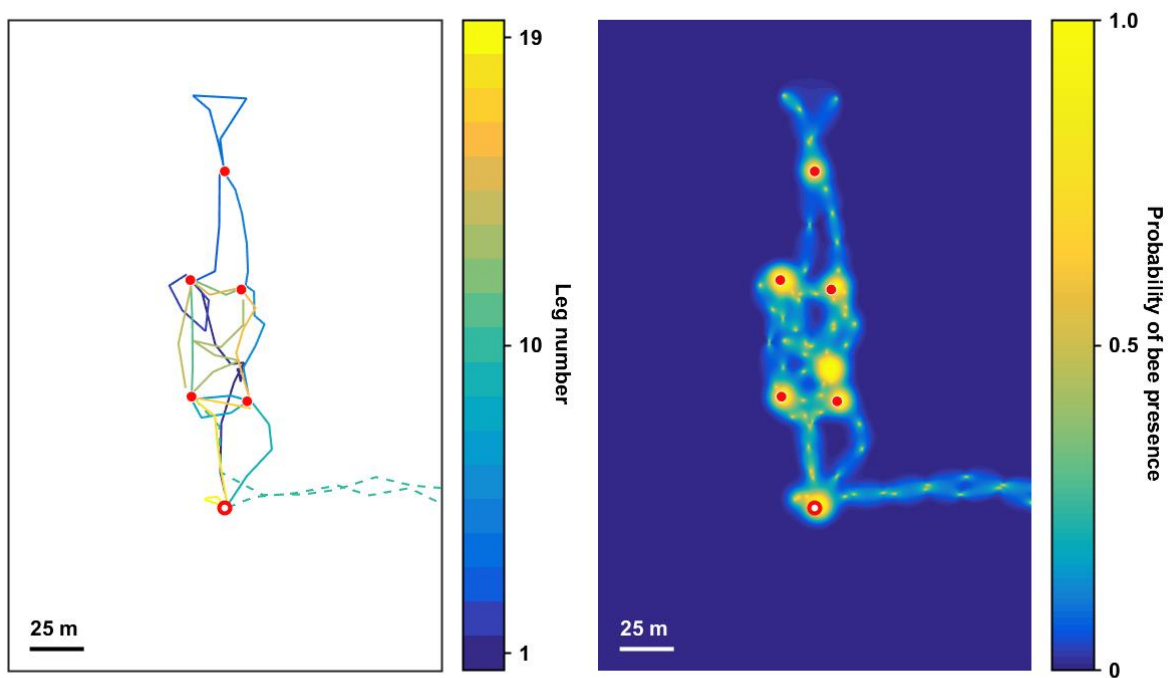




Fig S10

Bee 1, Bout 10, 16/09/2014  
Duration: 00:33:49

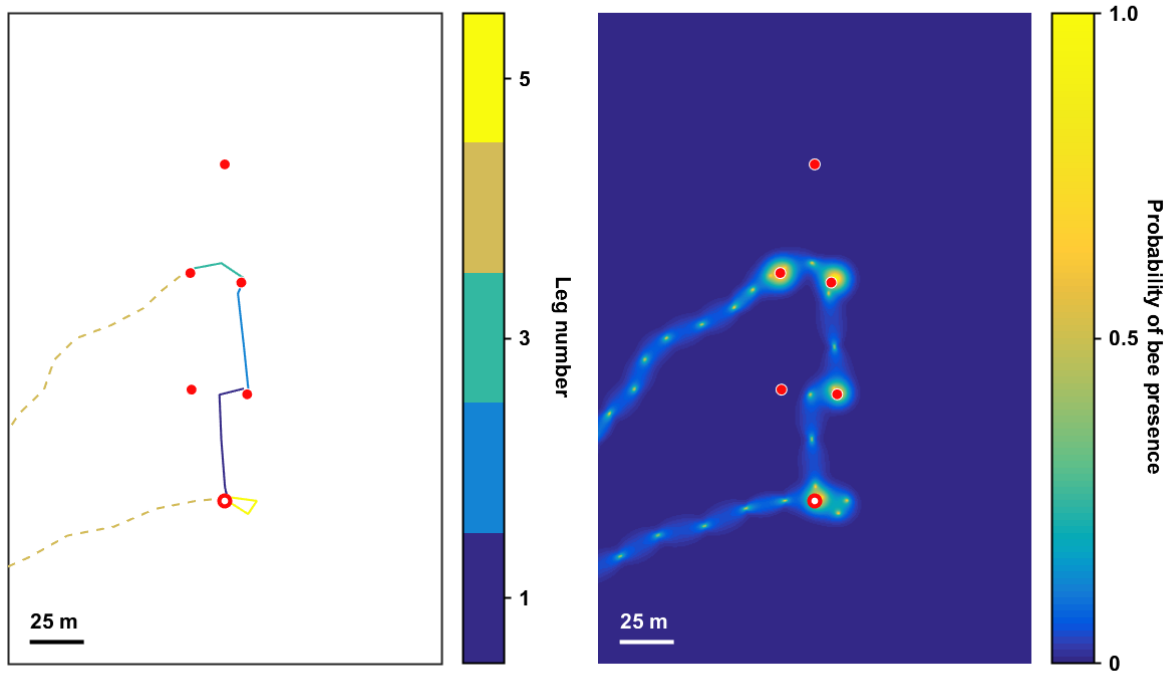


Fig S11

Bee 1, Bout 11, 16/09/2014  
Duration: 00:05:33

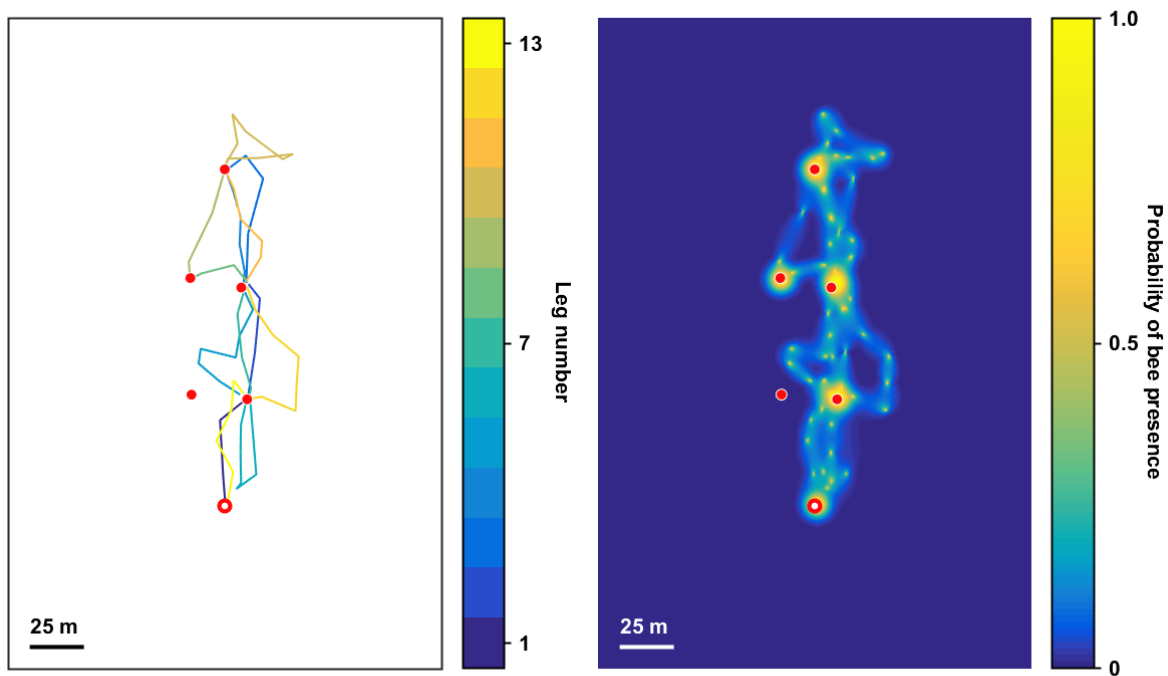


Fig S12

Bee 1, Bout 12, 16/09/2014  
Duration: 00:06:12

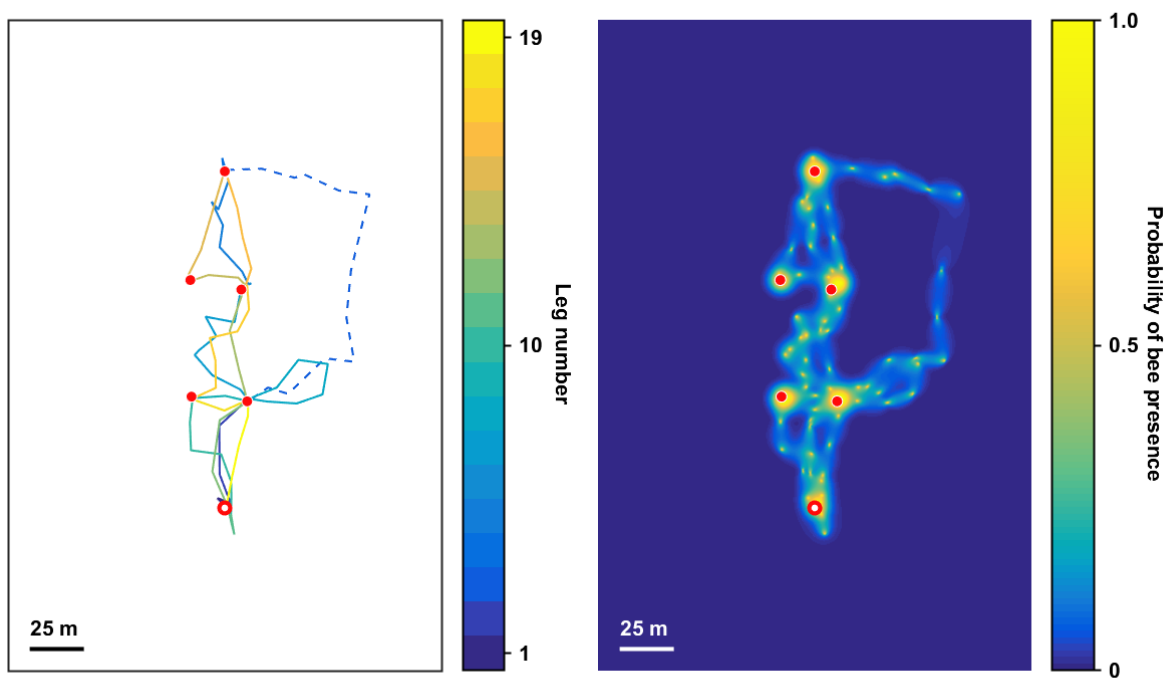


Fig S13

Bee 1, Bout 13, 16/09/2014  
Duration: 00:06:27

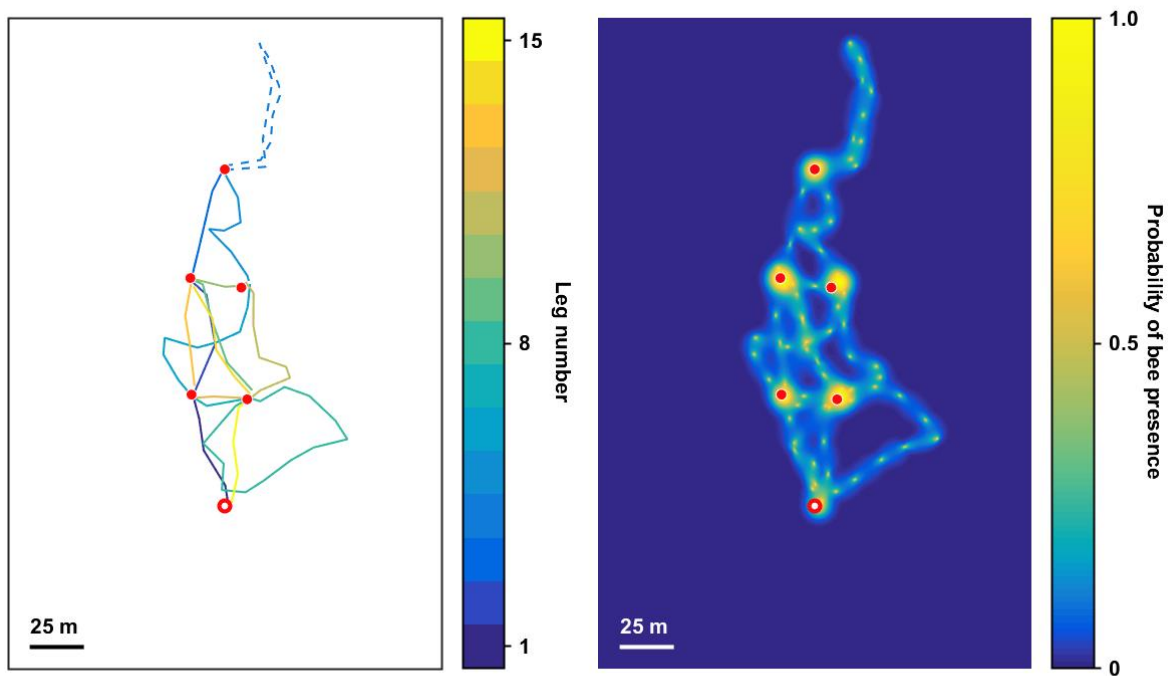


Fig S14

Bee 1, Bout 14, 16/09/2014  
Duration: 00:04:53

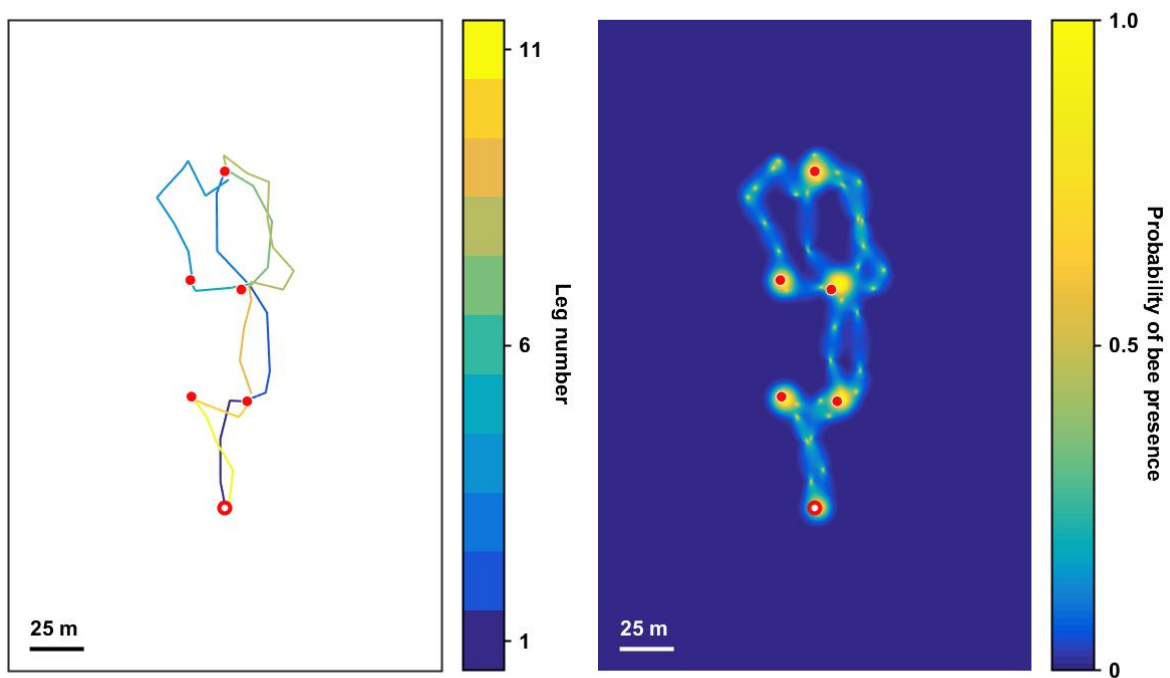


Fig S15

Bee 1, Bout 15, 16/09/2014  
Duration: 00:05:24

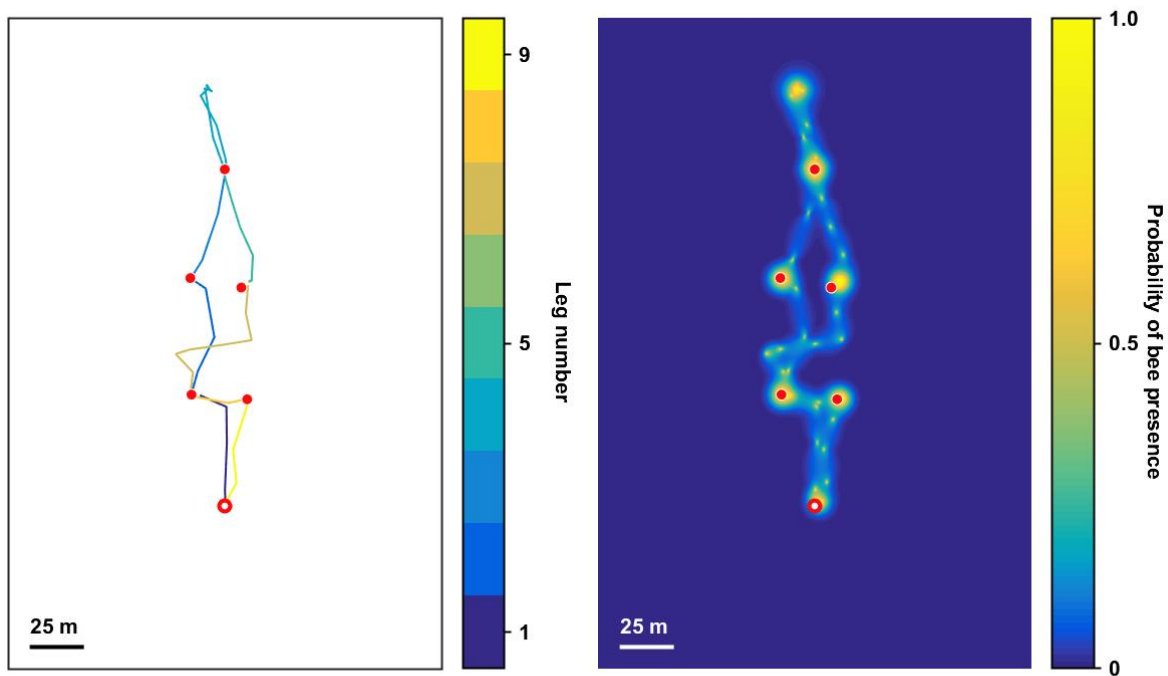


Fig S16

Bee 1, Bout 16, 16/09/2014  
Duration: 00:04:19

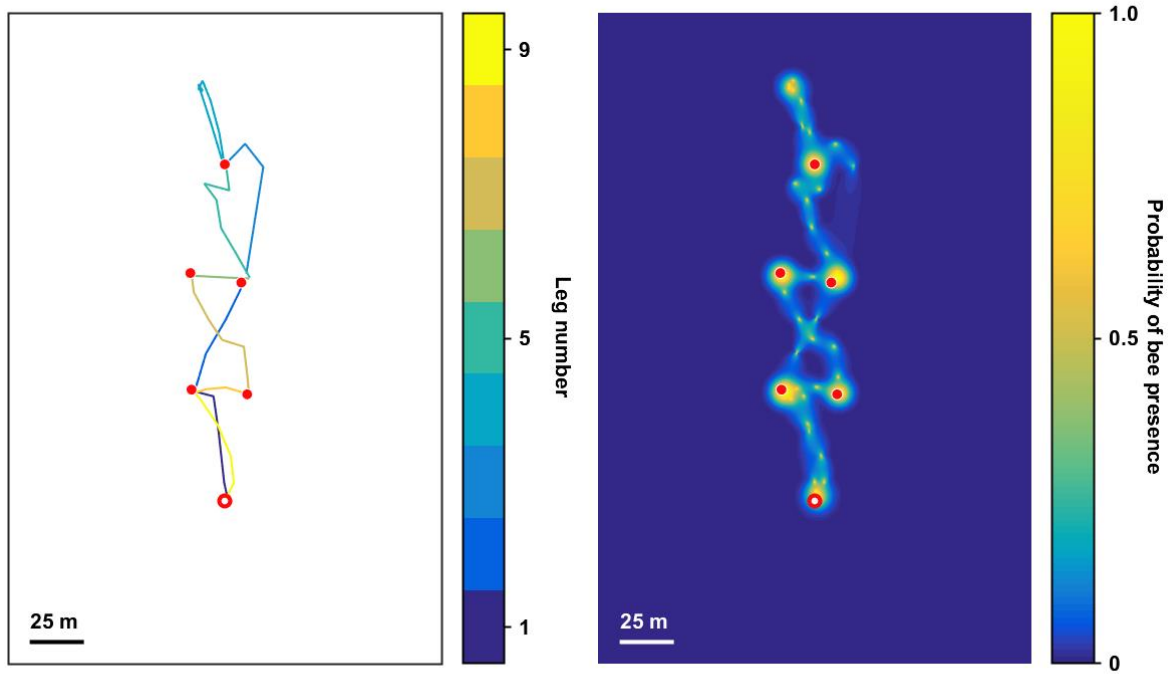


Fig S17

Bee 1, Bout 17, 16/09/2014  
Duration: 00:07:51

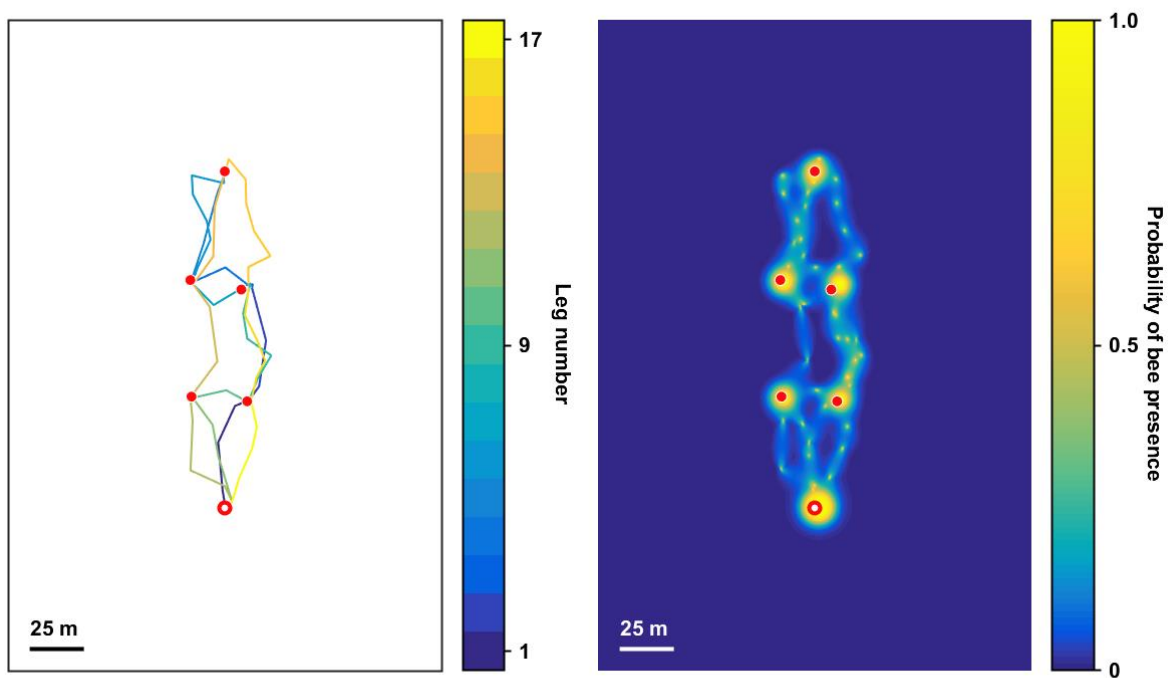




Fig S18

Bee 1, Bout 18, 16/09/2014  
Duration: 00:04:59

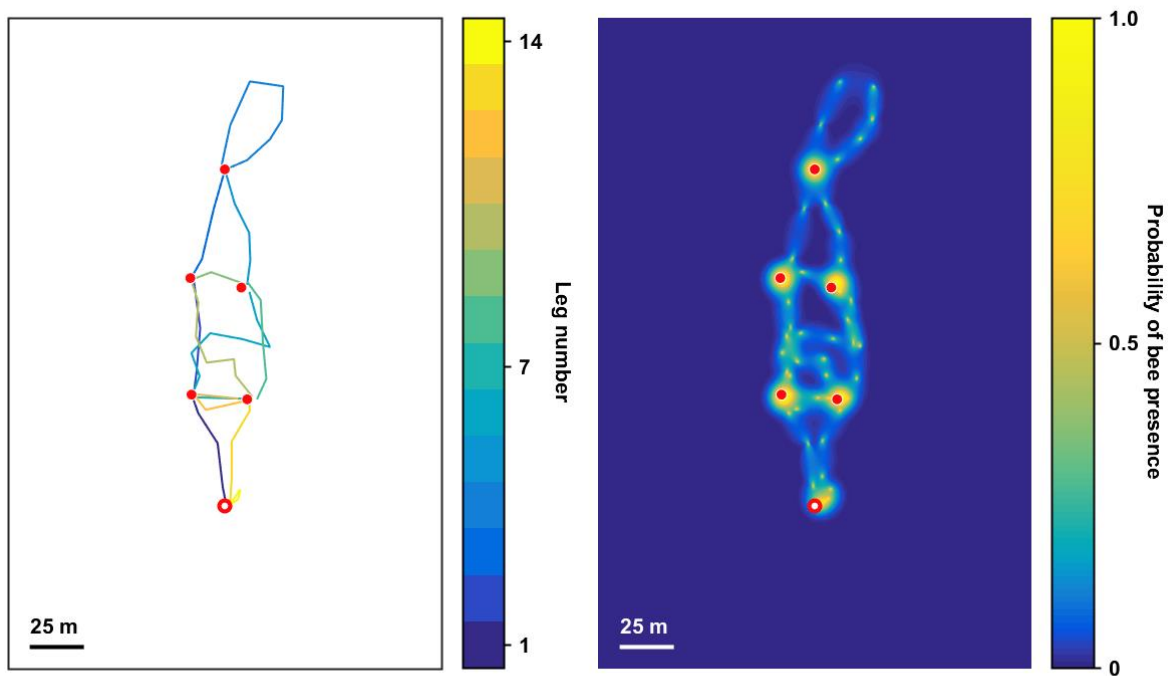


Fig S19

Bee 1, Bout 19, 16/09/2014  
Duration: 00:07:52

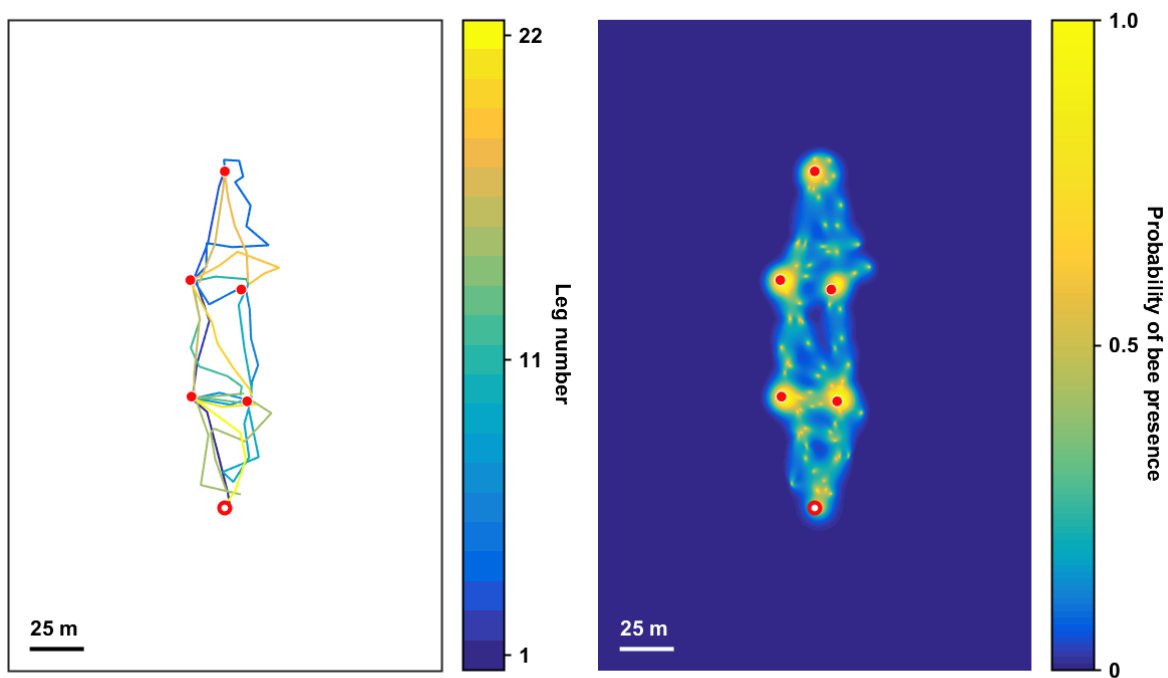


Fig S20

Bee 1, Bout 20, 16/09/2014  
Duration: 00:07:40

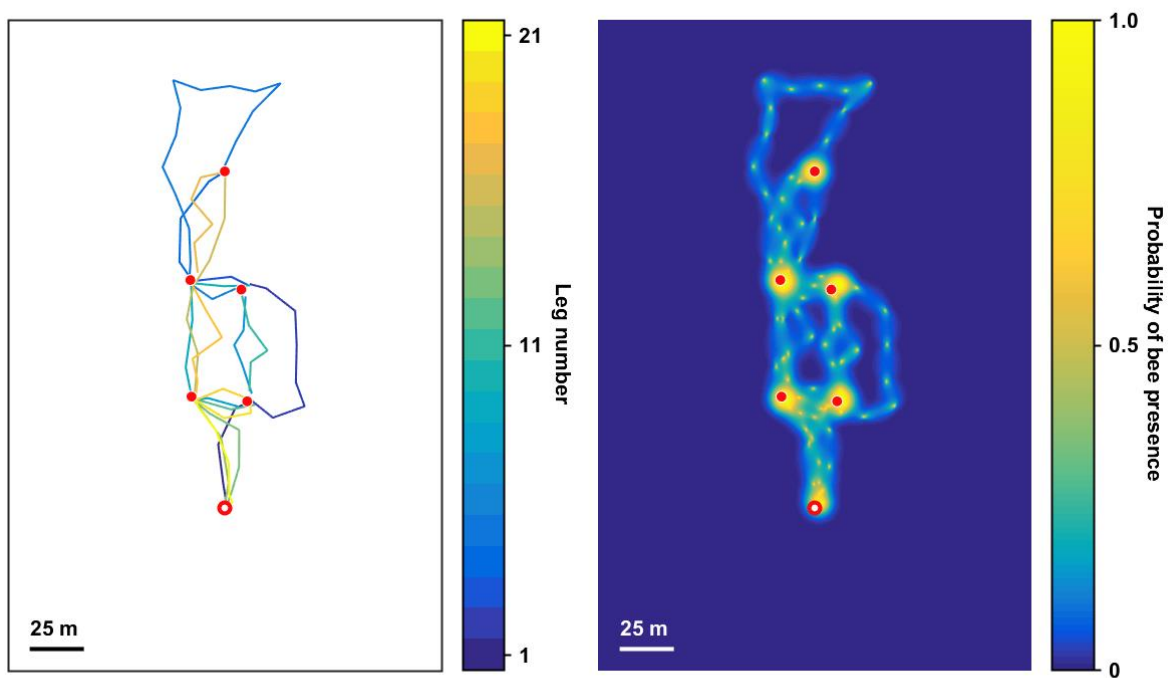


Fig S21

Bee 1, Bout 21, 16/09/2014  
Duration: 00:09:56

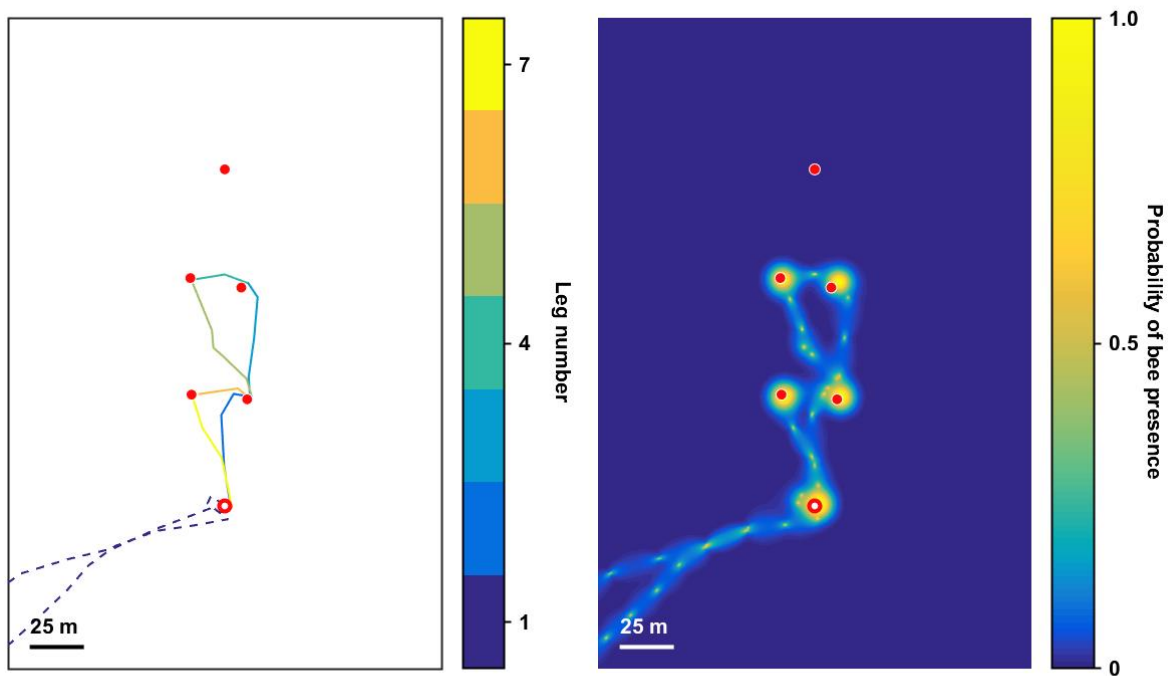


Fig S22

Bee 1, Bout 22, 21/09/2014  
Duration: 00:04:46

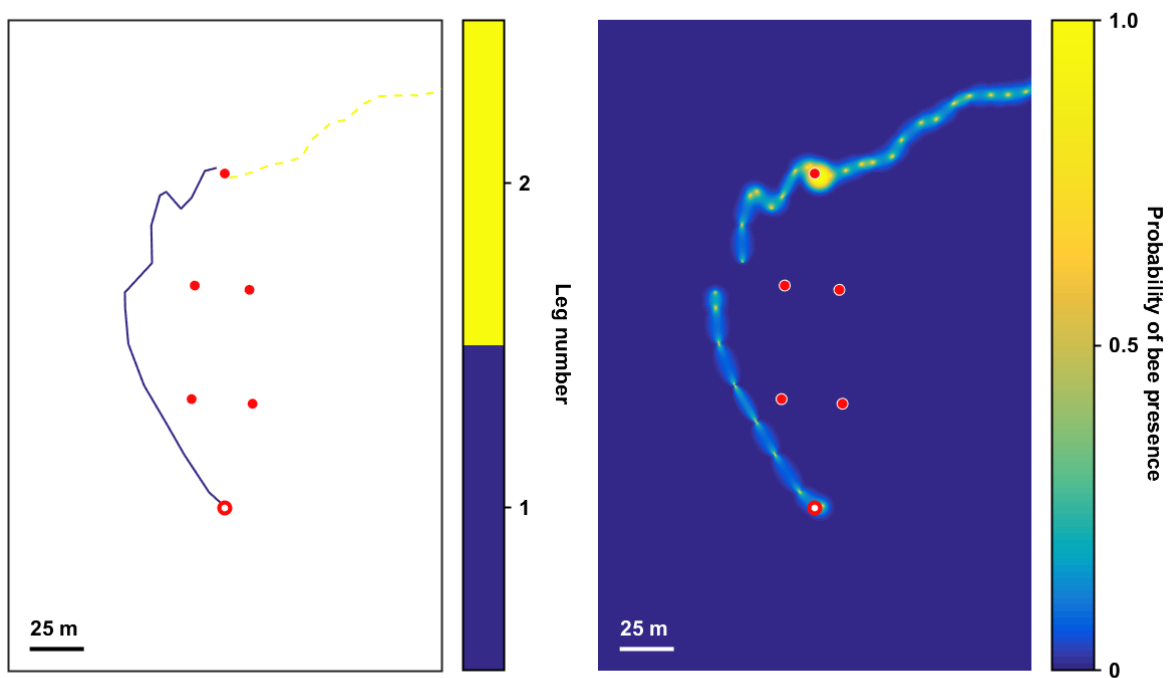


Fig S23

Bee 1, Bout 23, 21/09/2014  
Duration: 00:28:55

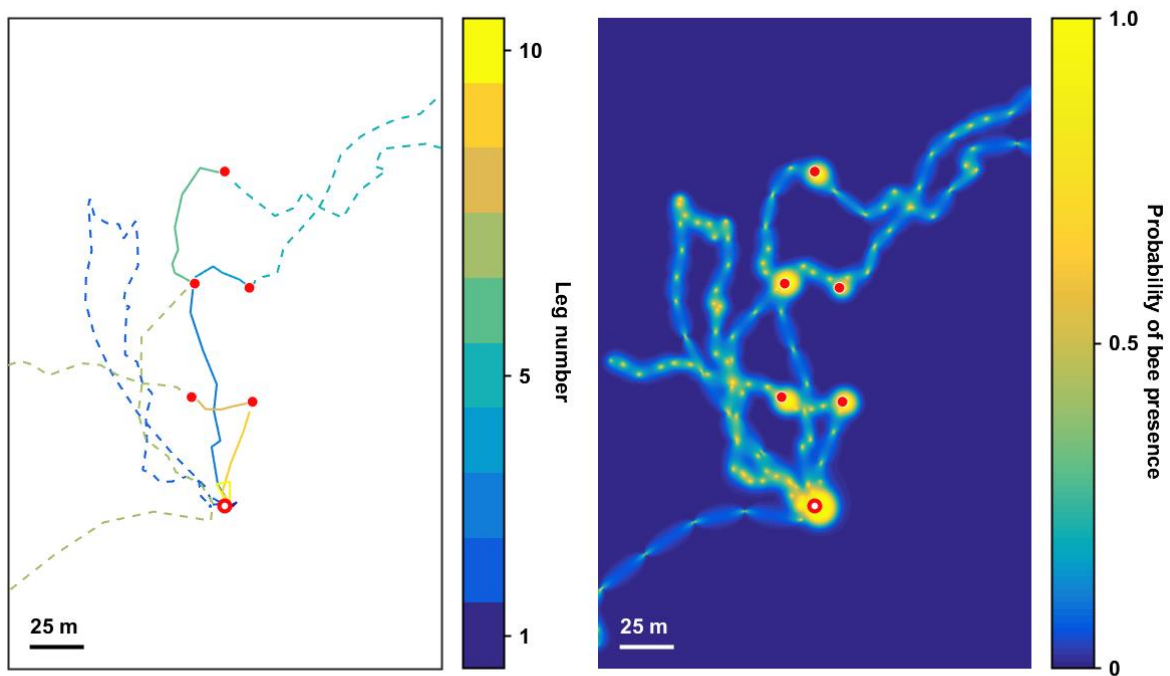


Fig S24

Bee 1, Bout 24, 21/09/2014  
Duration: 00:08:34

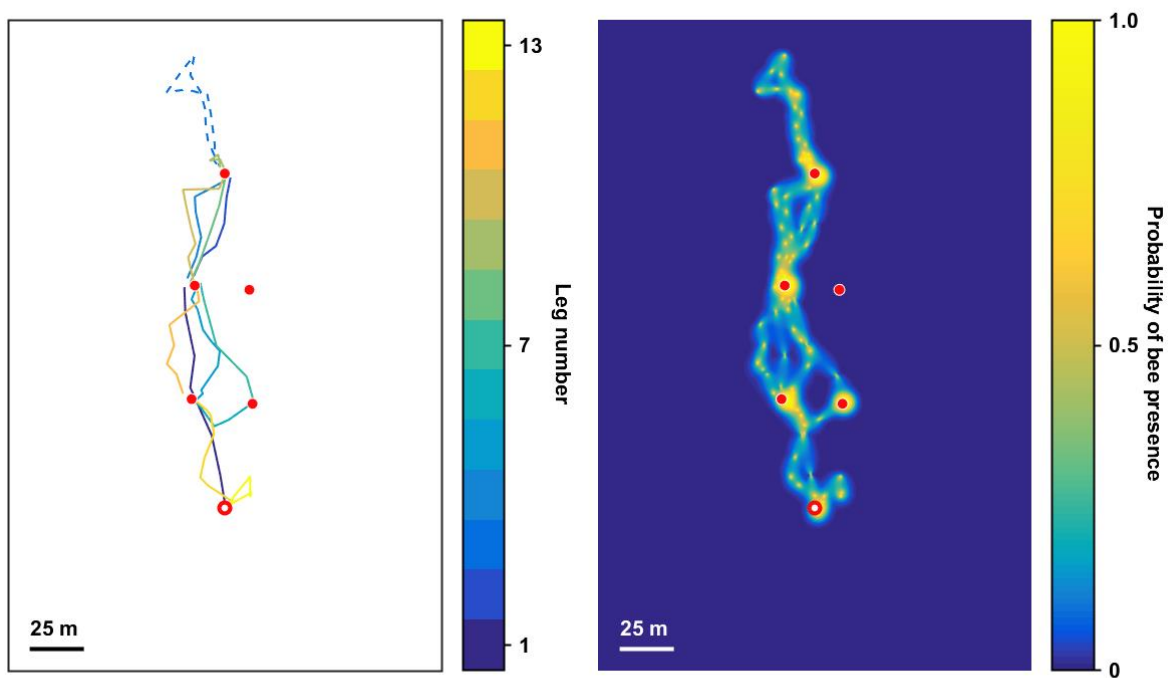


Fig S25

Bee 1, Bout 25, 21/09/2014  
Duration: 00:11:40

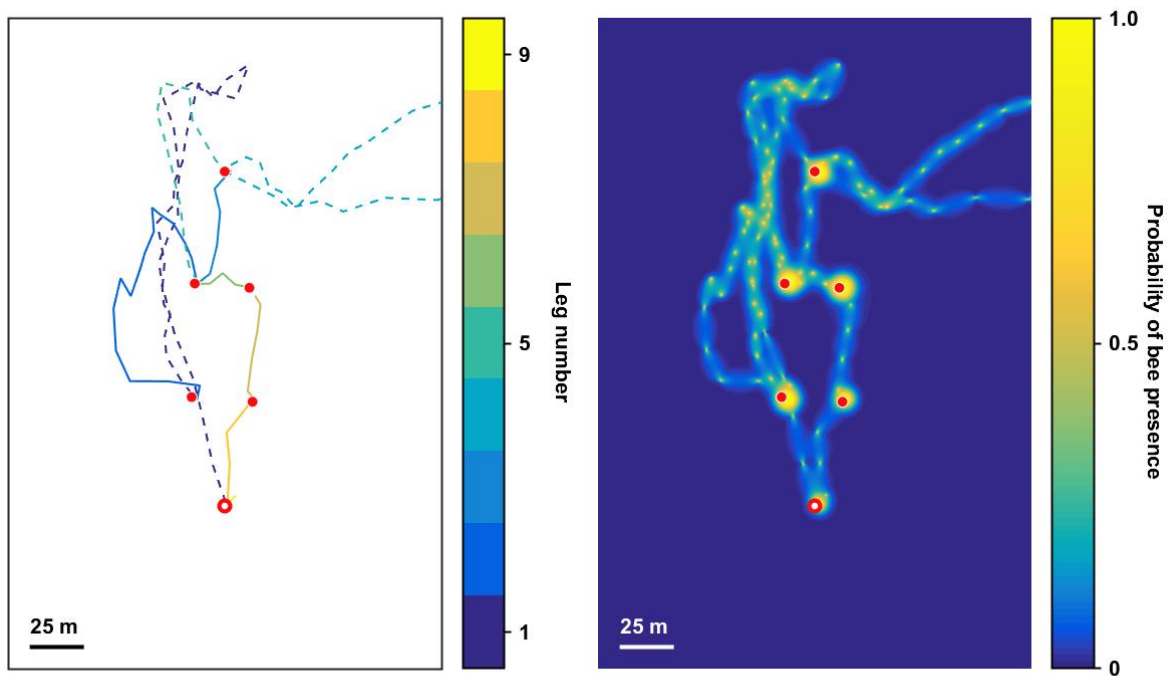




Fig S26

Bee 1, Bout 26, 21/09/2014  
Duration: 00:06:33

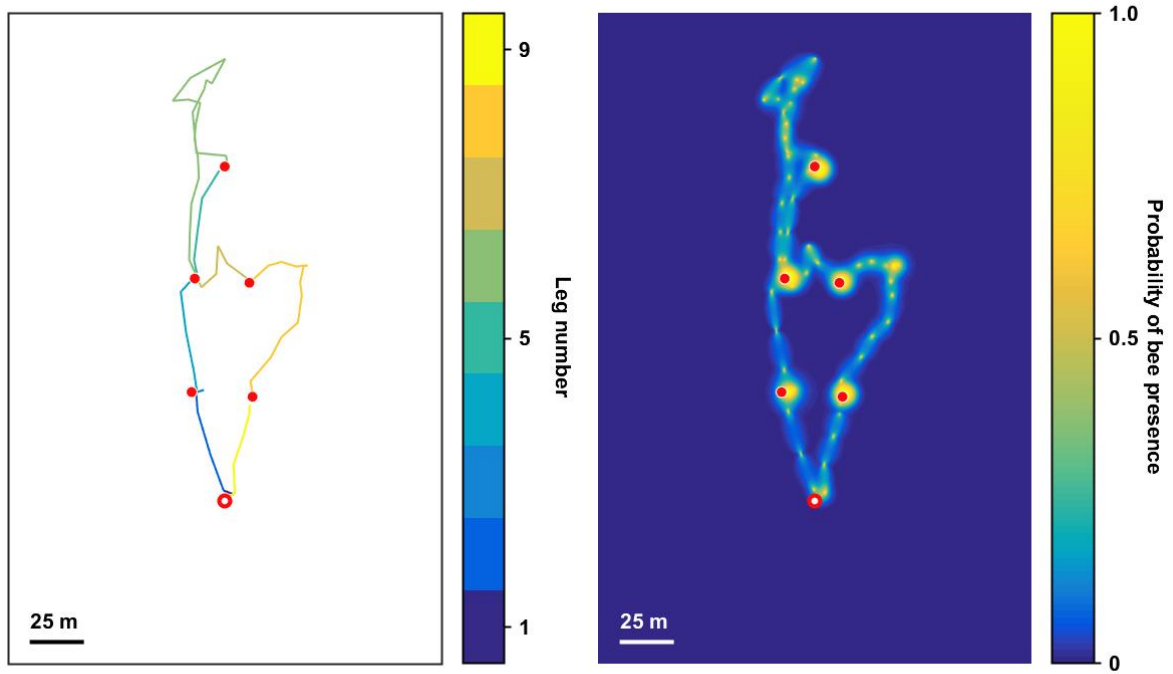


Fig S27

Bee 1, Bout 27, 21/09/2014  
Duration: 00:05:58

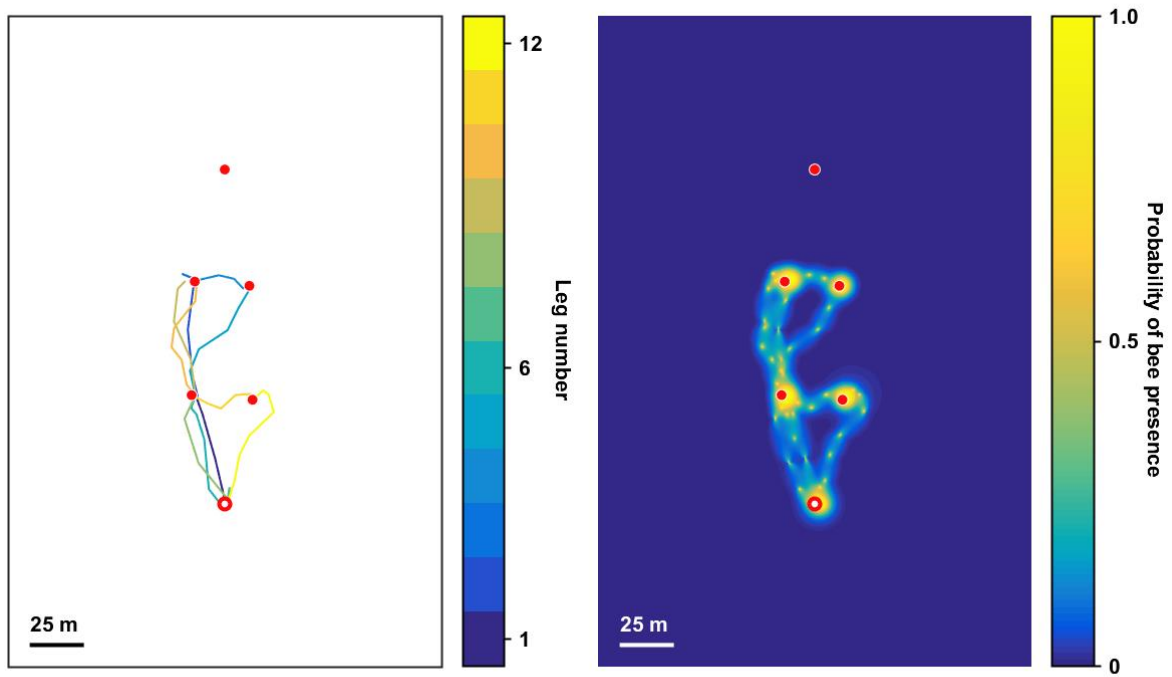


Fig S28

Bee 1, Bout 28, 21/09/2014  
Duration: 00:06:13

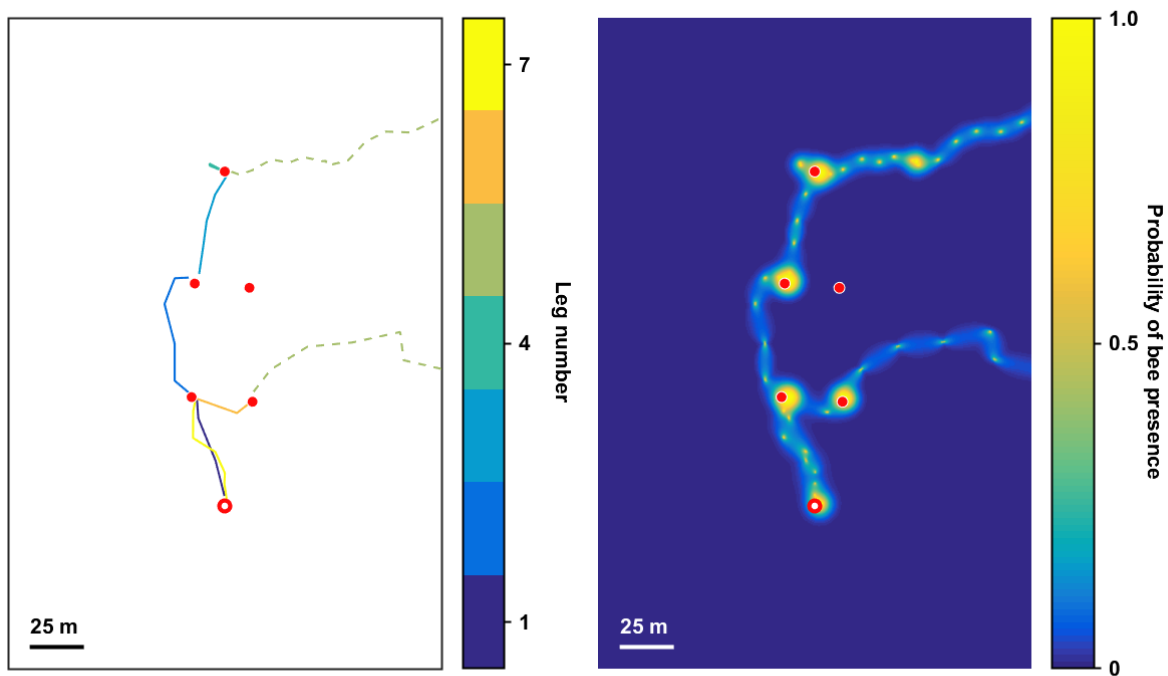


Fig S29

Bee 1, Bout 29, 21/09/2014  
Duration: 00:08:54

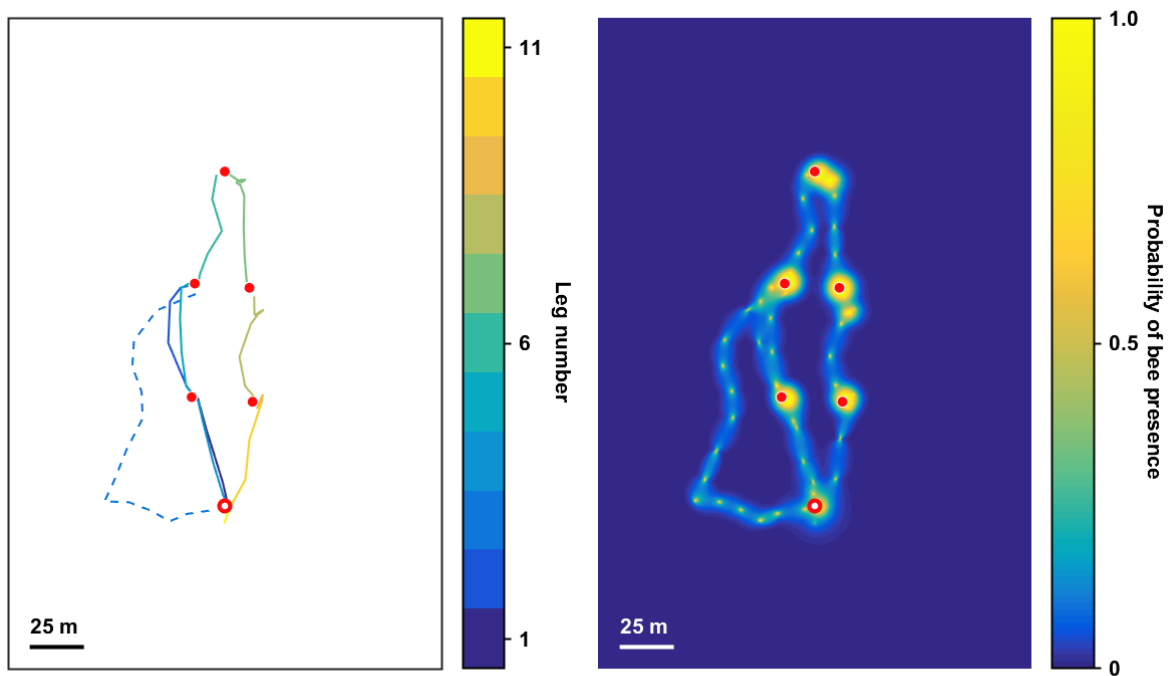


Fig S30

Bee 1, Bout 30, 21/09/2014  
Duration: 00:06:44

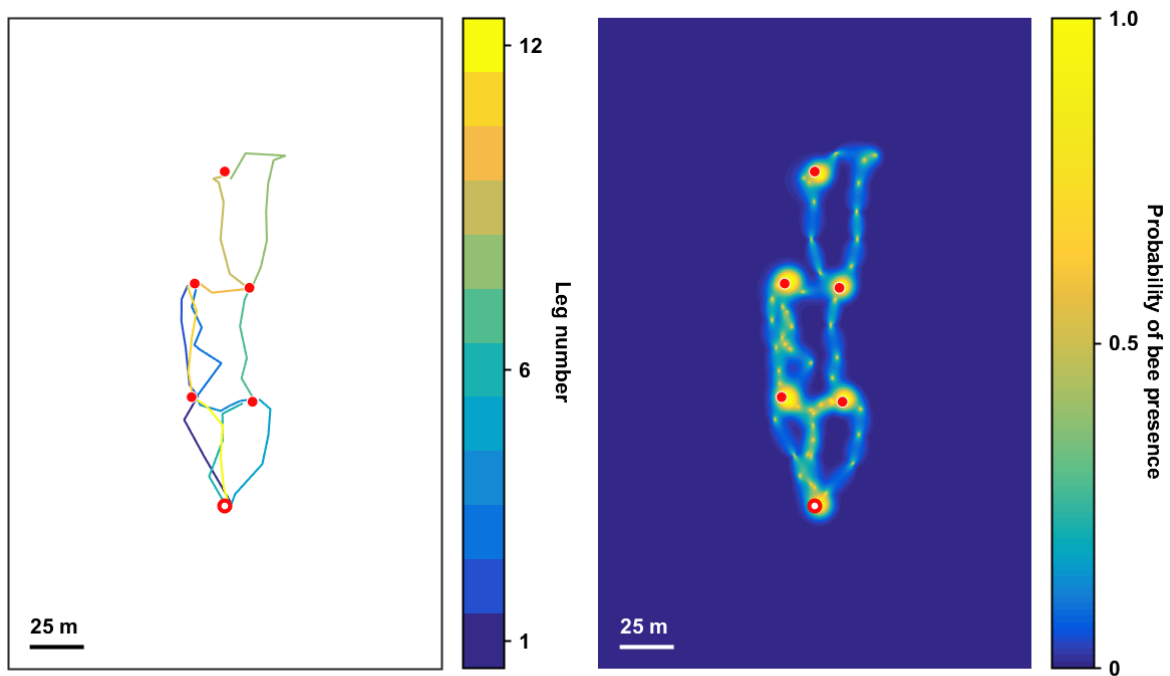


Fig S31

Bee 1, Bout 31, 21/09/2014  
Duration: 00:05:05

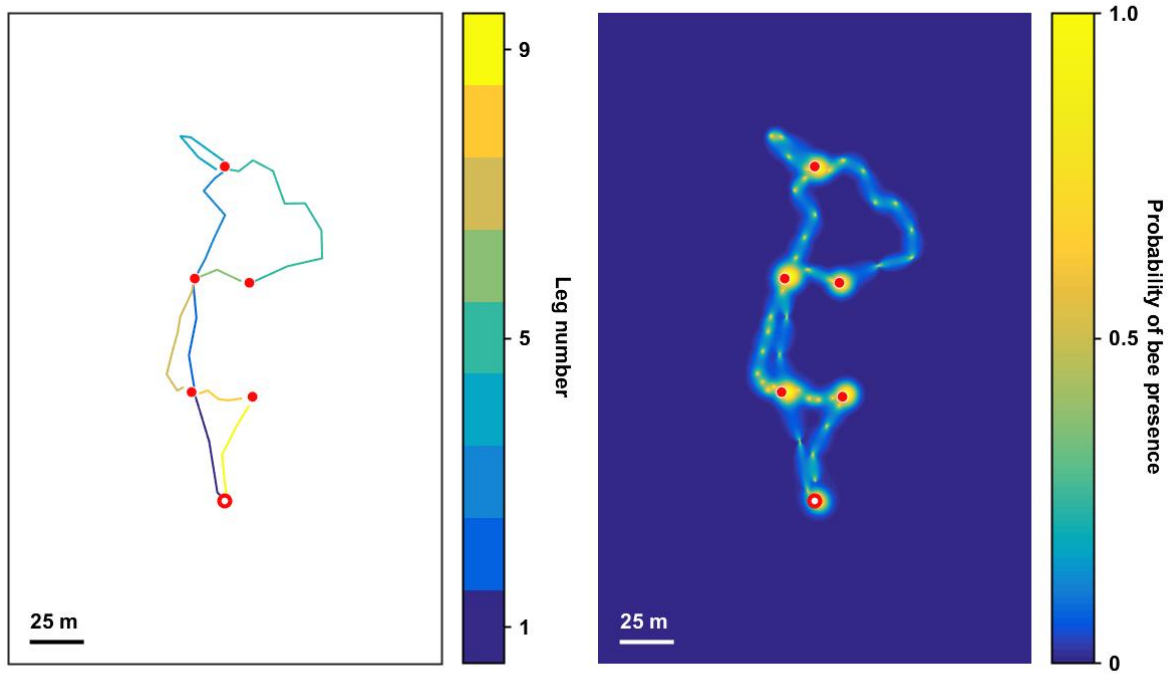


Fig S32

Bee 1, Bout 32, 21/09/2014  
Duration: 00:05:33

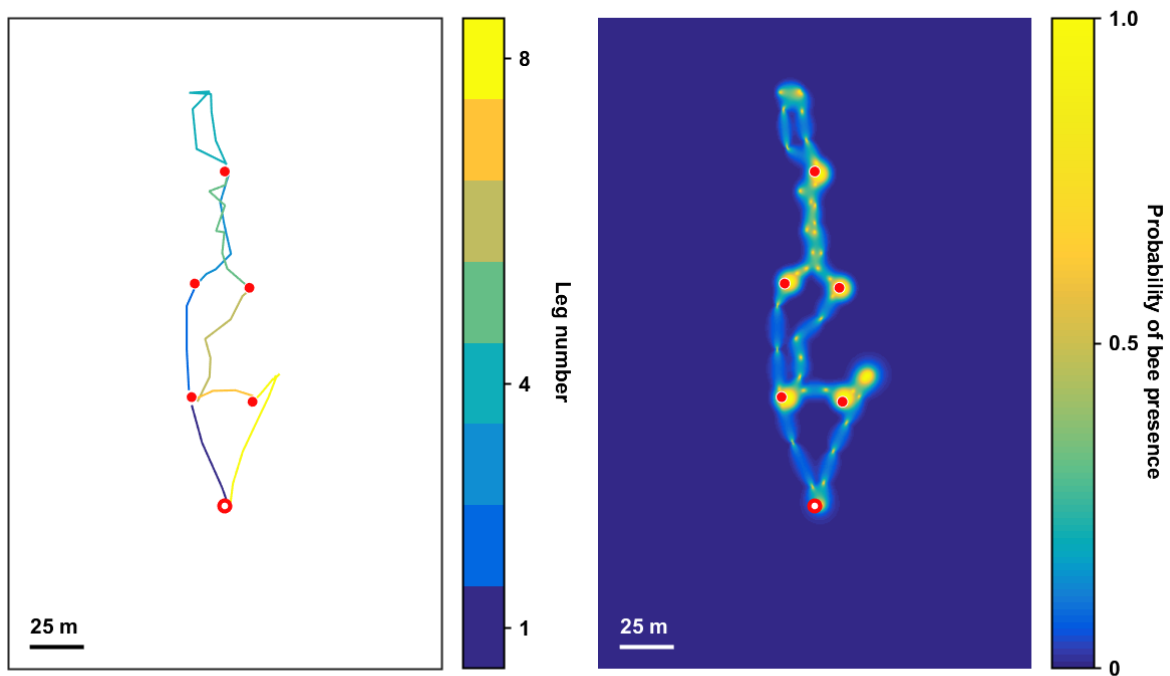


Fig S33

Bee 1, Bout 33, 21/09/2014  
Duration: 00:05:28

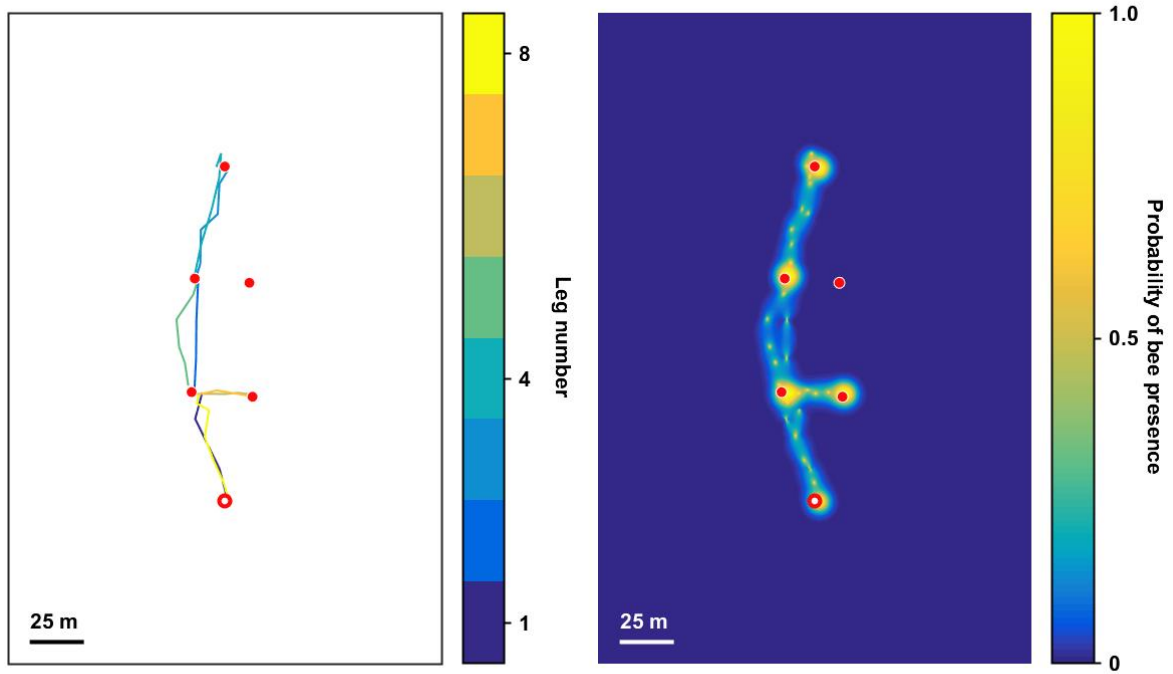




Fig S34

Bee 1, Bout 34, 21/09/2014  
Duration: 00:06:25

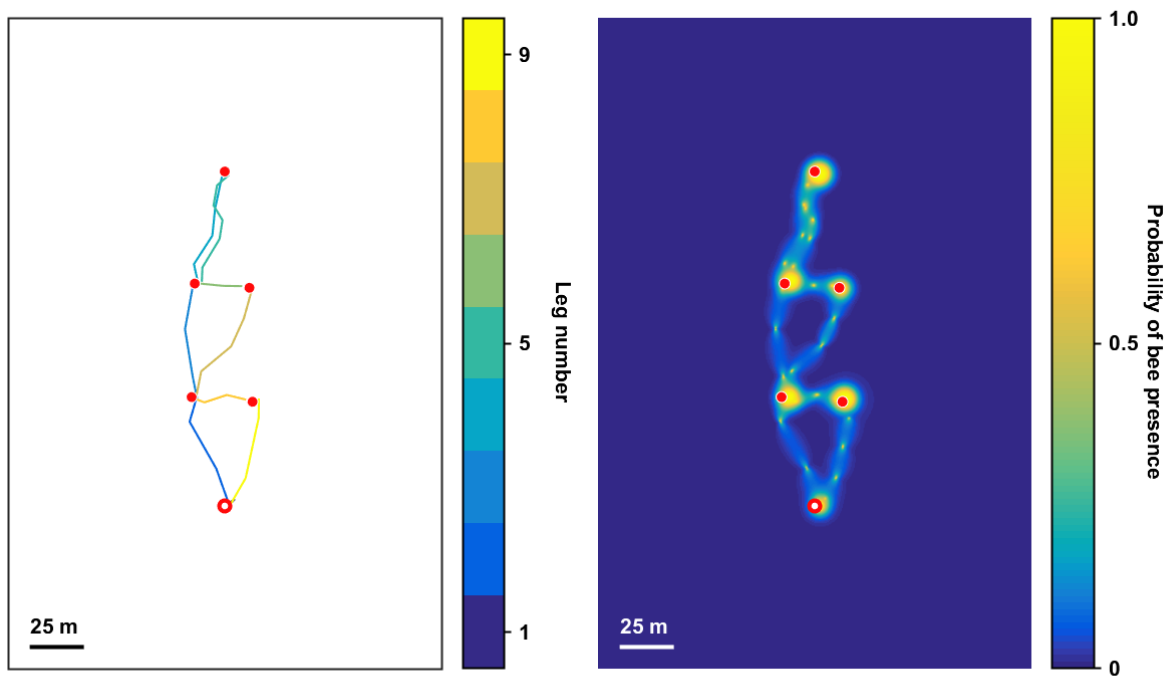


Fig S35

Bee 1, Bout 35, 21/09/2014  
Duration: 00:06:44

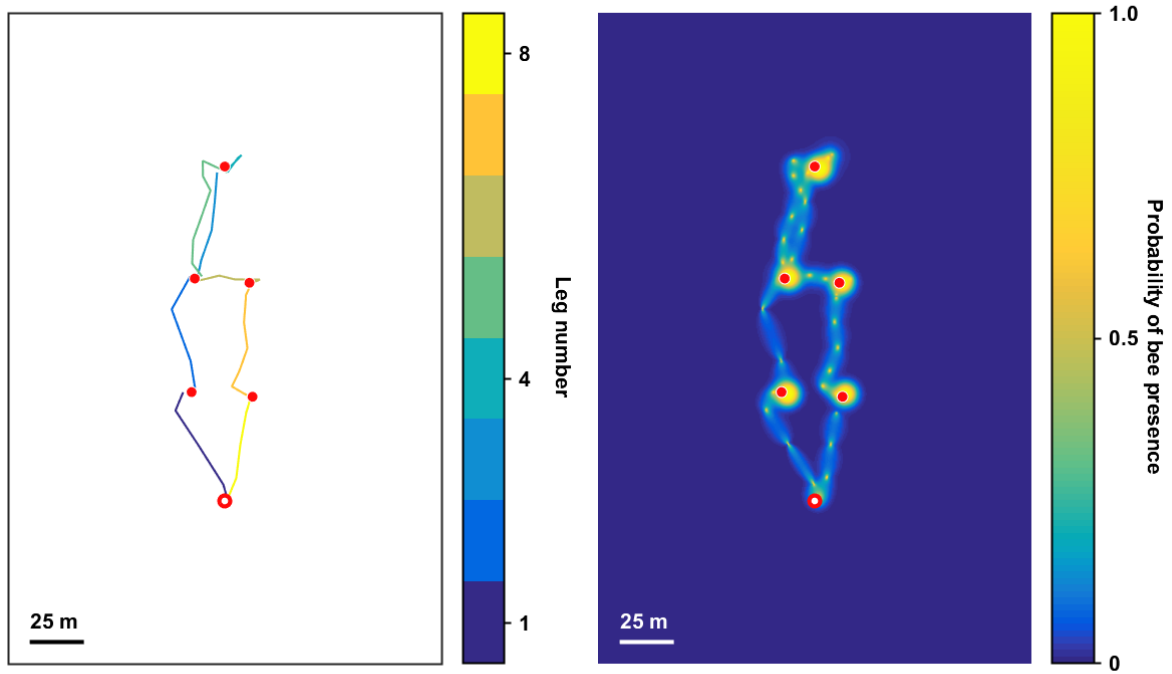


Fig S36

Bee 1, Bout 36, 21/09/2014  
Duration: 00:05:42

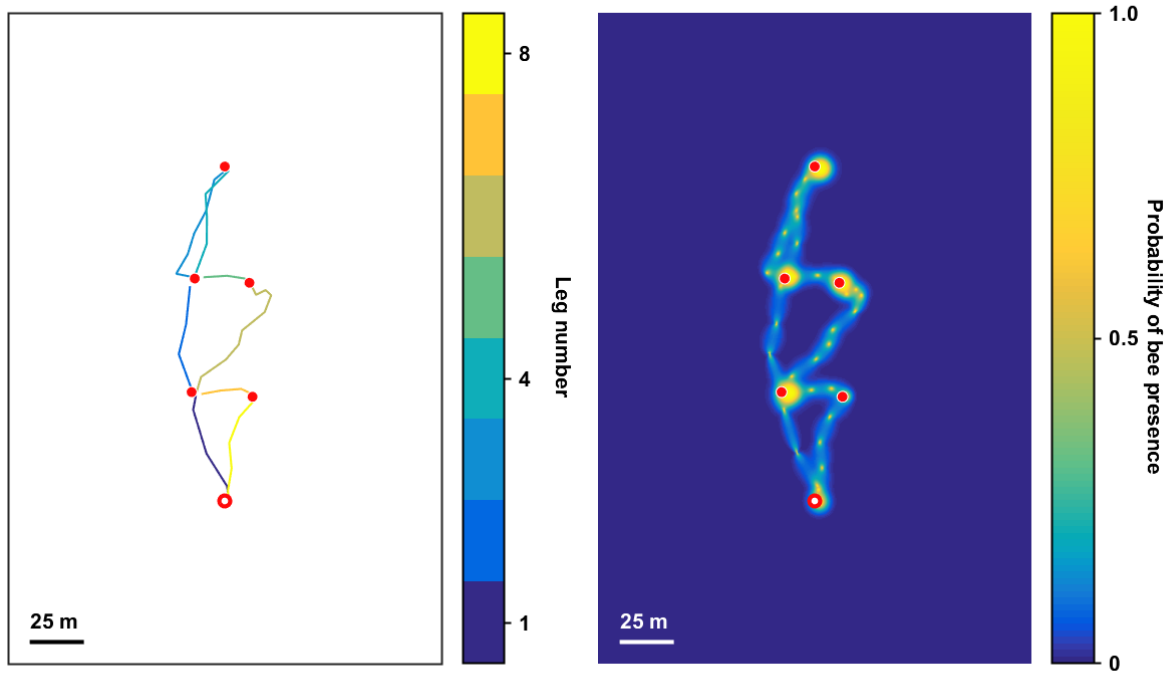


Fig S37

Bee 1, Bout 37, 21/09/2014  
Duration: 00:04:50

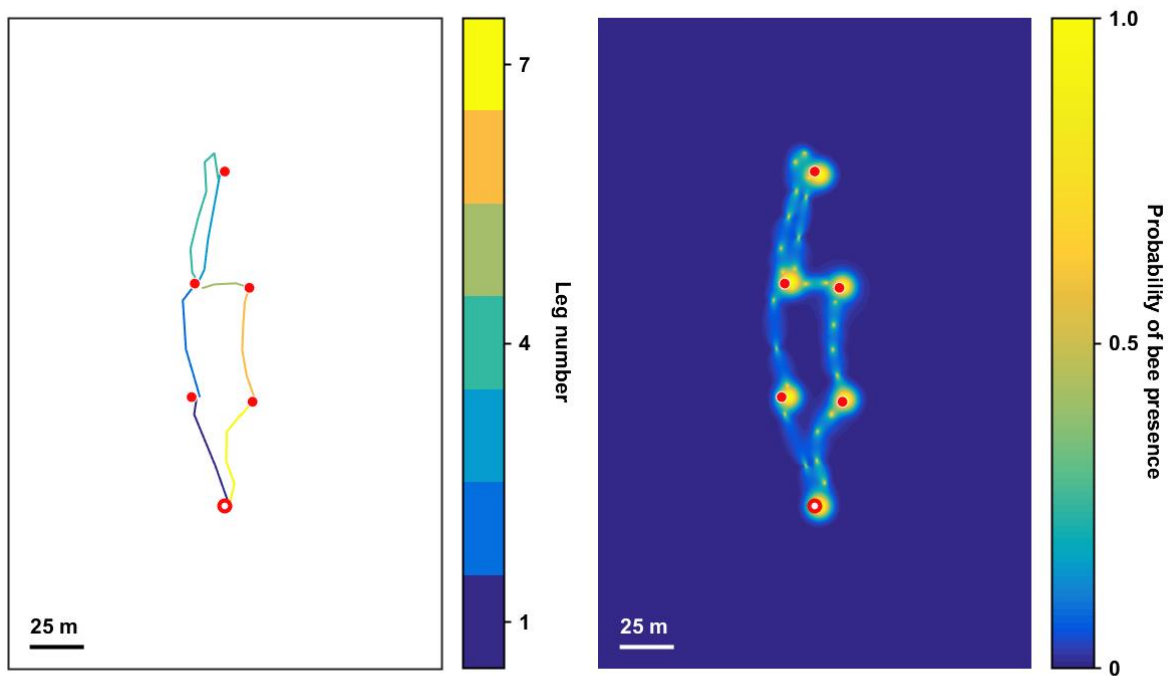


Fig S38

Bee 1, Bout 38, 21/09/2014  
Duration: 00:06:43

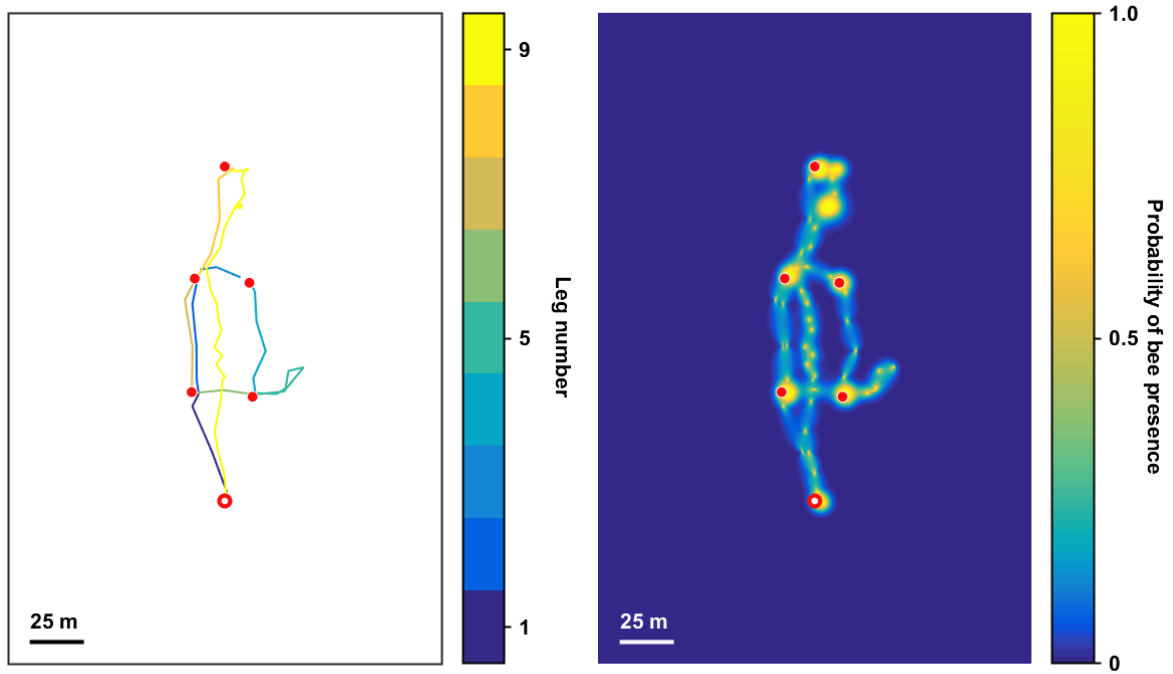


Fig S39

Bee 1, Bout 39, 21/09/2014  
Duration: 00:06:22

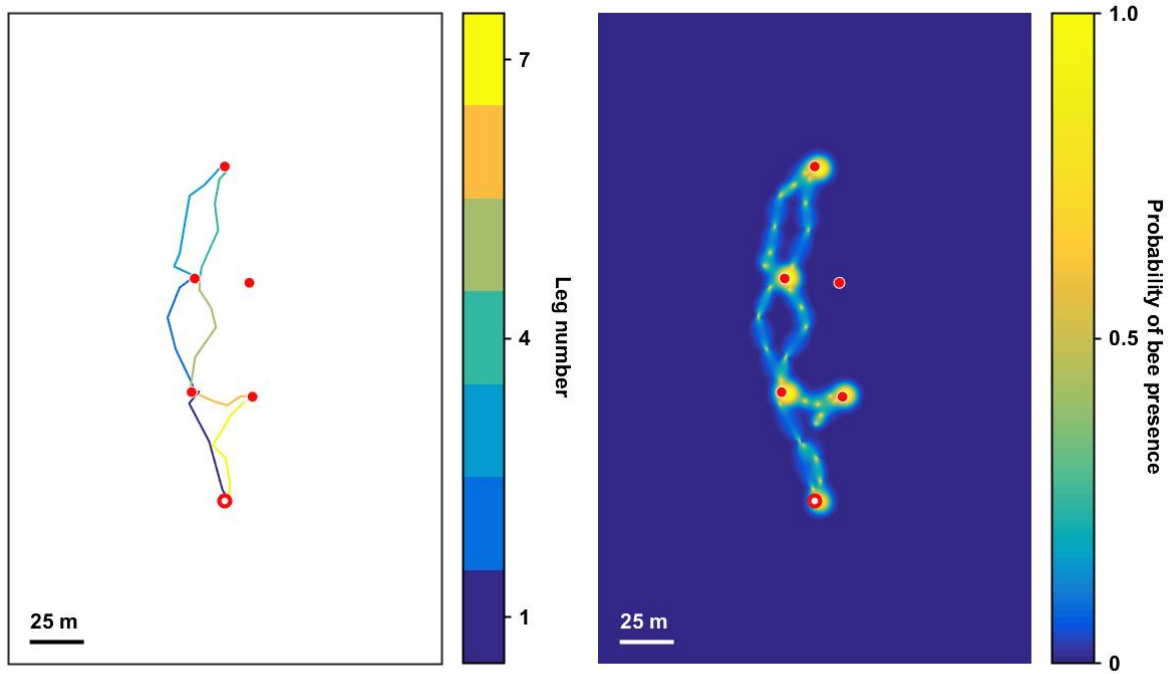


Fig S40

Bee 1, Bout 40, 21/09/2014  
Duration: 00:13:23

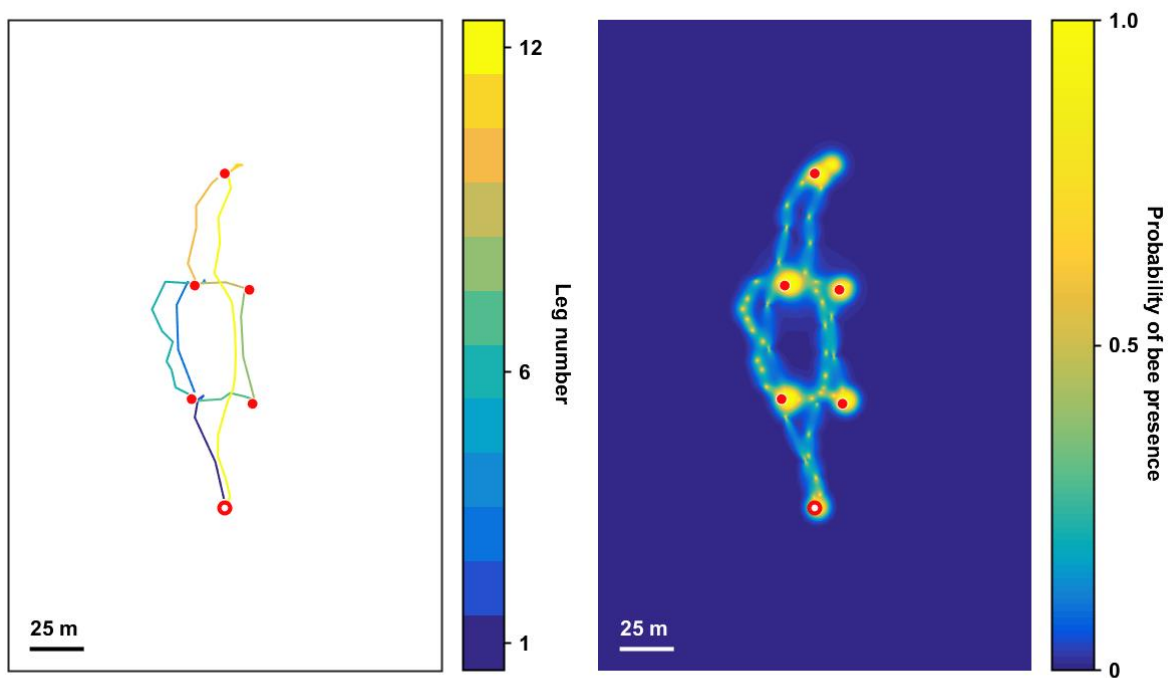


Fig S41

Bee 1, Bout 41, 21/09/2014  
Duration: 00:06:13

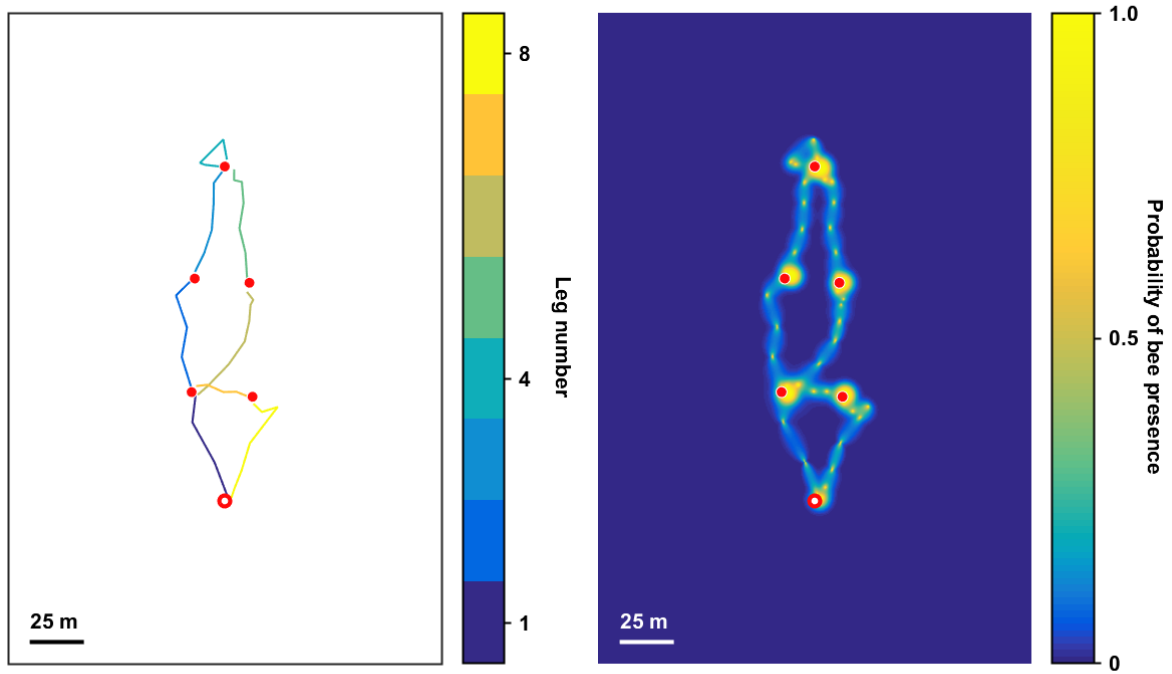




Fig S42

Bee 1, Bout 42, 21/09/2014  
Duration: 00:07:29

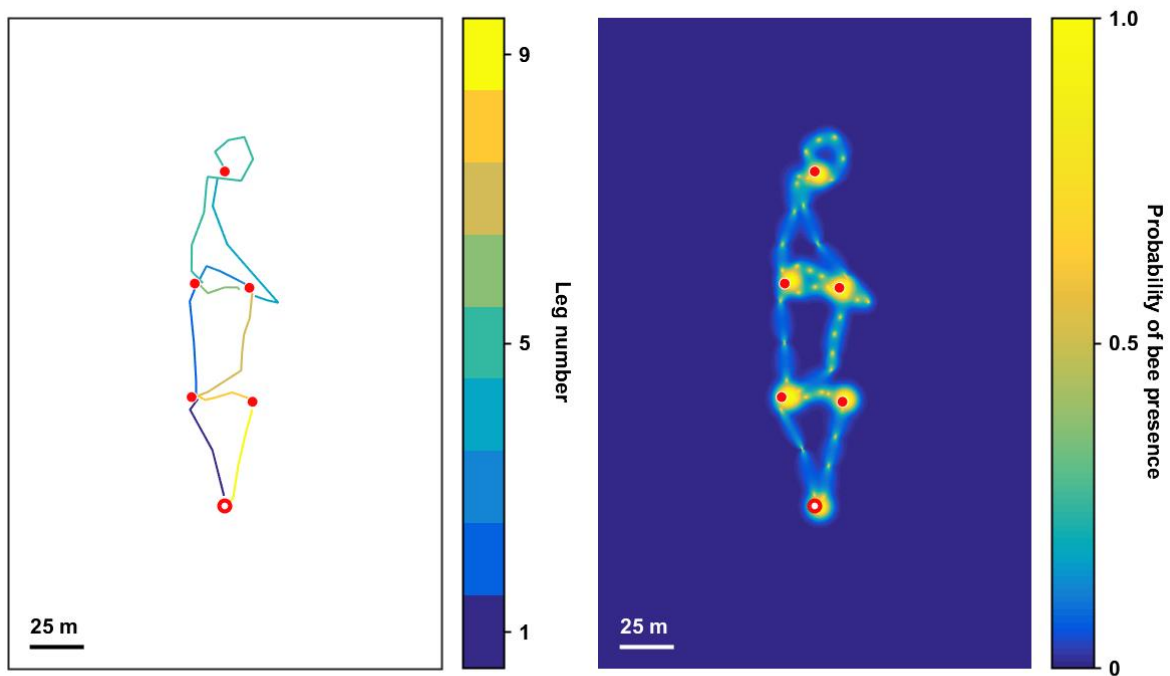


Fig S43

Bee 1, Bout 43, 21/09/2014  
Duration: 00:07:57

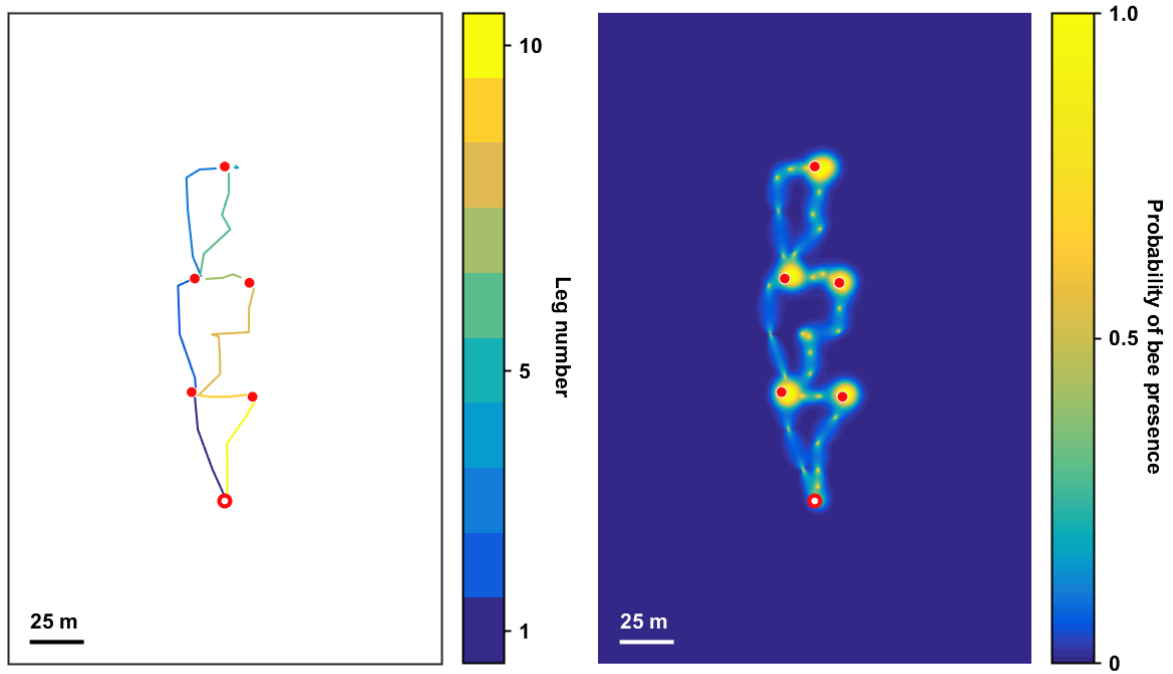


Fig S44

Bee 1, Bout 44, 21/09/2014  
Duration: 00:06:39

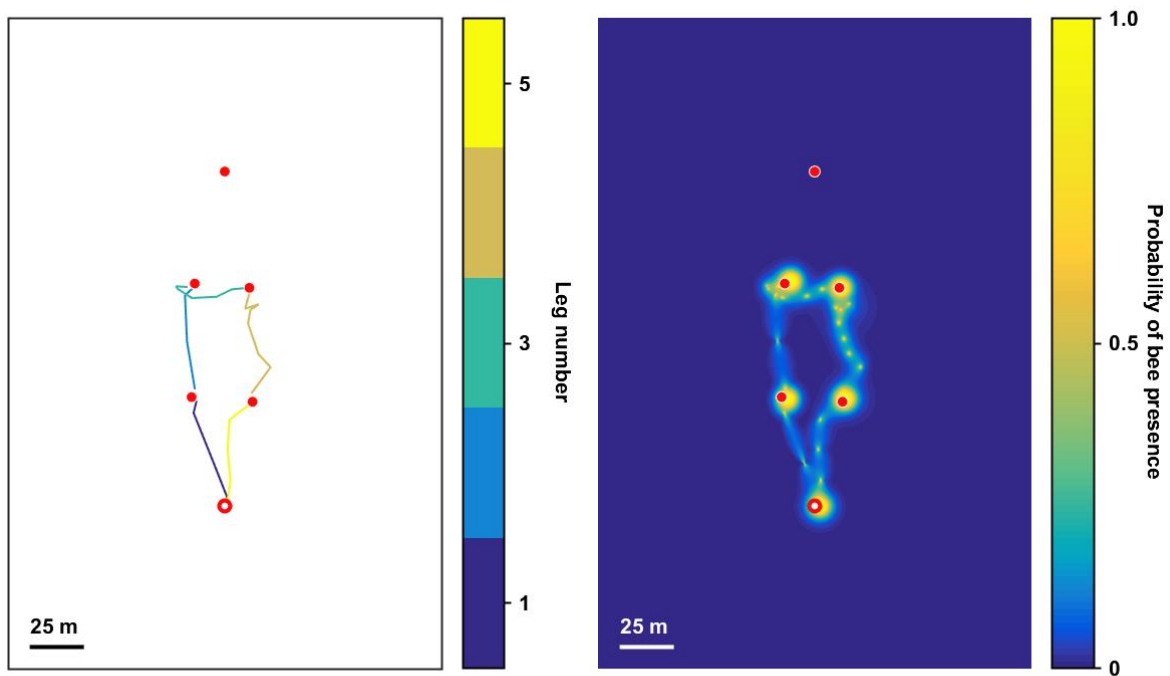


Fig S45

Bee 1, Bout 45, 21/09/2014  
Duration: 00:05:48

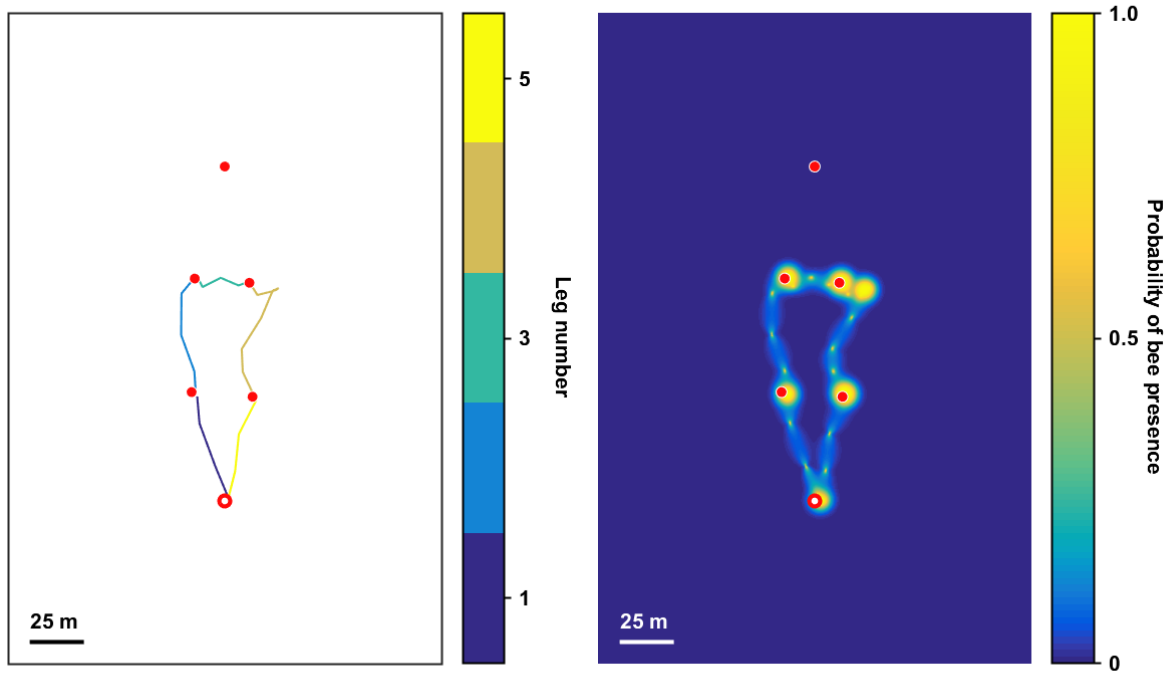


Fig S46

Bee 1, Bout 46, 21/09/2014  
Duration: 00:07:46

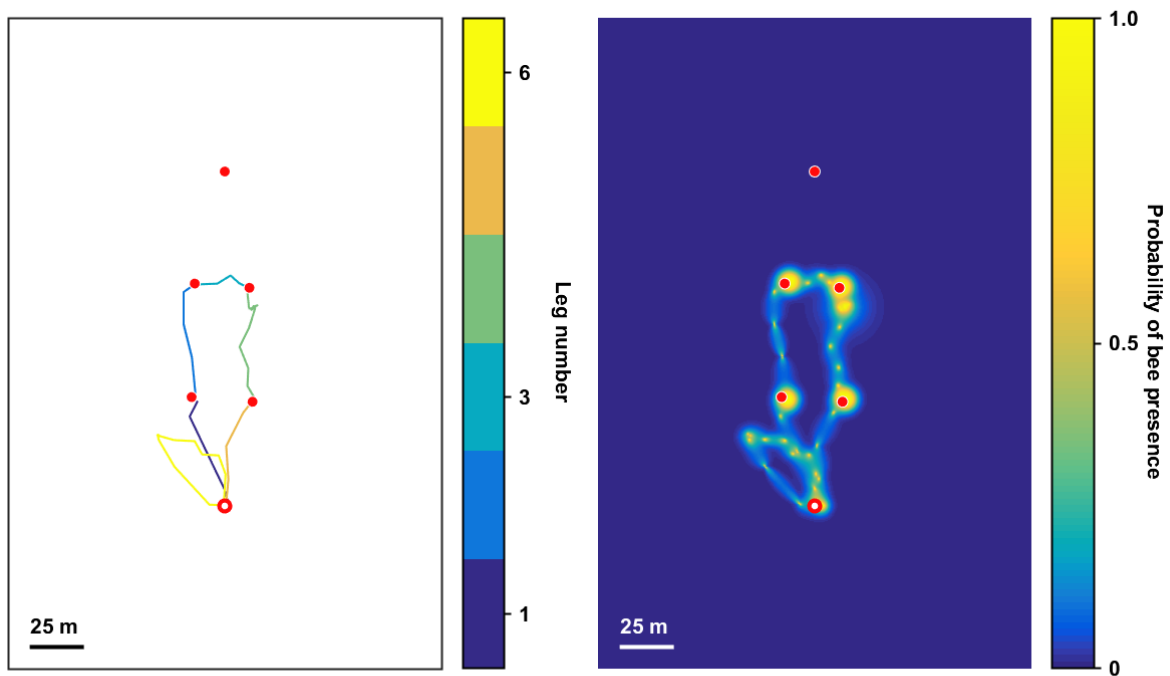


Fig S47

Bee 1, Bout 47, 21/09/2014  
Duration: 00:10:13

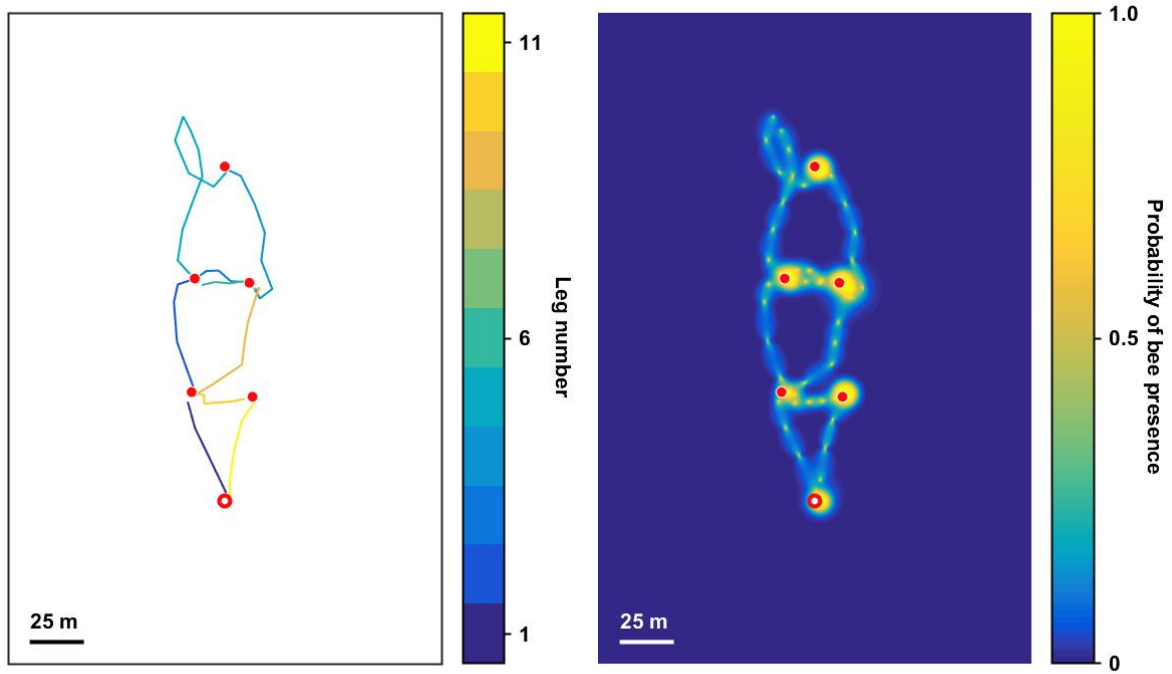


Fig S48

Bee 2, Bout 1, 17/09/2014  
Duration: 00:51:51

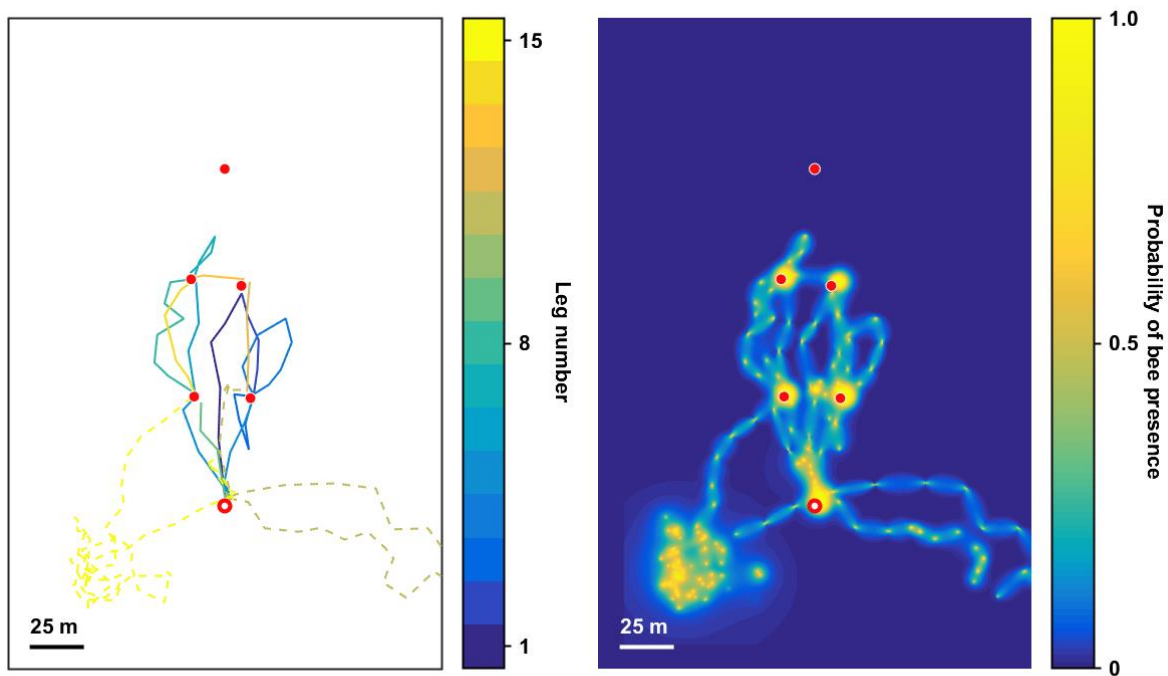


Fig S49

Bee 2, Bout 2, 17/09/2014  
Duration: 00:05:34

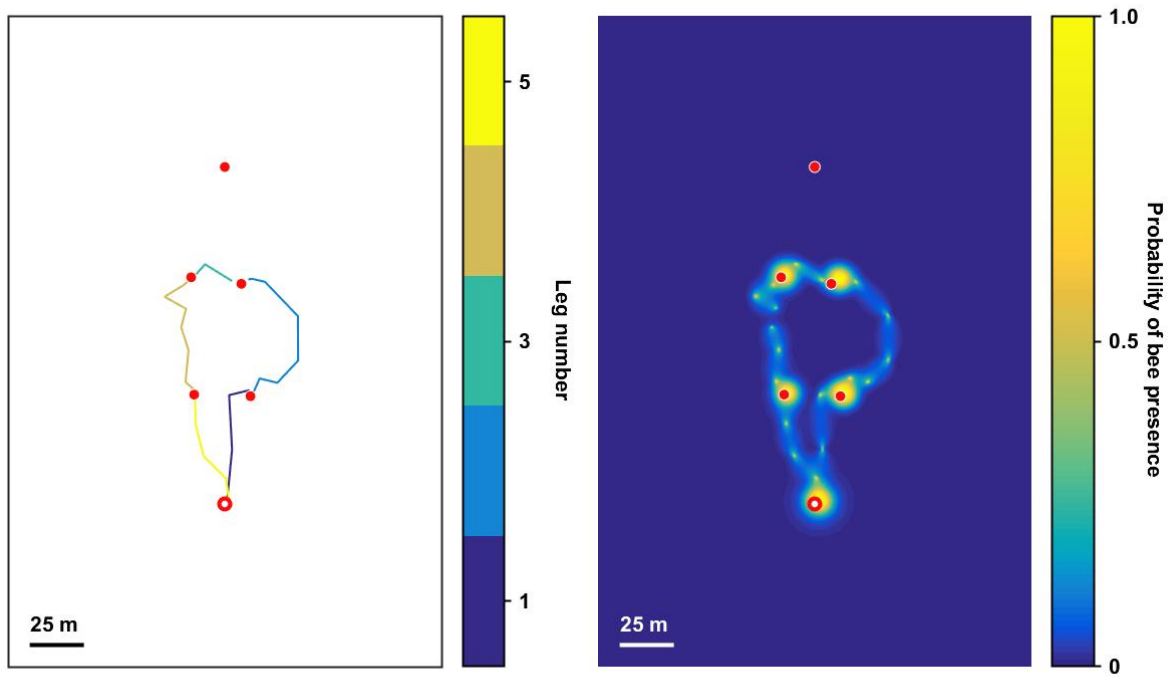




Fig S50

Bee 2, Bout 3, 17/09/2014  
Duration: 00:03:41

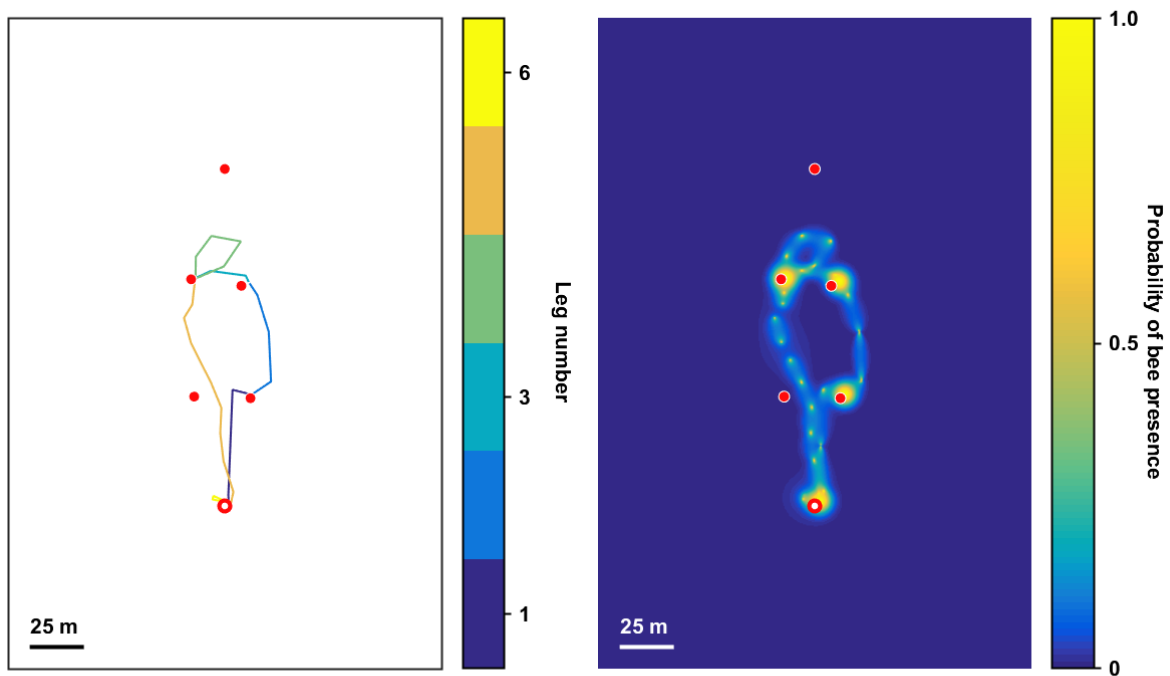


Fig S51

Bee 2, Bout 4, 17/09/2014  
Duration: 00:03:58

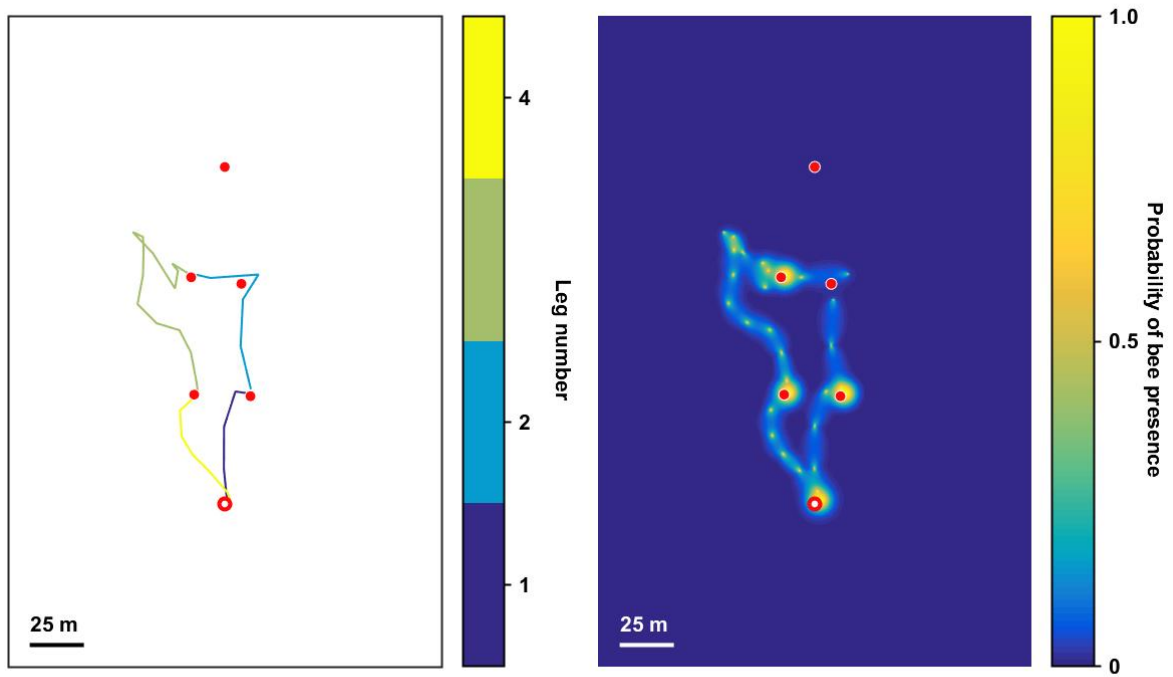


Fig S52

Bee 2, Bout 5, 17/09/2014  
Duration: 00:05:42

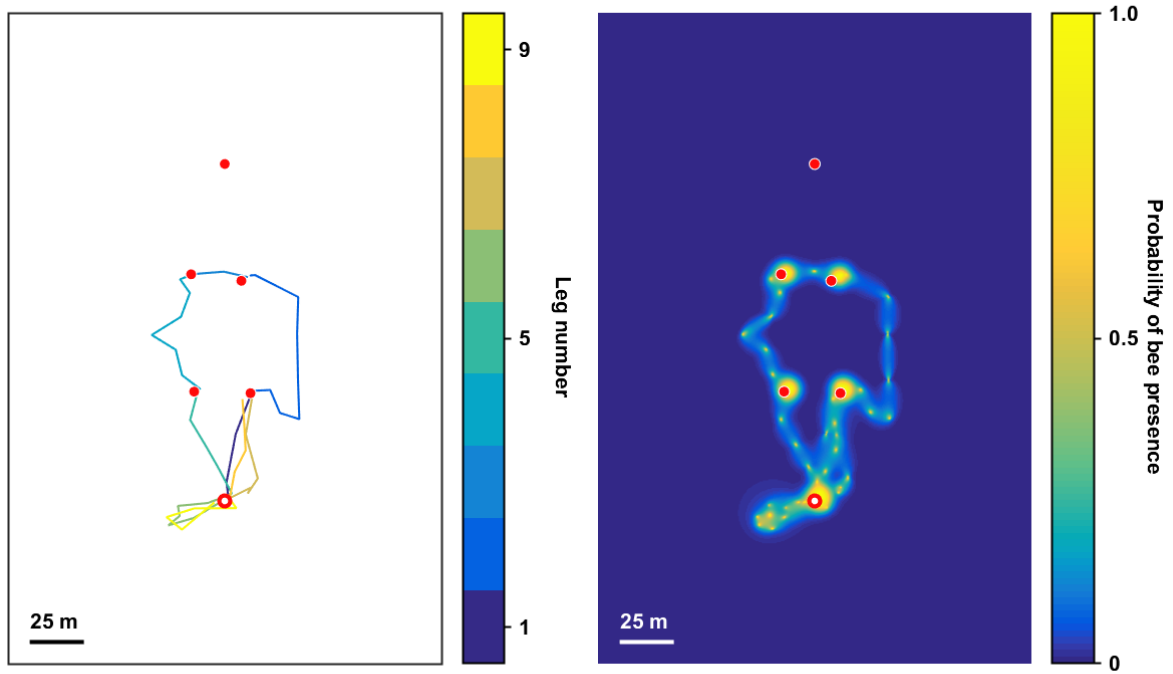


Fig S53

Bee 2, Bout 6, 17/09/2014  
Duration: 00:05:23

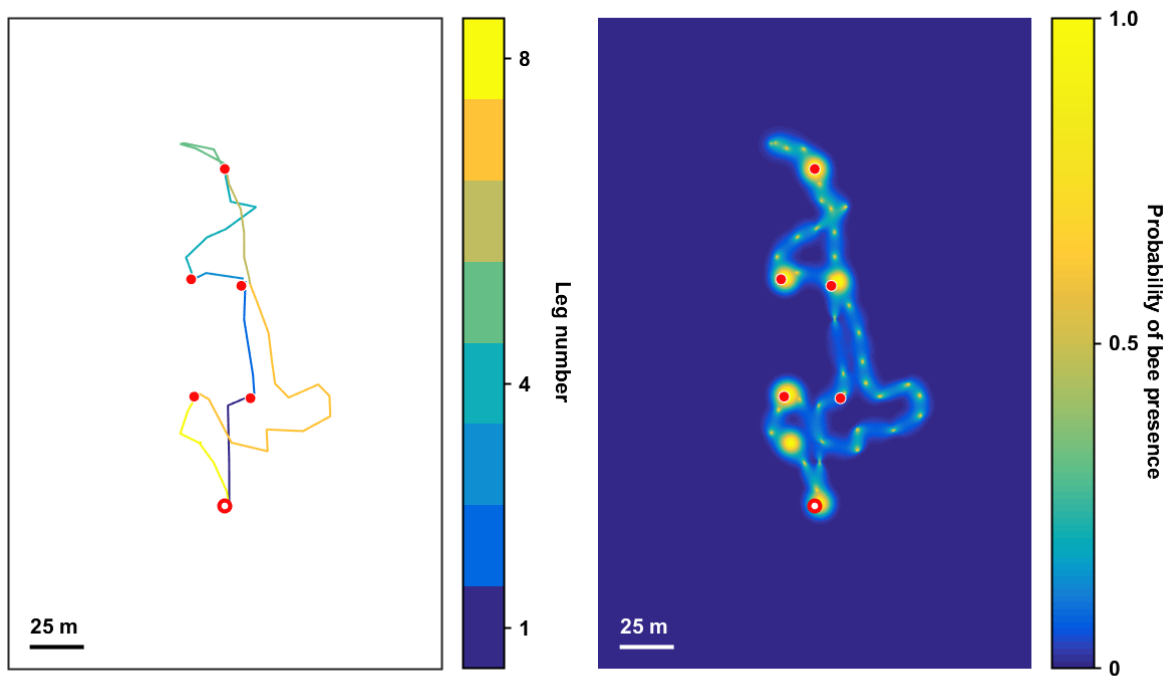


Fig S54

Bee 2, Bout 7, 17/09/2014  
Duration: 00:41:26

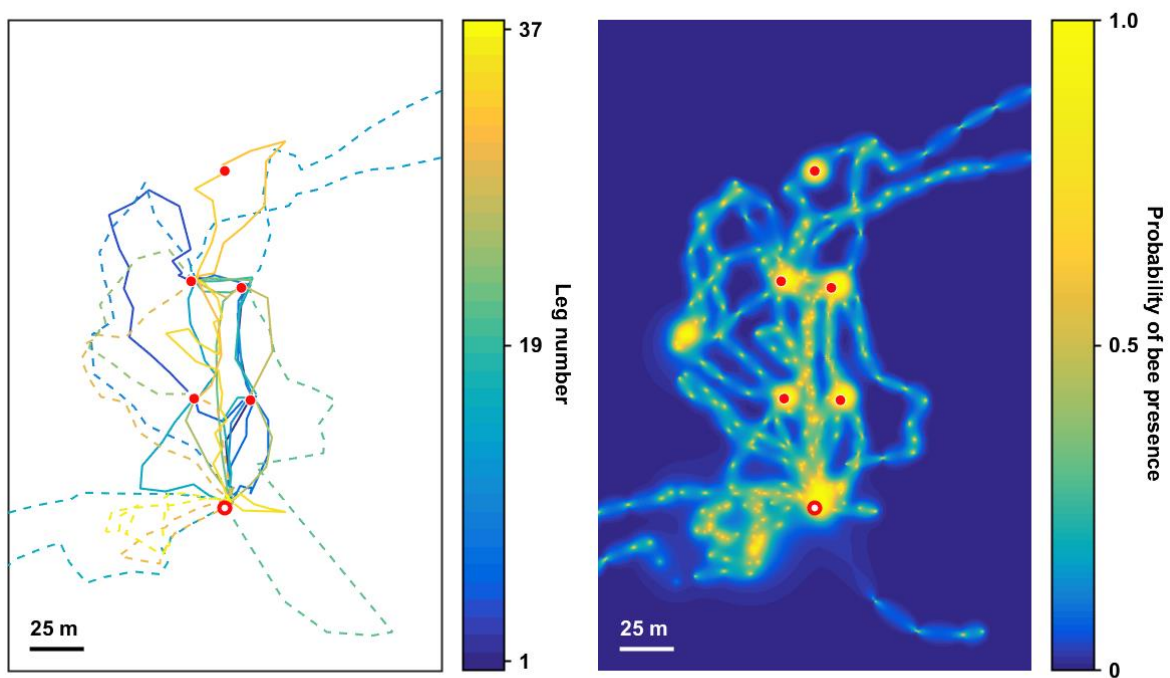


Fig S55

Bee 2, Bout 8, 17/09/2014  
Duration: 00:03:12

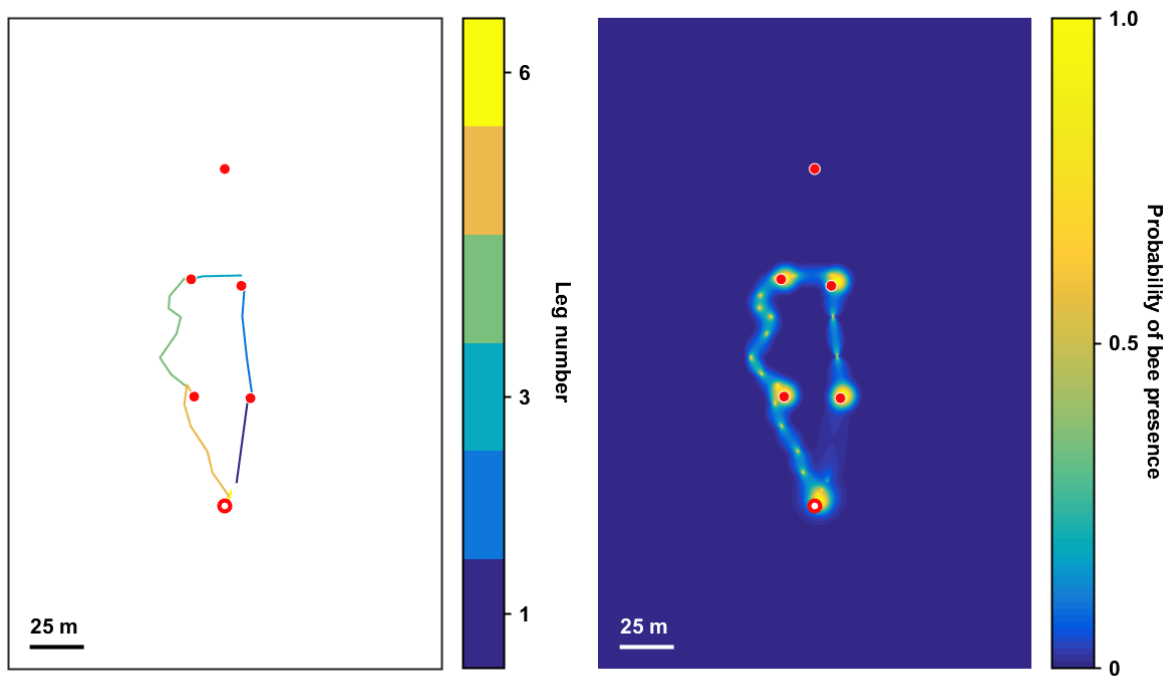


Fig S56

Bee 2, Bout 9, 17/09/2014  
Duration: 00:03:21

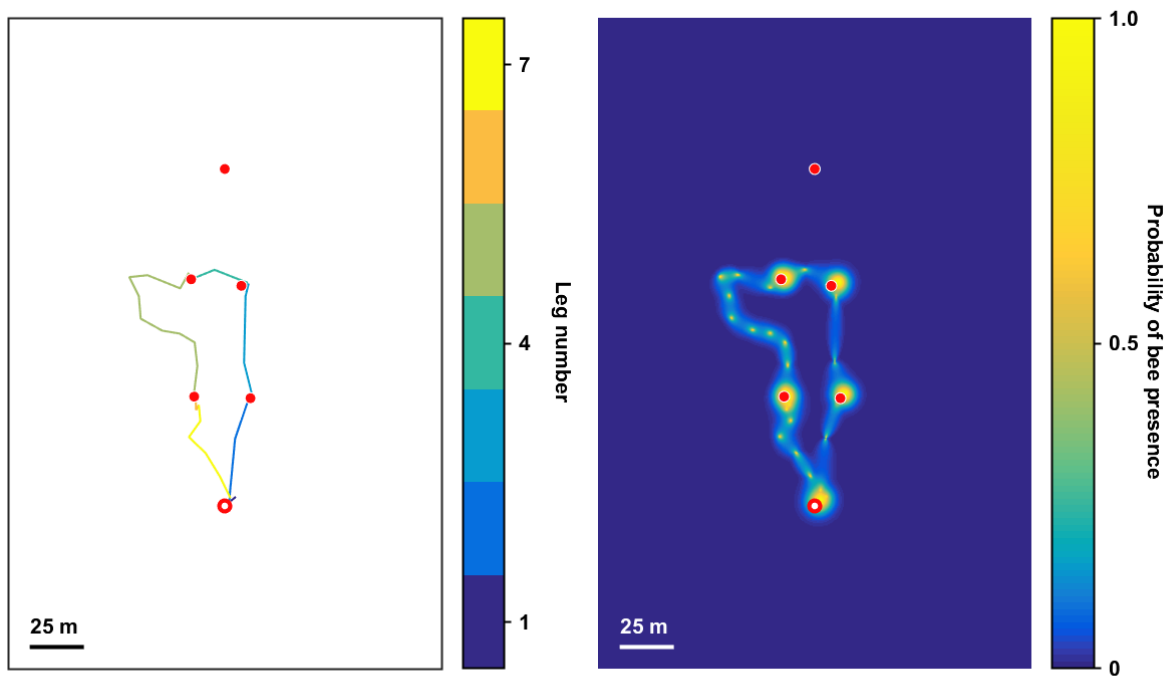


Fig S57

Bee 2, Bout 10, 17/09/2014  
Duration: 00:06:50

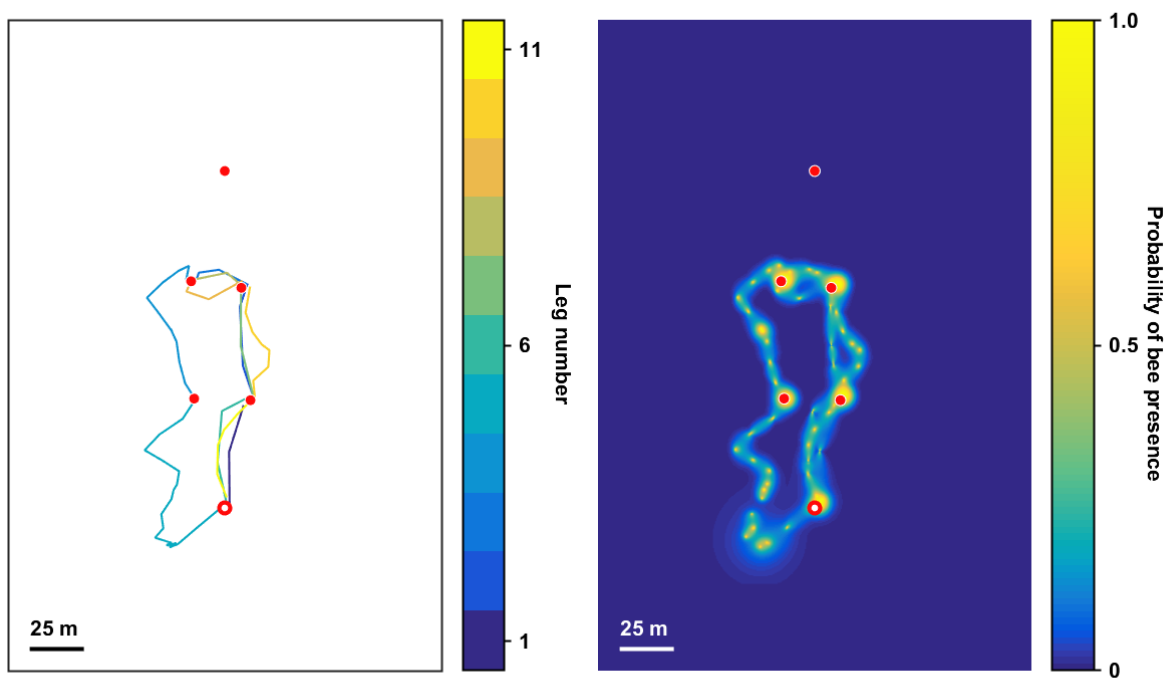




Fig S58

Bee 2, Bout 11, 17/09/2014  
Duration: 00:10:41

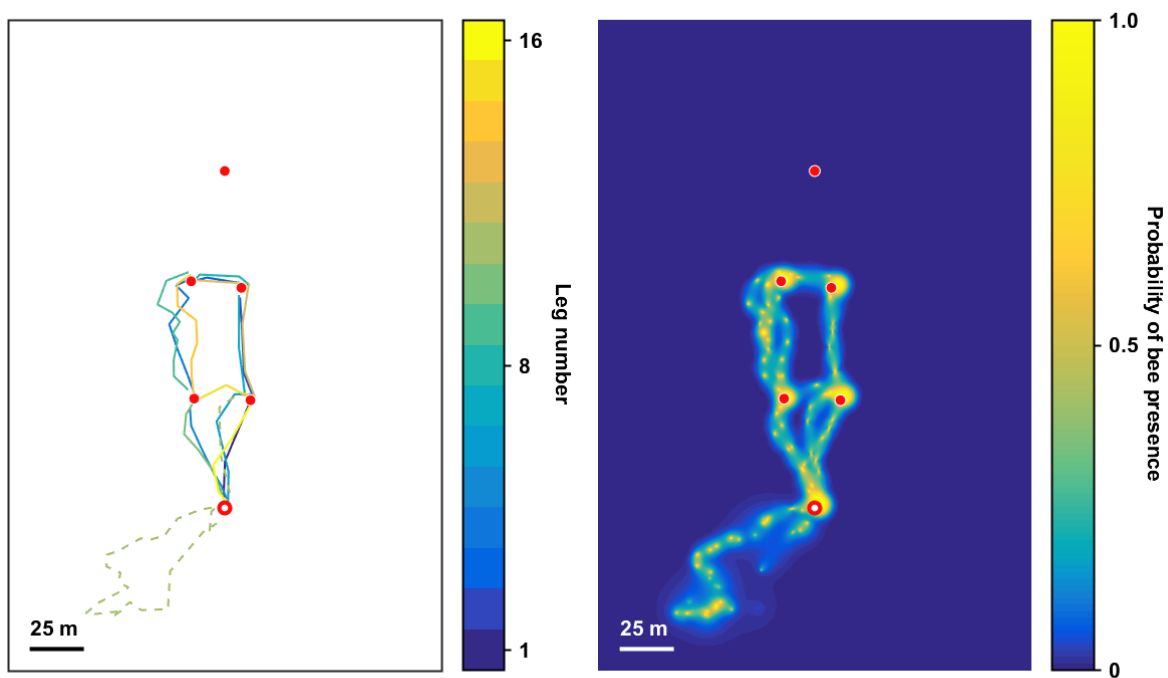


Fig S59

Bee 2, Bout 12, 17/09/2014  
Duration: 00:04:32

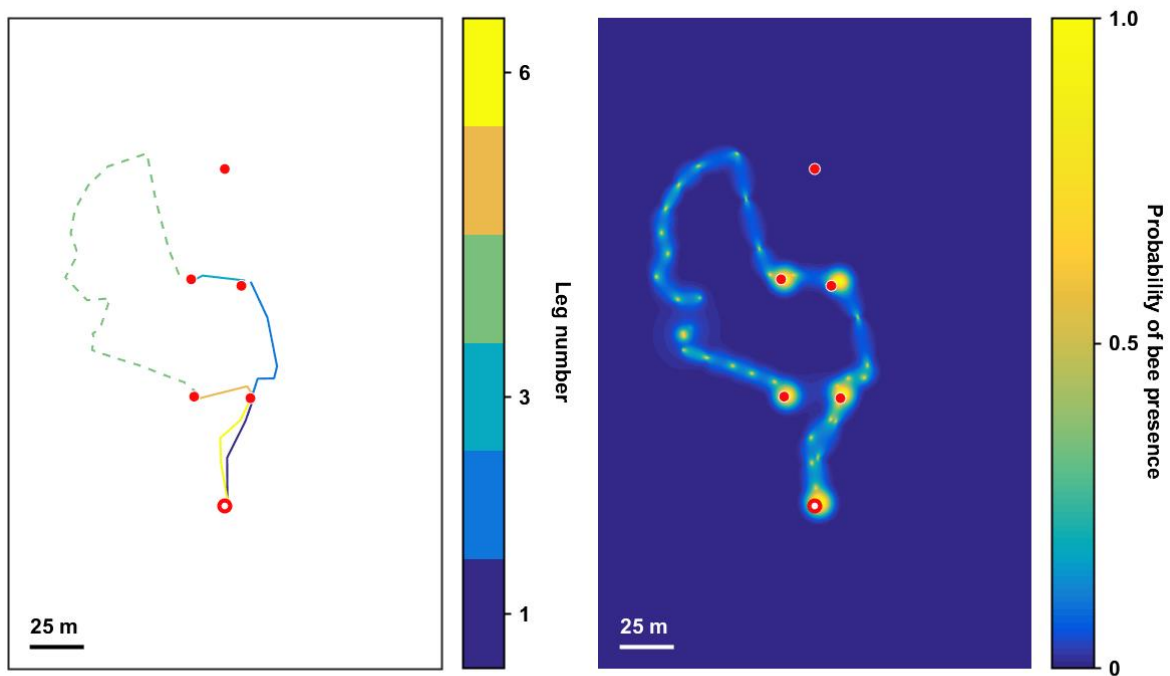


Fig S60

Bee 2, Bout 13, 17/09/2014  
Duration: 00:03:40

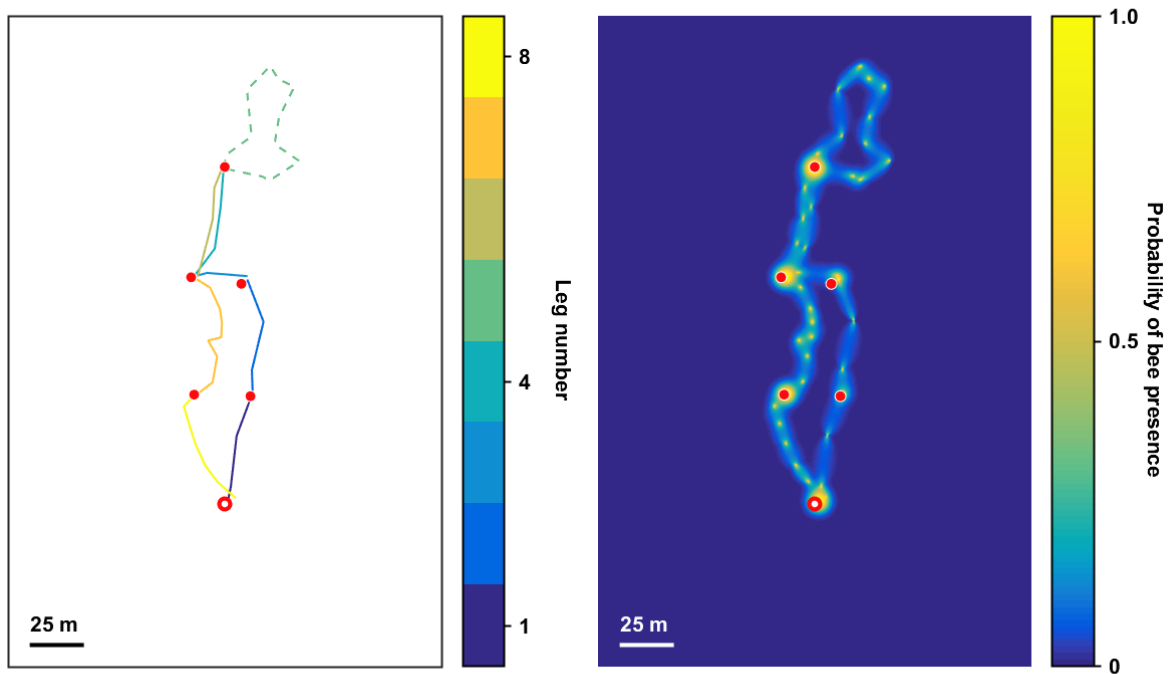


Fig S61

Bee 2, Bout 14, 17/09/2014  
Duration: 00:07:04

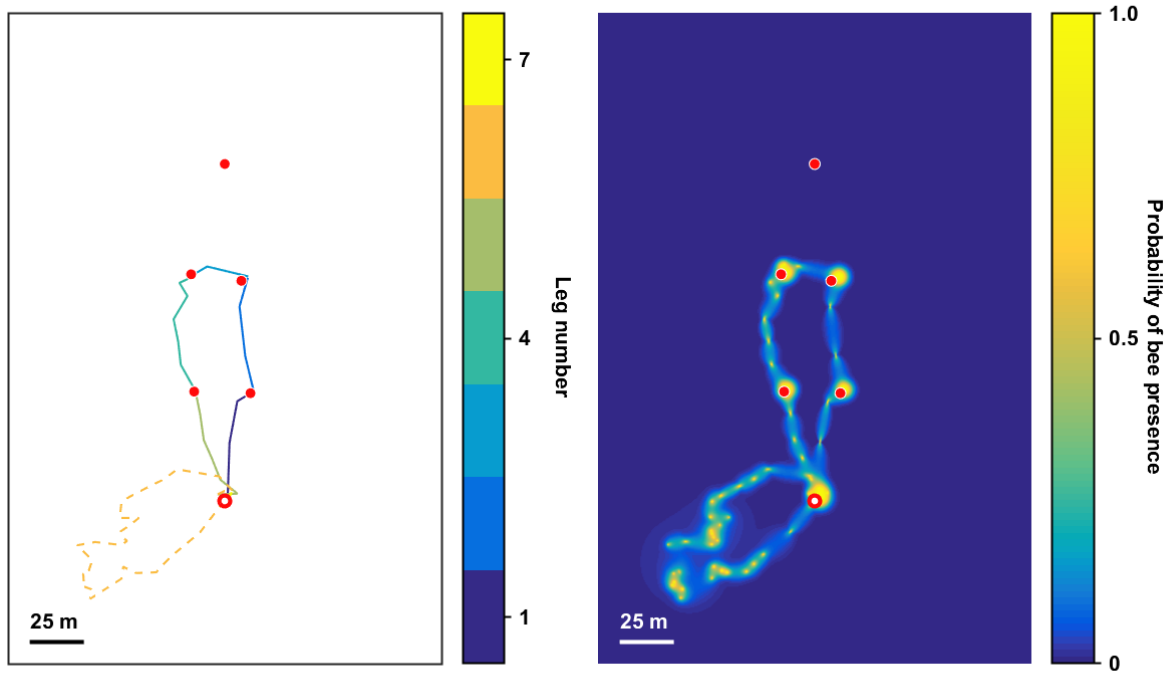


Fig S62

Bee 2, Bout 15, 17/09/2014  
Duration: 00:02:53

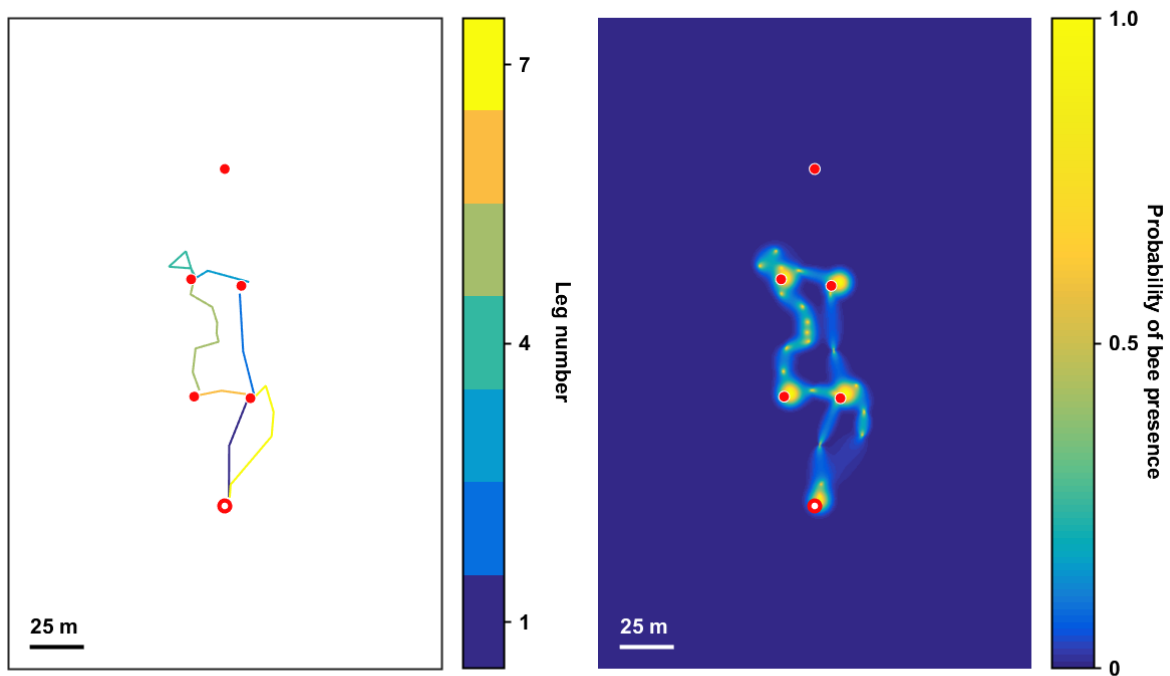


Fig S63

Bee 2, Bout 16, 17/09/2014  
Duration: 00:04:09

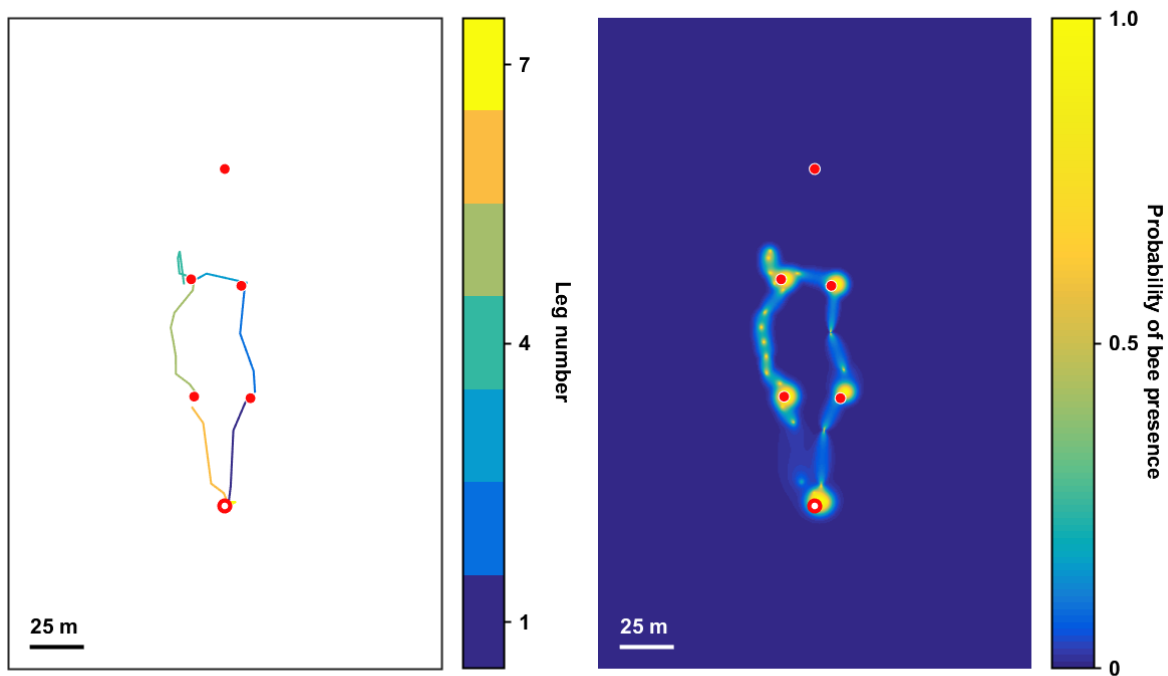


Fig S64

Bee 2, Bout 17, 17/09/2014  
Duration: 00:04:32

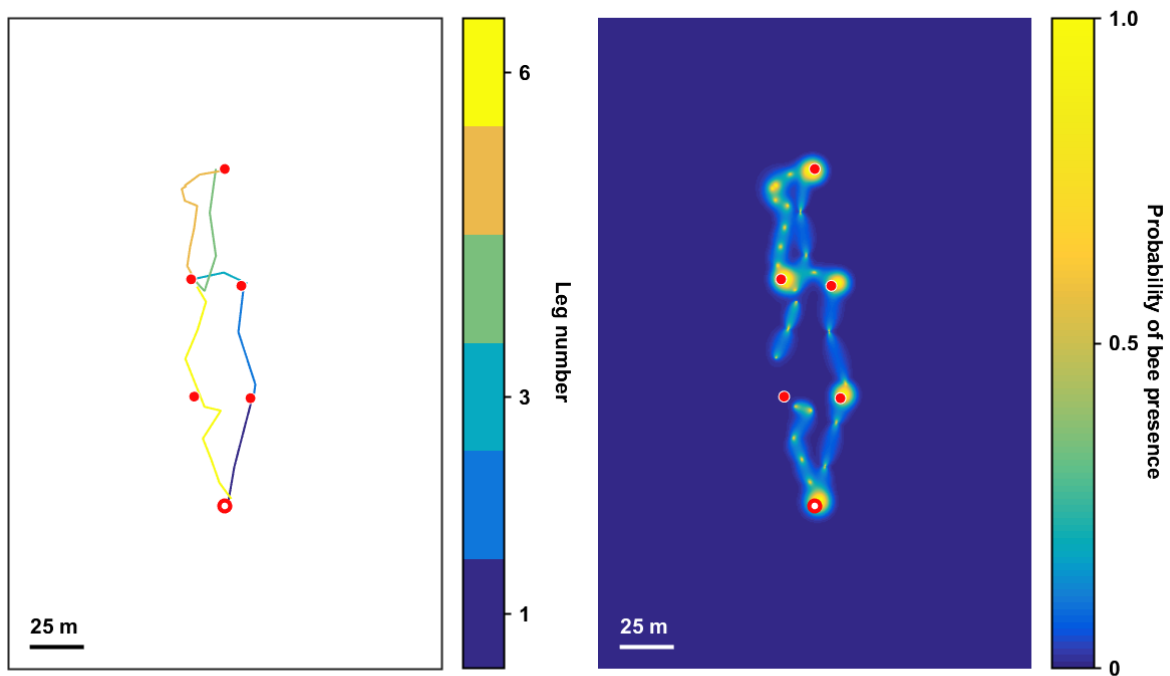


Fig S65

Bee 2, Bout 18, 17/09/2014  
Duration: 00:03:15

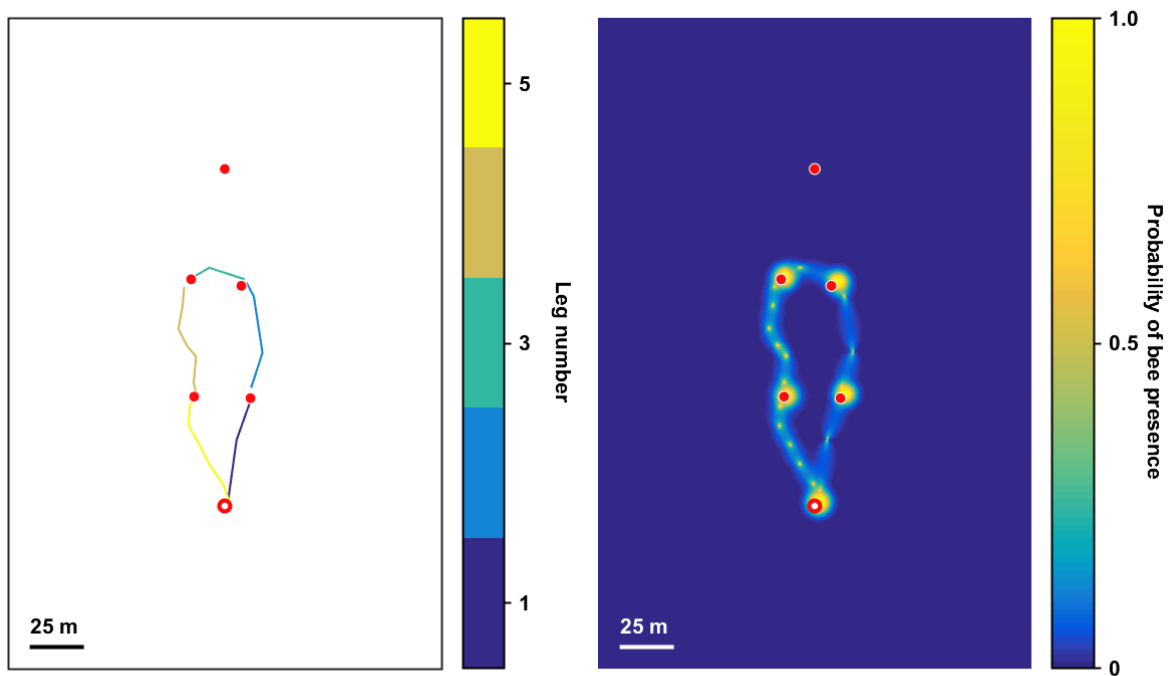




Fig S66

Bee 2, Bout 19, 17/09/2014  
Duration: 00:04:29

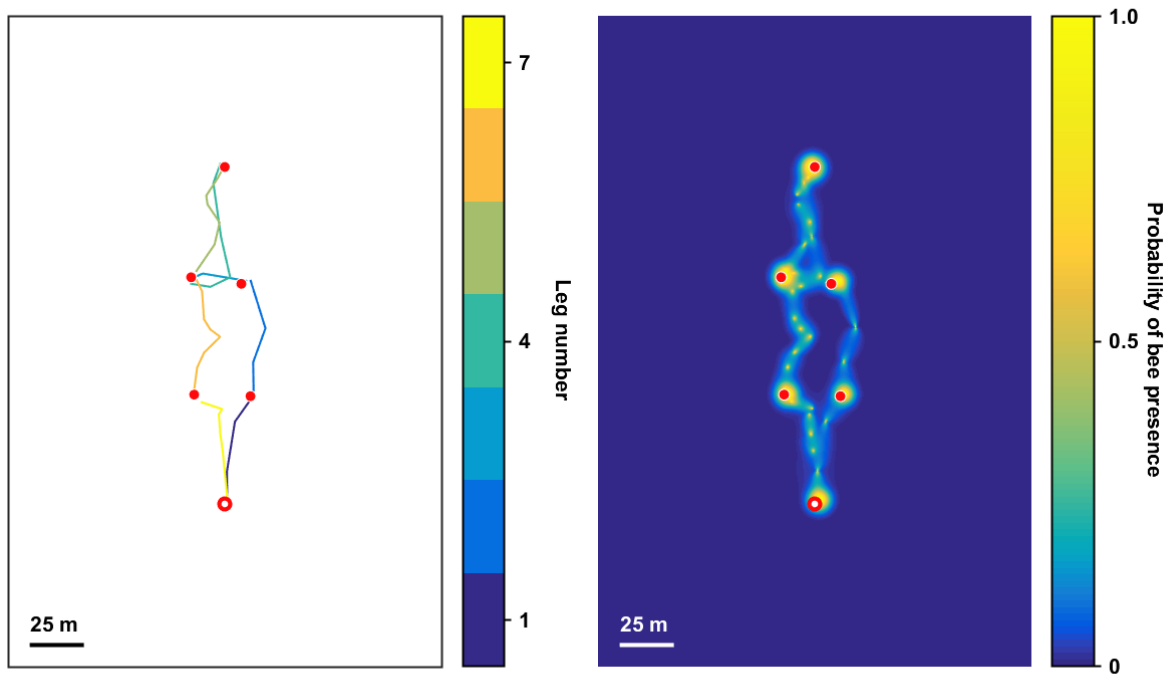


Fig S67

Bee 2, Bout 20, 17/09/2014  
Duration: 00:03:37

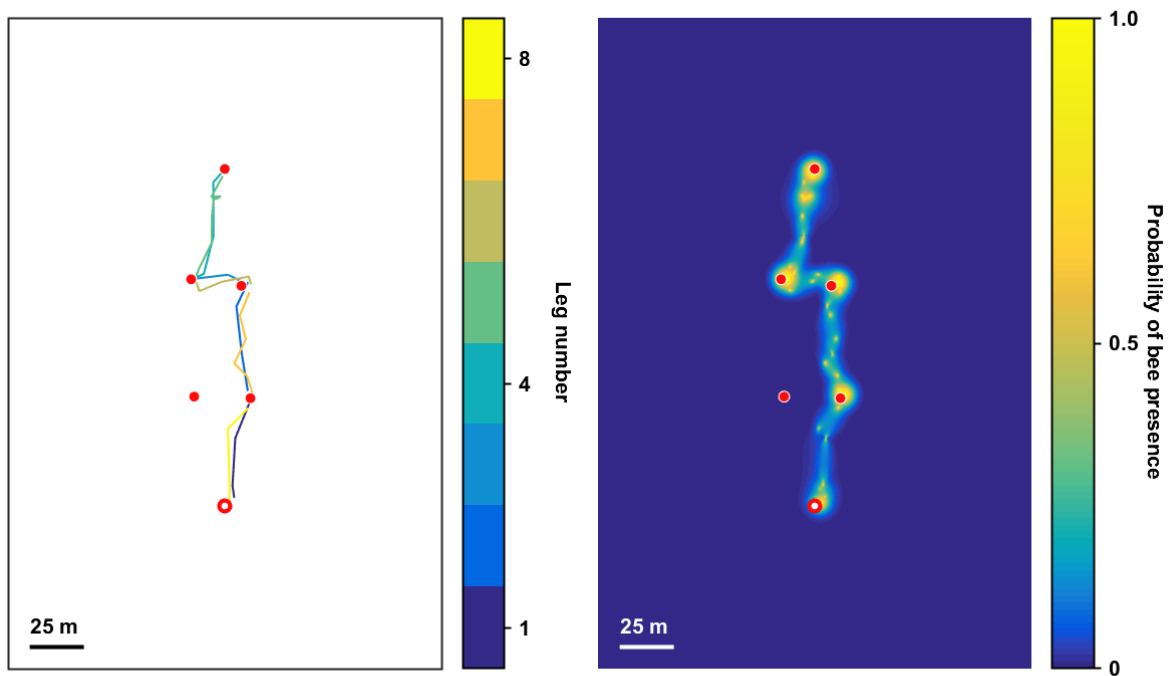


Fig S68

Bee 2, Bout 21, 17/09/2014  
Duration: 00:13:24

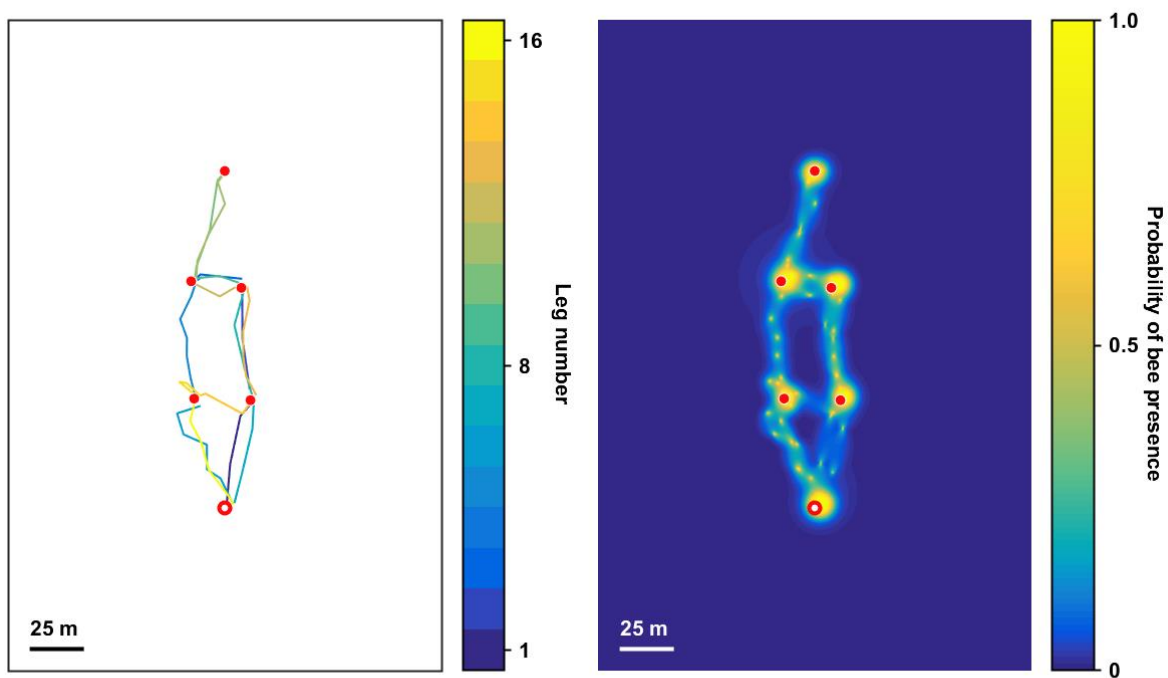


Fig S69

Bee 2, Bout 22, 17/09/2014  
Duration: 00:04:40

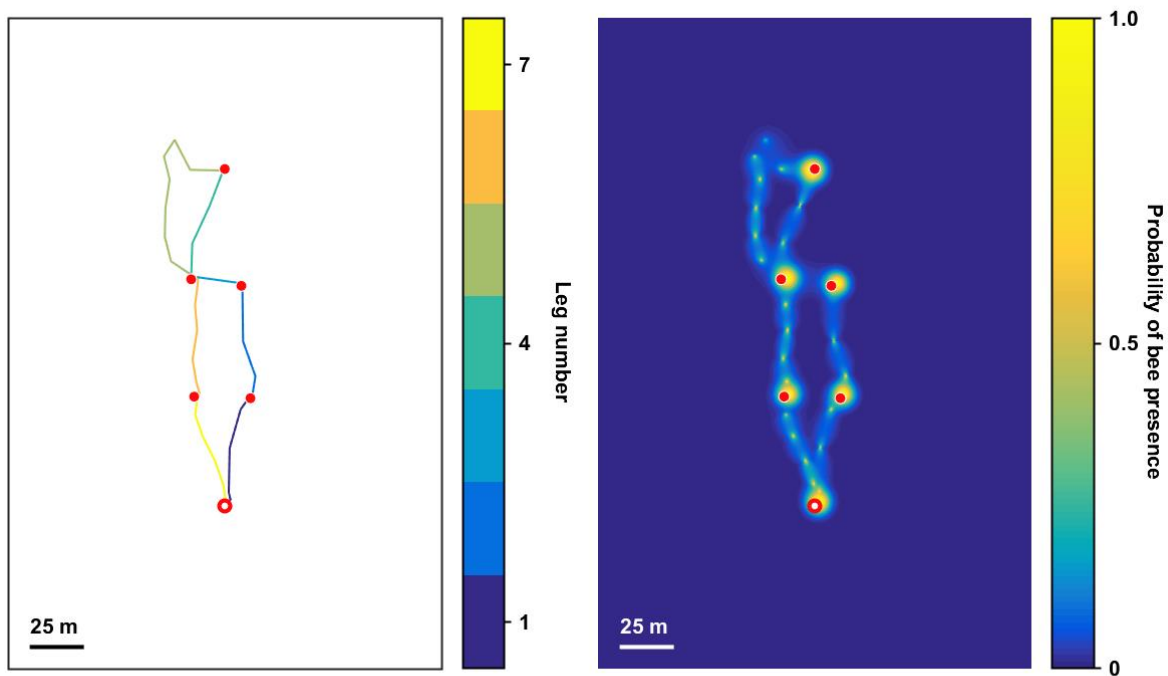


Fig S70

Bee 2, Bout 23, 17/09/2014  
Duration: 00:03:52

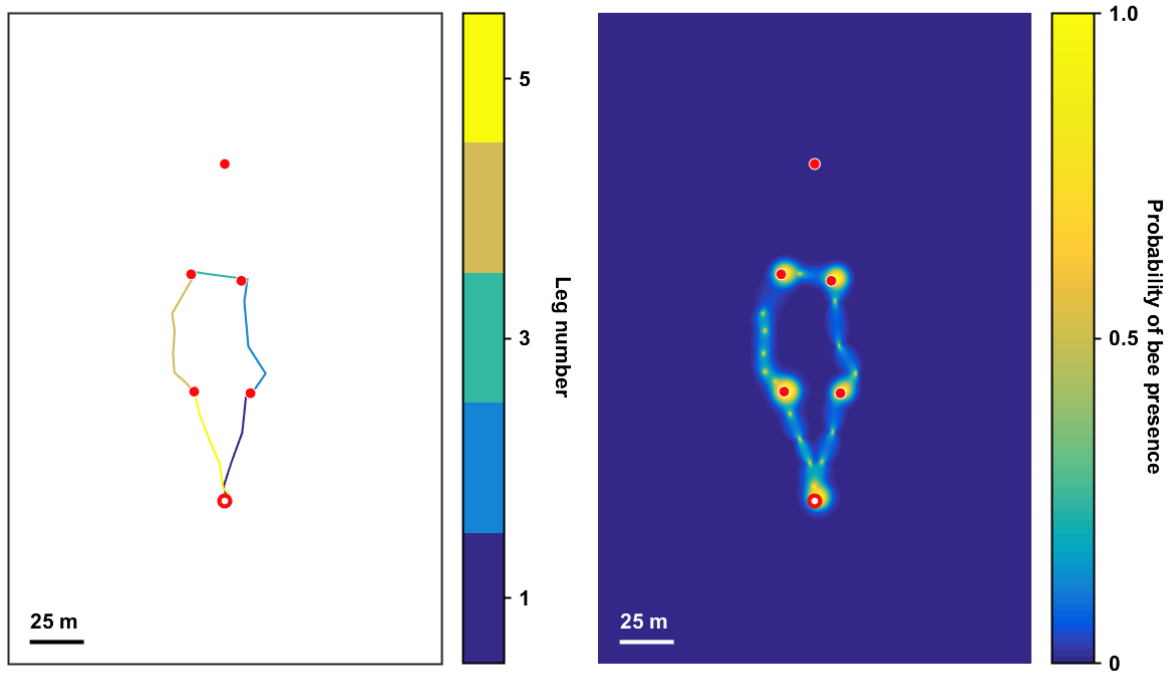


Fig S71

Bee 2, Bout 24, 17/09/2014  
Duration: 00:04:54

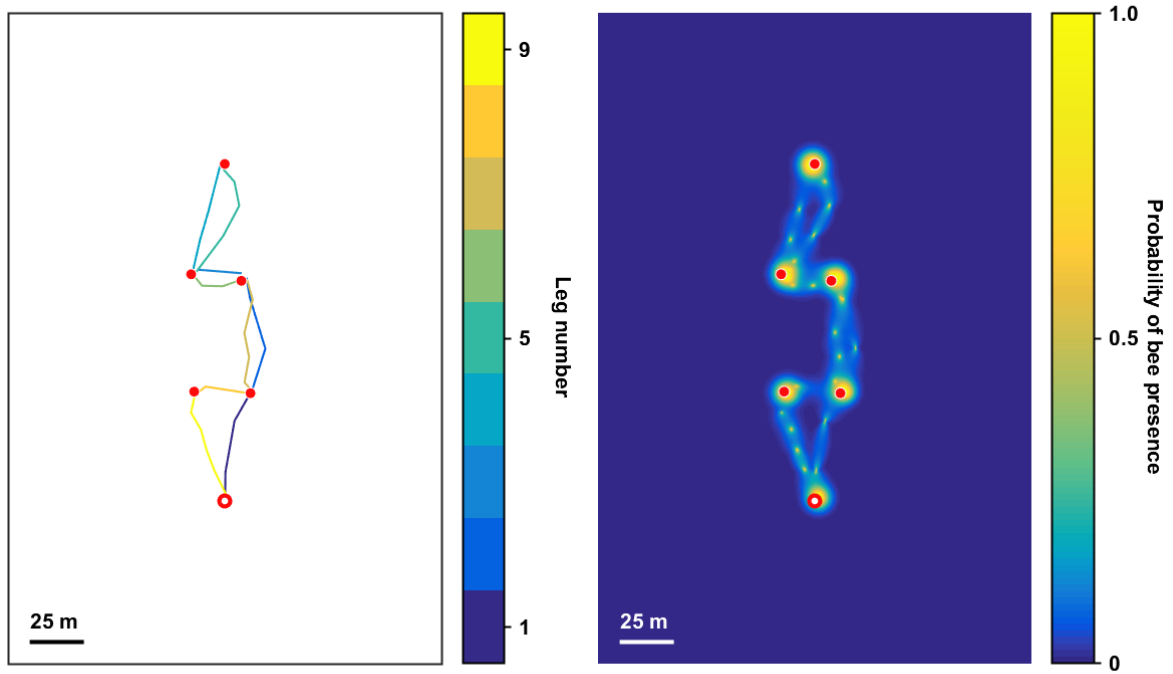


Fig S72

Bee 2, Bout 25, 17/09/2014  
Duration: 00:04:20

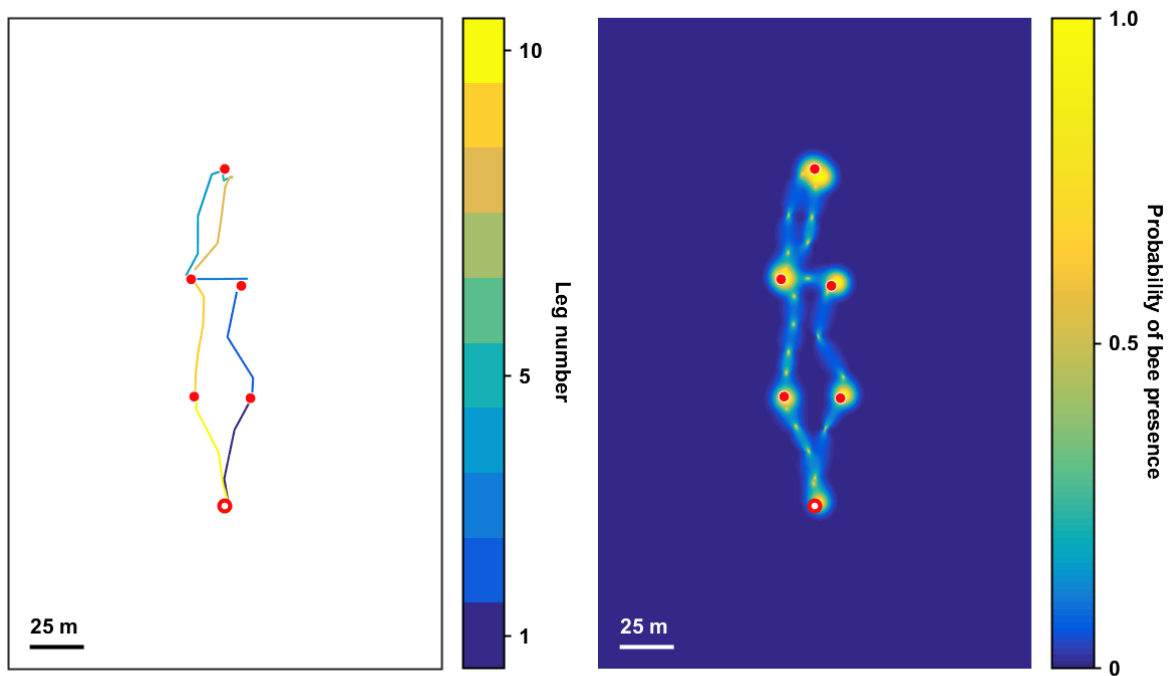


Fig S73

Bee 2, Bout 26, 17/09/2014  
Duration: 00:04:15

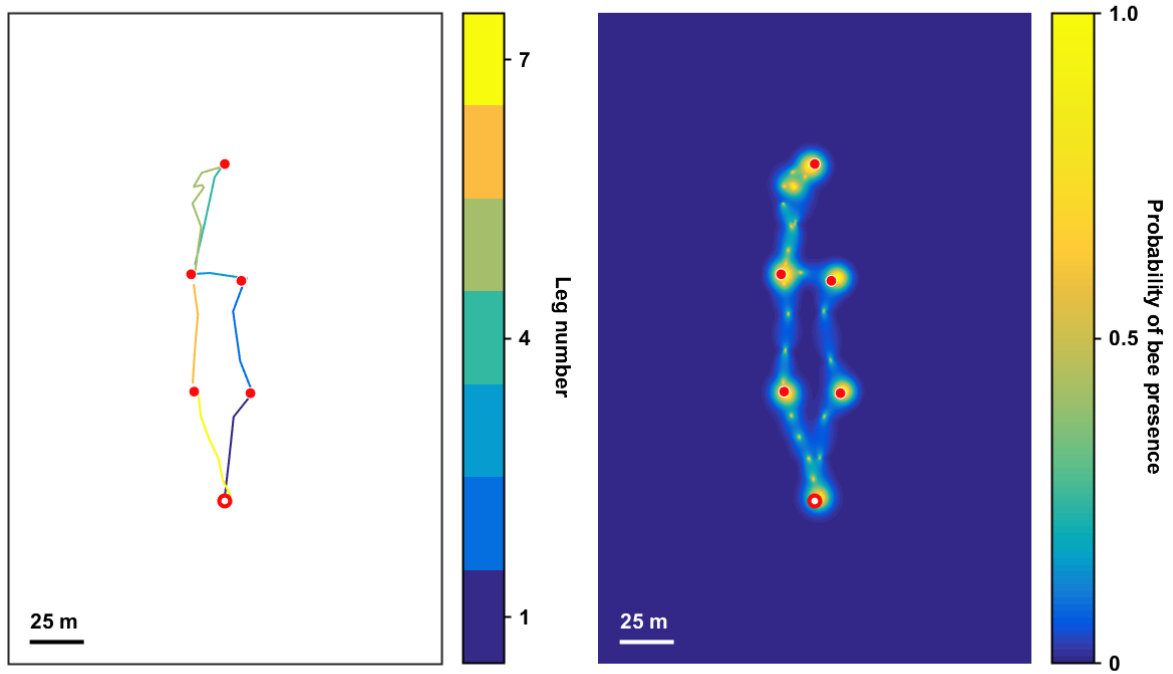




Fig S74

Bee 2, Bout 27, 17/09/2014  
Duration: 00:10:44

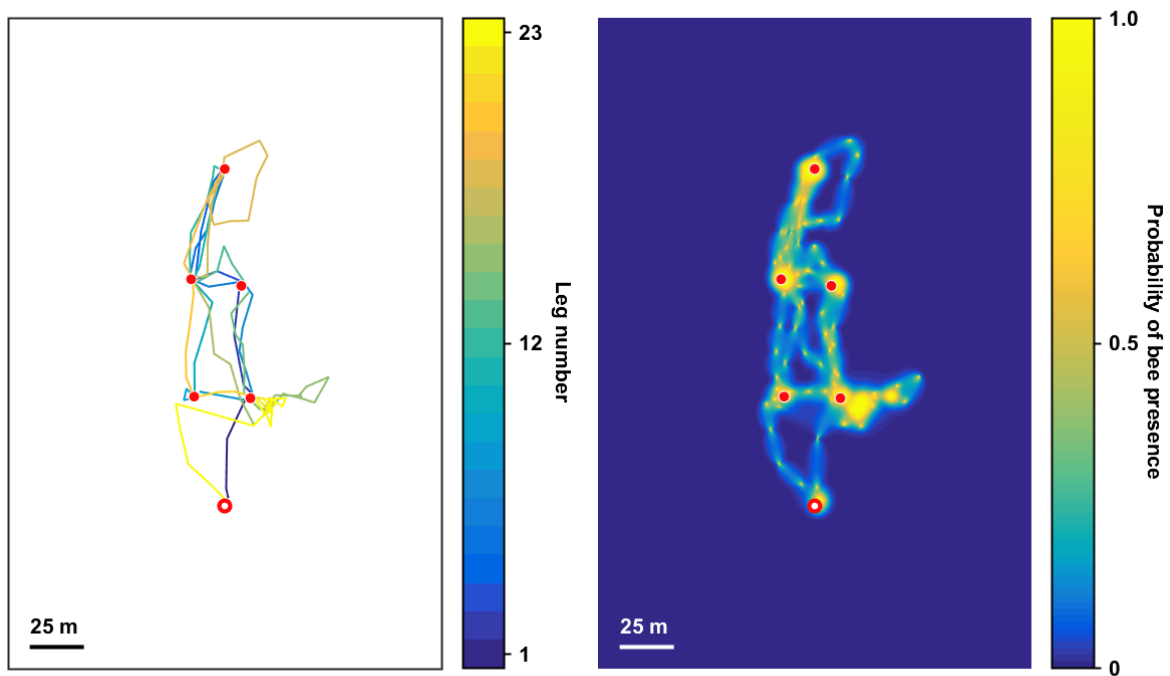


Fig S75

Bee 2, Bout 28, 17/09/2014  
Duration: 00:05:26

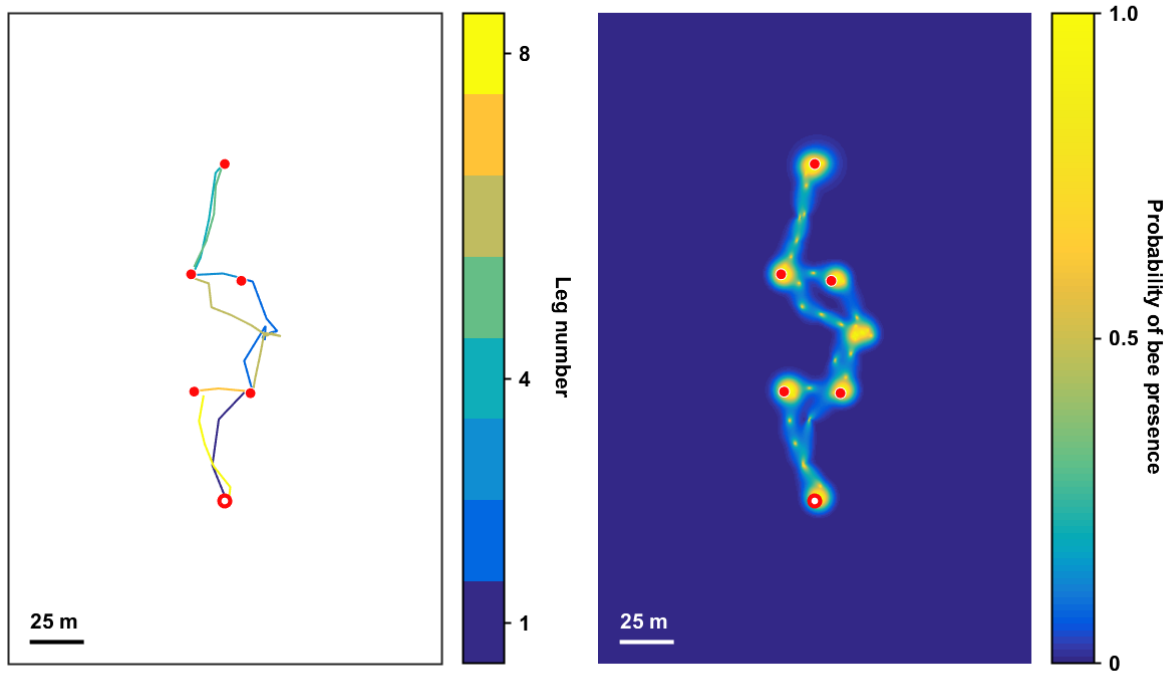


Fig S76

Bee 2, Bout 29, 17/09/2014  
Duration: 00:03:47

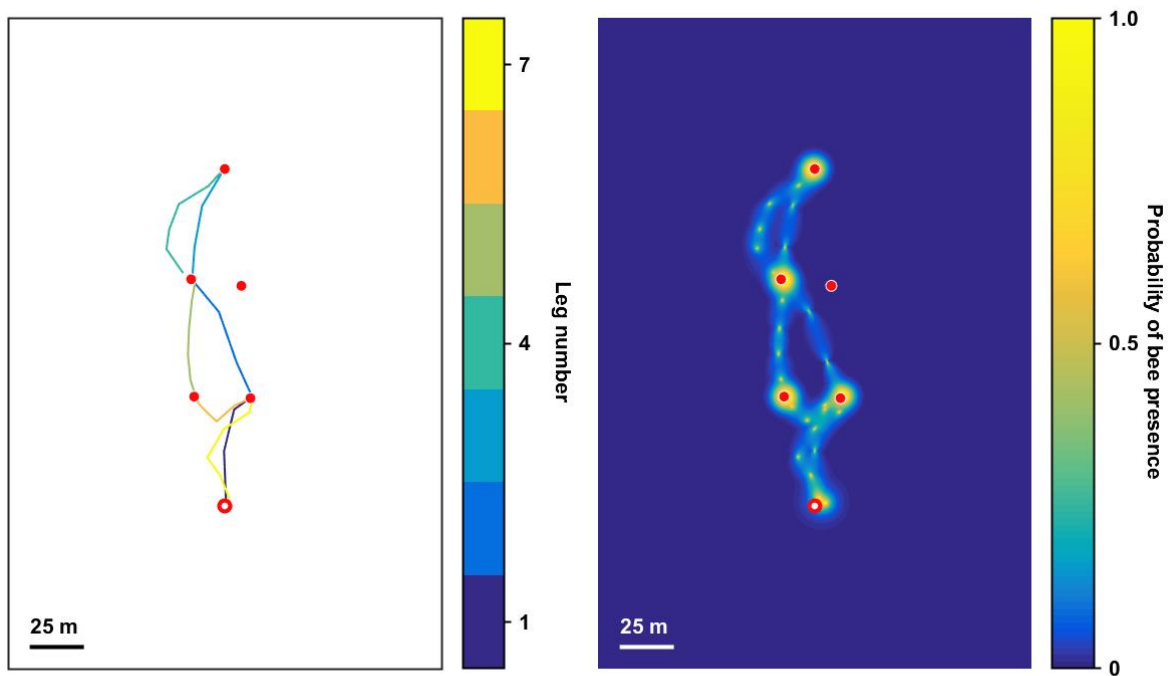


Fig S77

Bee 2, Bout 30, 17/09/2014  
Duration: 00:06:00

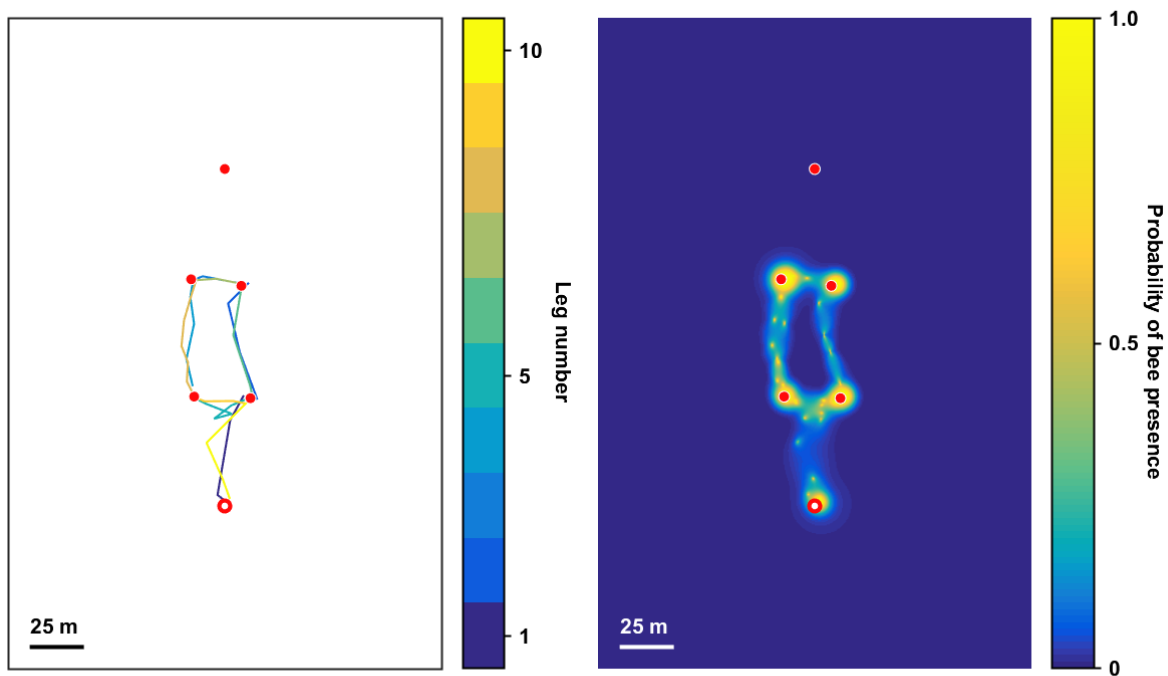


Fig S78

Bee 2, Bout 31, 17/09/2014  
Duration: 00:04:33

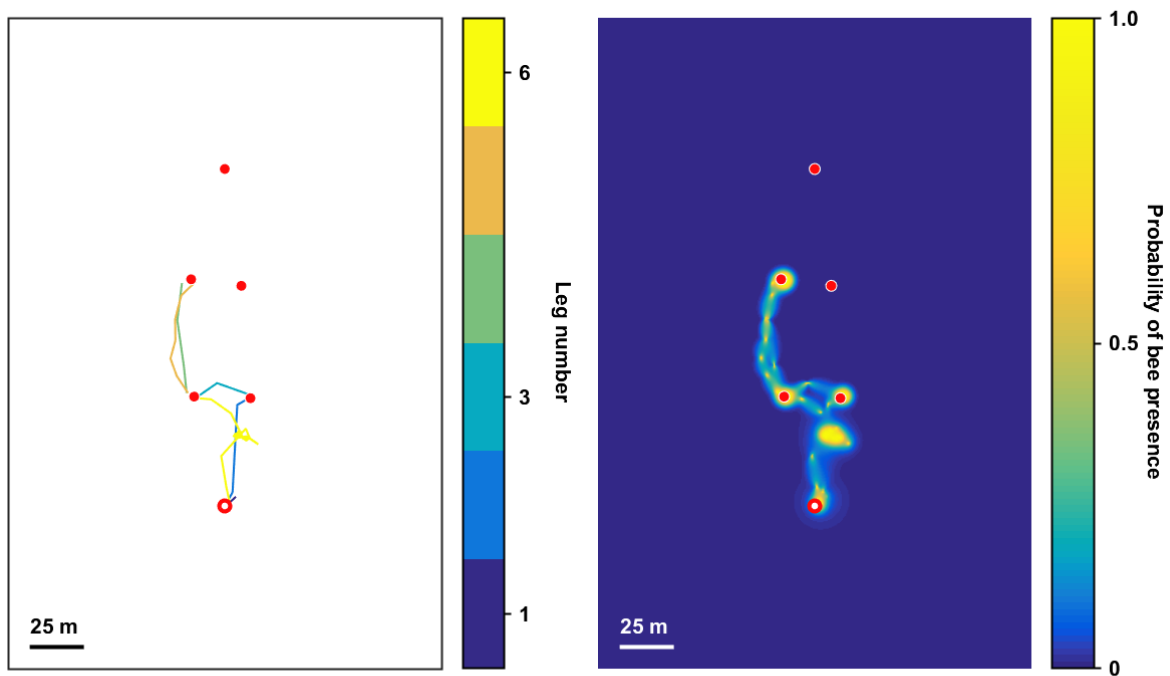


Fig S79

Bee 2, Bout 32, 17/09/2014  
Duration: 00:05:46

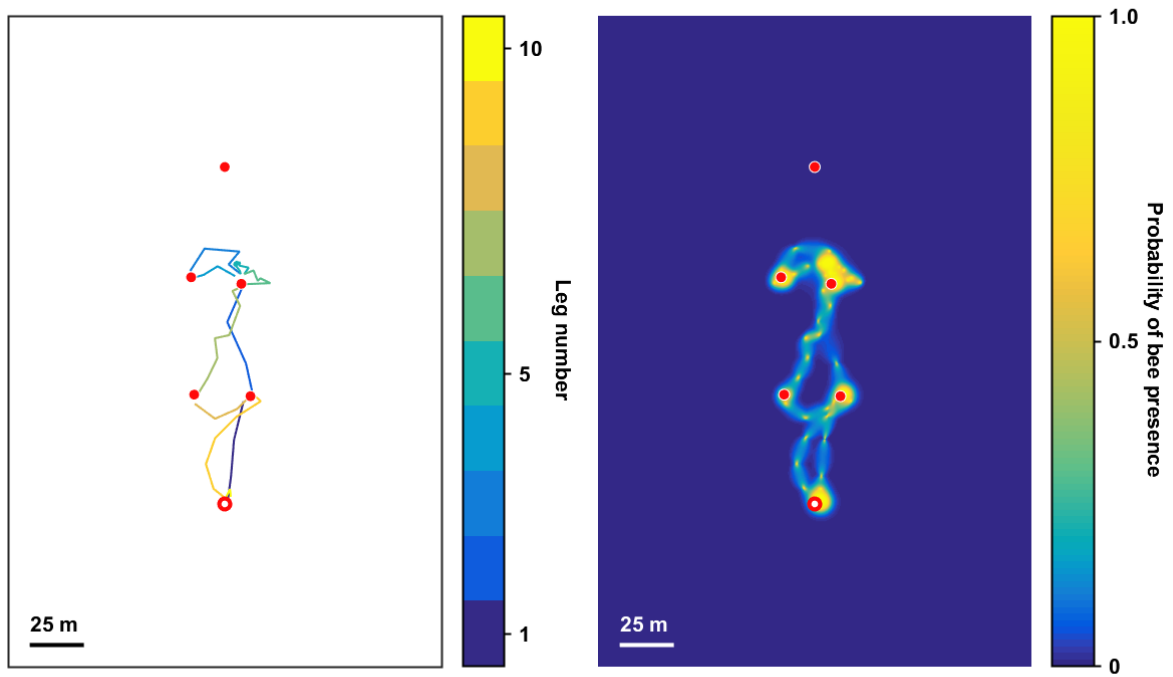


Fig S80

Bee 2, Bout 33, 17/09/2014  
Duration: 00:07:23

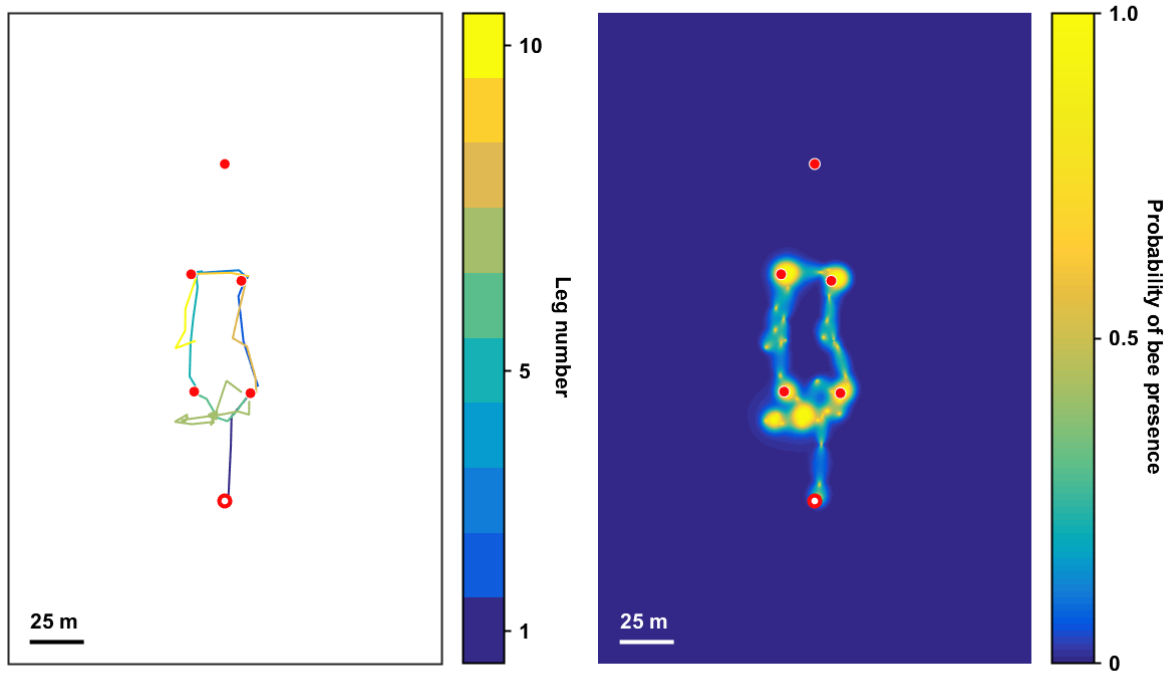


Fig S81

Bee 2, Bout 34, 18/09/2014  
Duration: 00:06:39

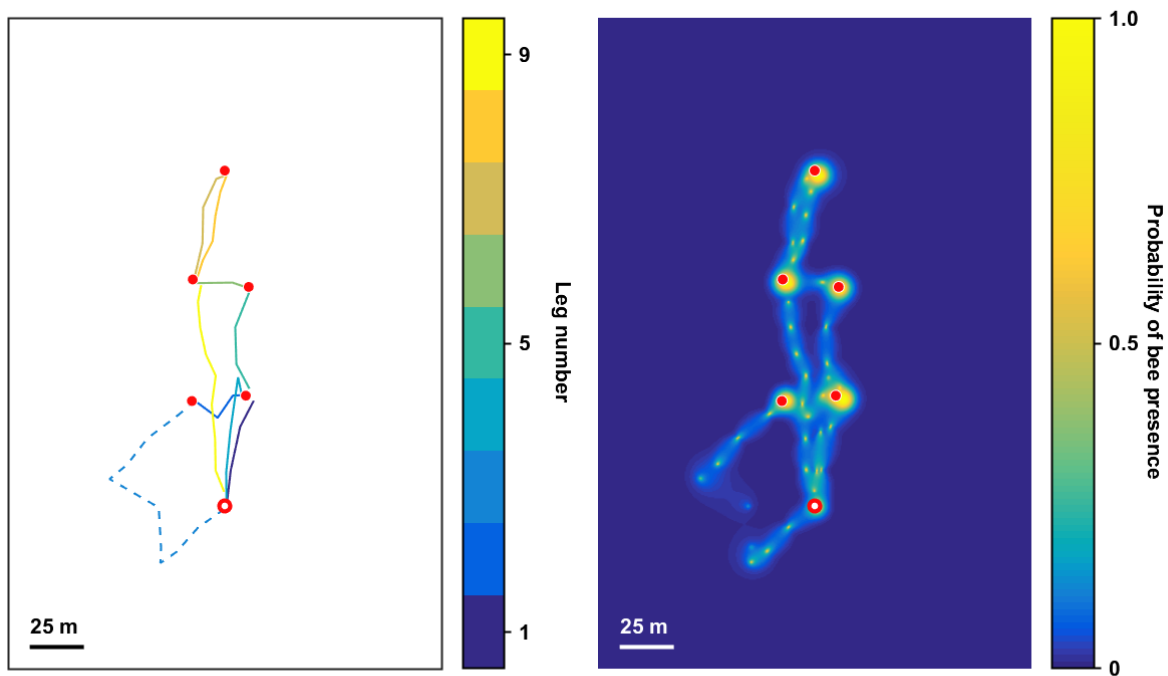




Fig S82

Bee 2, Bout 35, 18/09/2014  
Duration: 00:05:14

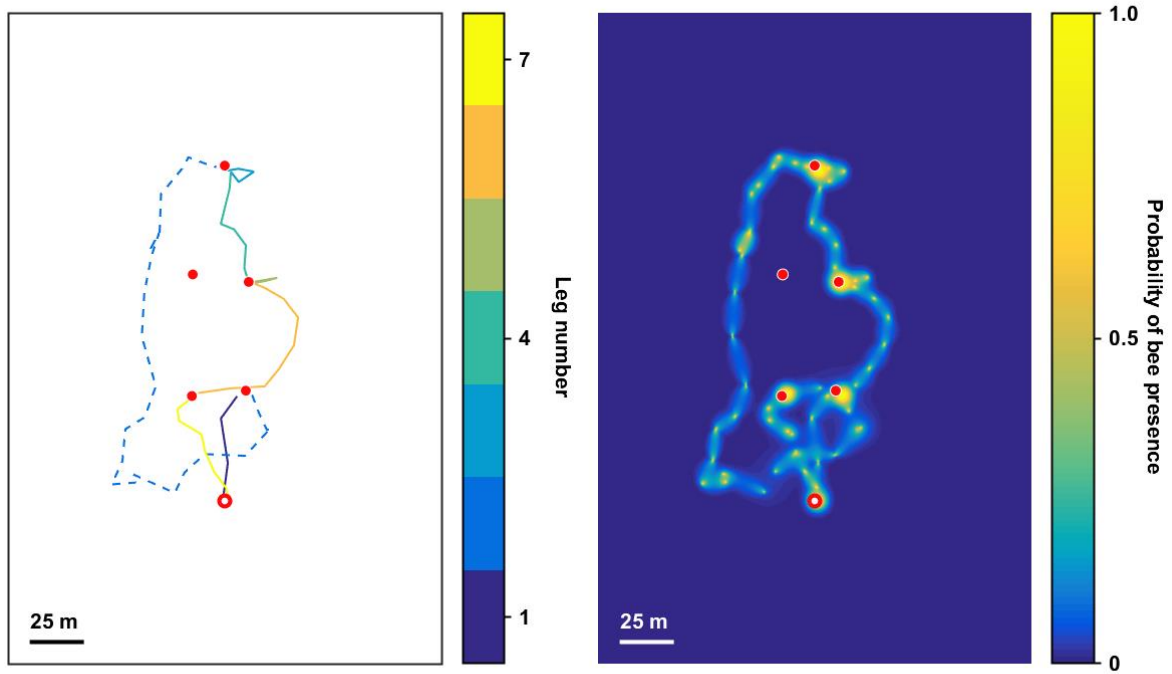


Fig S83

Bee 2, Bout 36, 18/09/2014  
Duration: 00:06:21

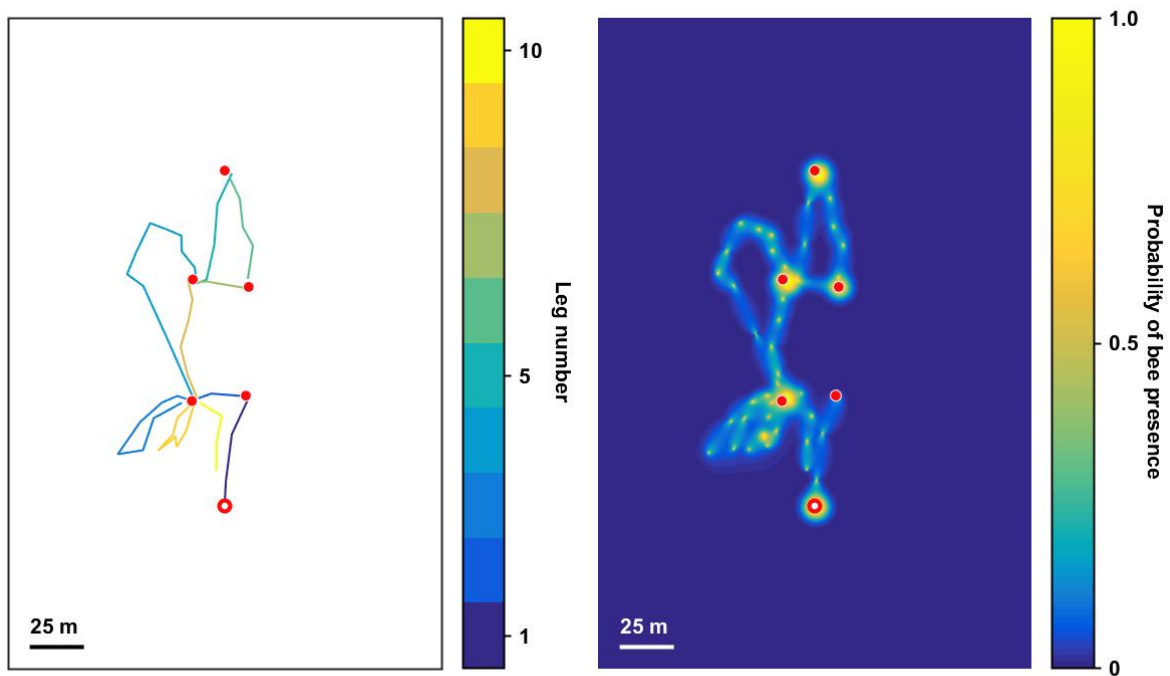


Fig S84

Bee 2, Bout 37, 18/09/2014  
Duration: 00:03:54

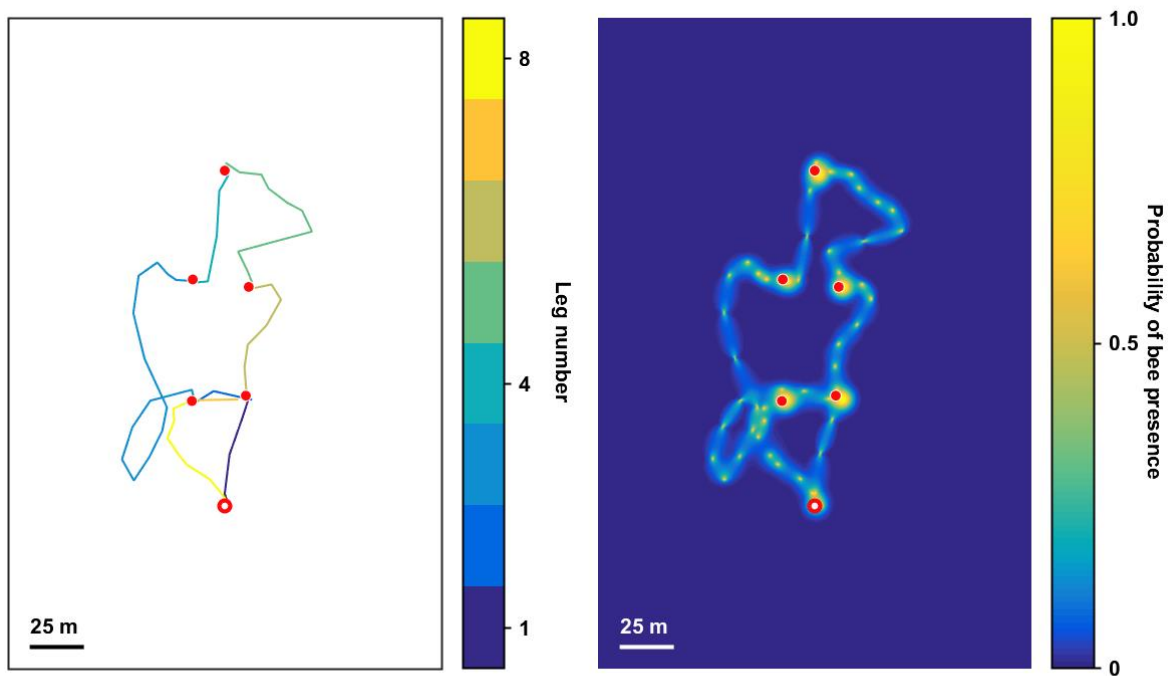


Fig S85

Bee 2, Bout 38, 18/09/2014  
Duration: 00:04:19

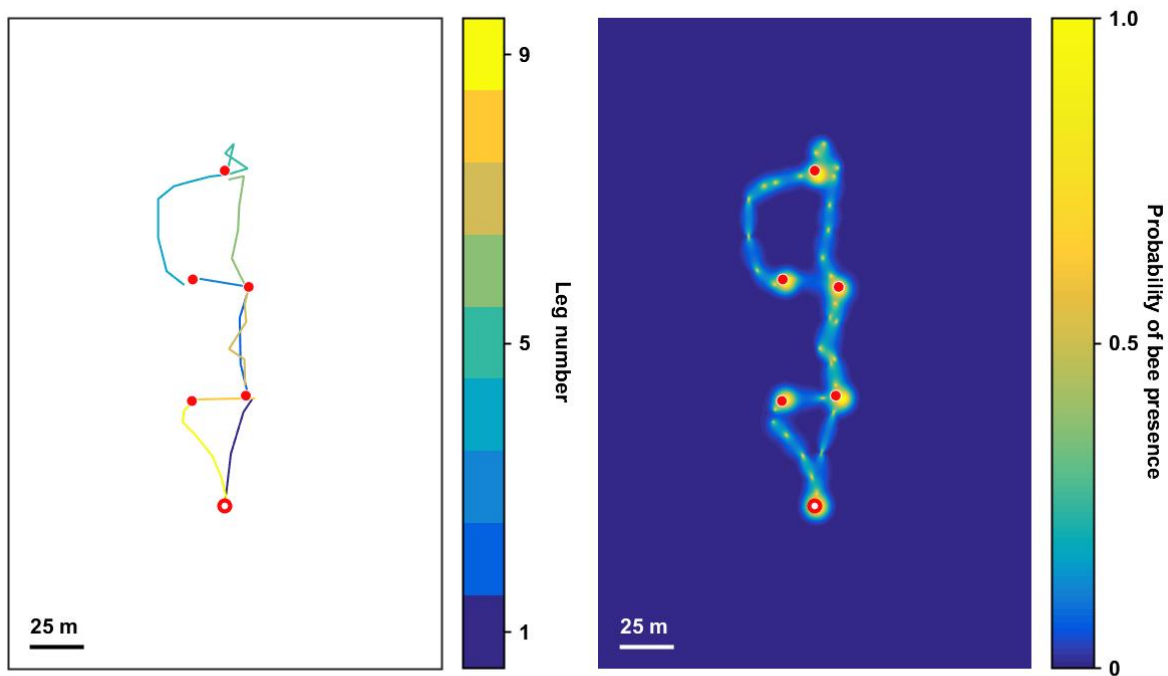


Fig S86

Bee 2, Bout 39, 18/09/2014  
Duration: 00:04:25

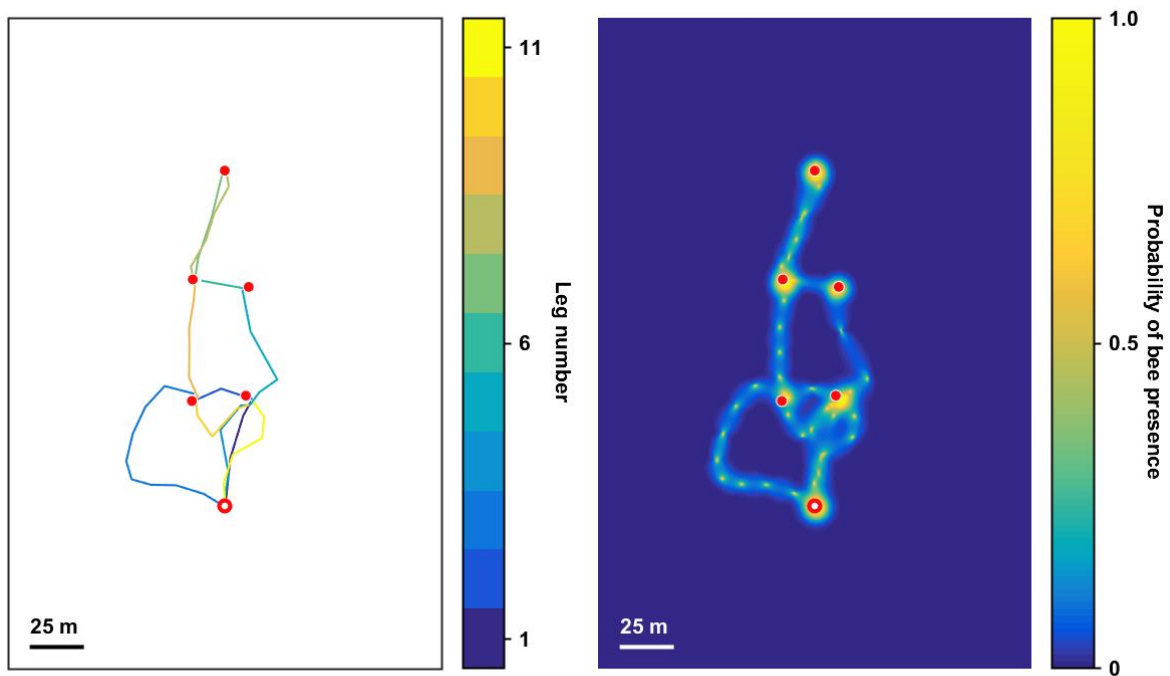


Fig S87

Bee 2, Bout 40, 18/09/2014  
Duration: 00:04:16

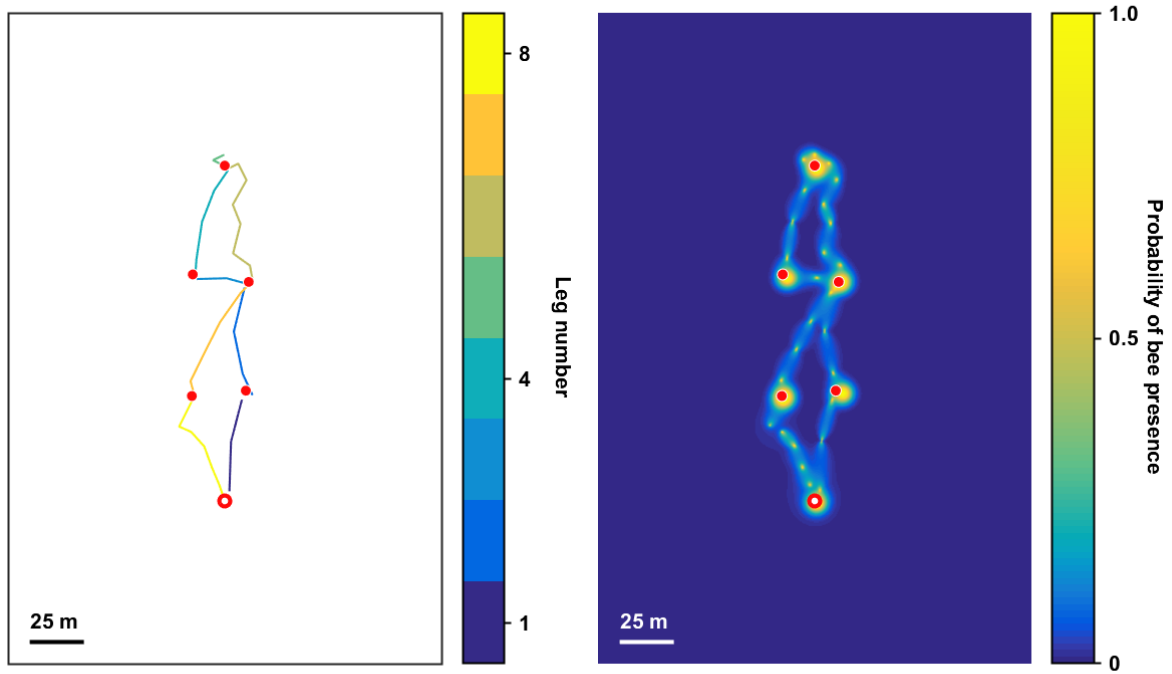


Fig S88

Bee 2, Bout 41, 18/09/2014  
Duration: 00:02:52

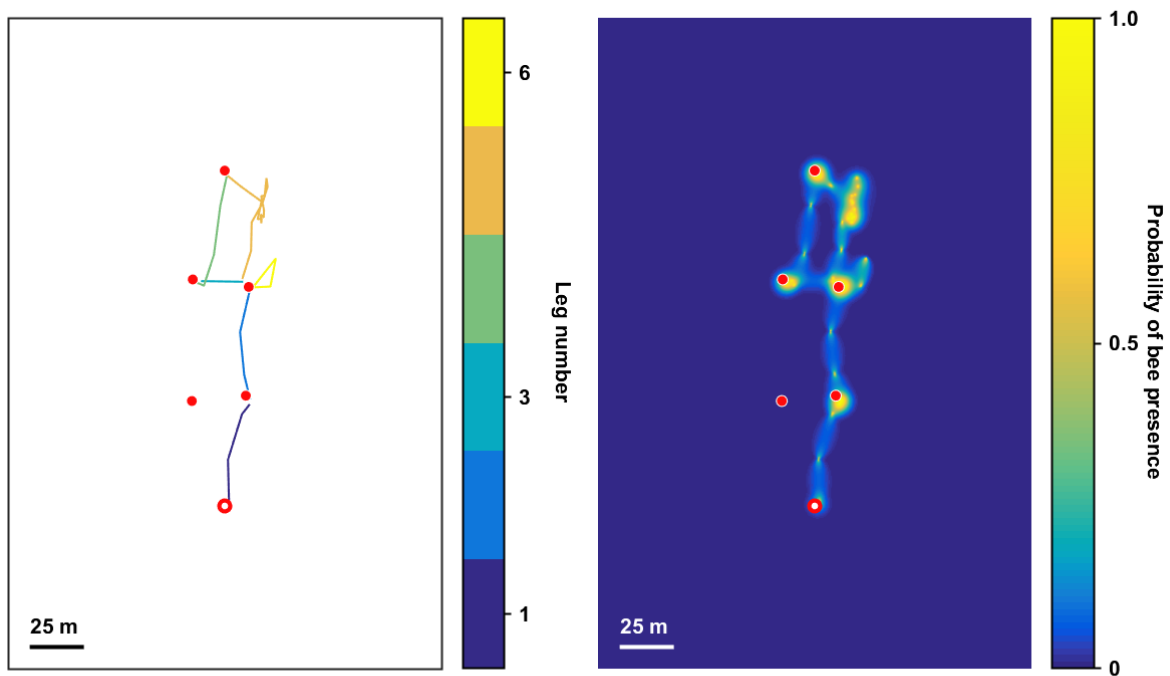


Fig S89

Bee 2, Bout 42, 18/09/2014  
Duration: 00:08:05

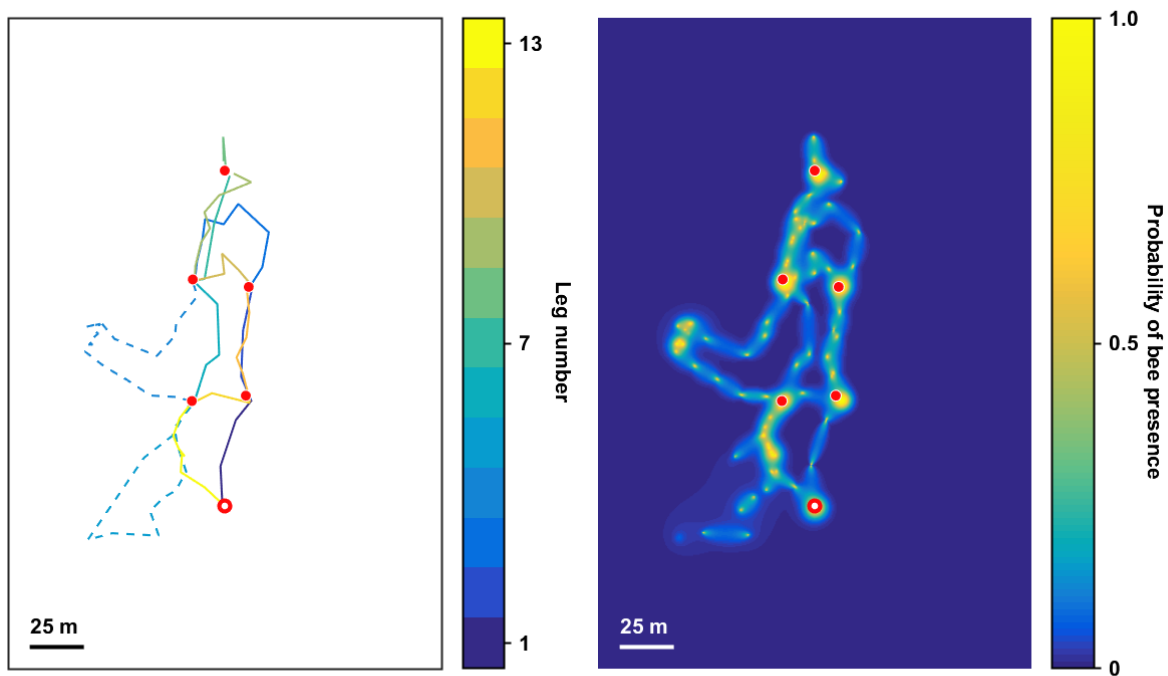




Fig S90

Bee 2, Bout 43, 18/09/2014  
Duration: 00:03:39

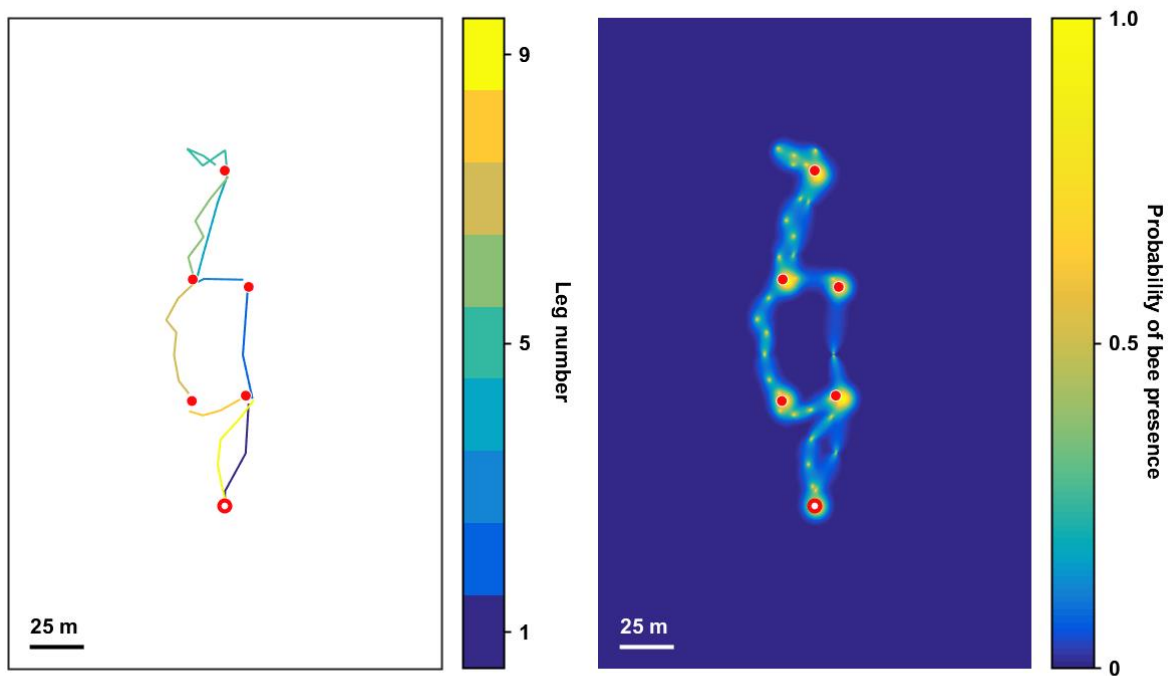
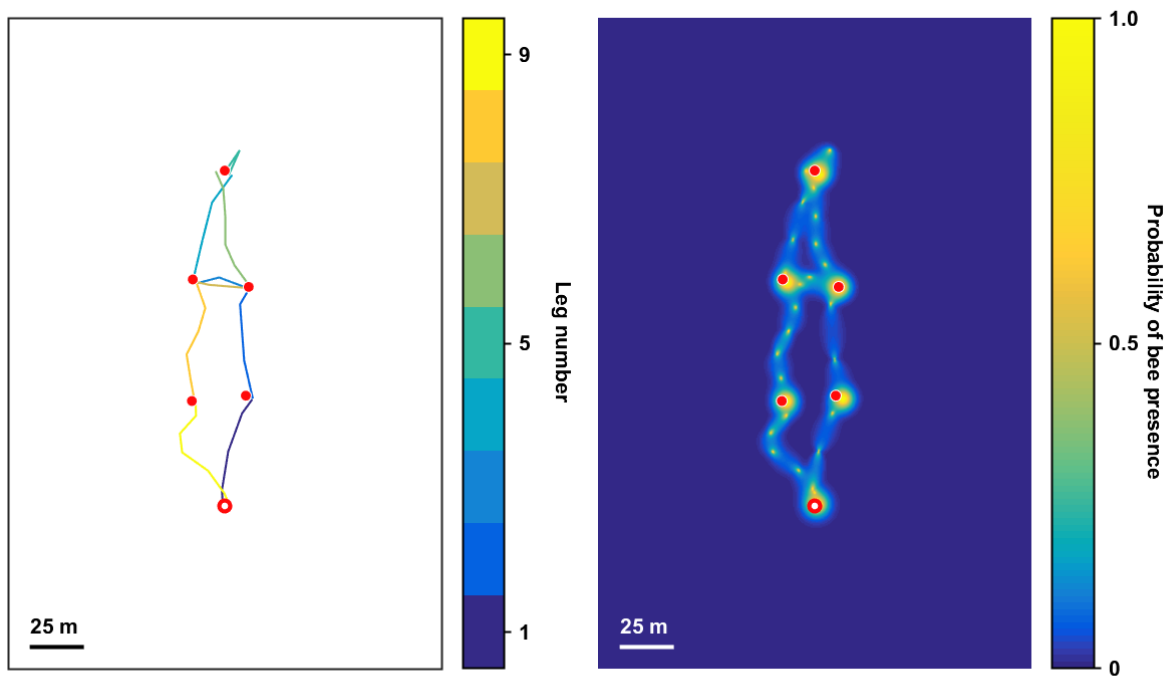


Fig S91

Bee 2, Bout 44, 18/09/2014  
Duration: 00:03:22



**Bee 2, Bout 45, 18/09/2014**  
**Duration: 00:03:46**

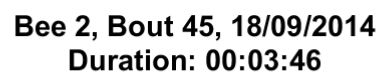


Fig S93

Bee 2, Bout 46, 18/09/2014  
Duration: 00:03:28

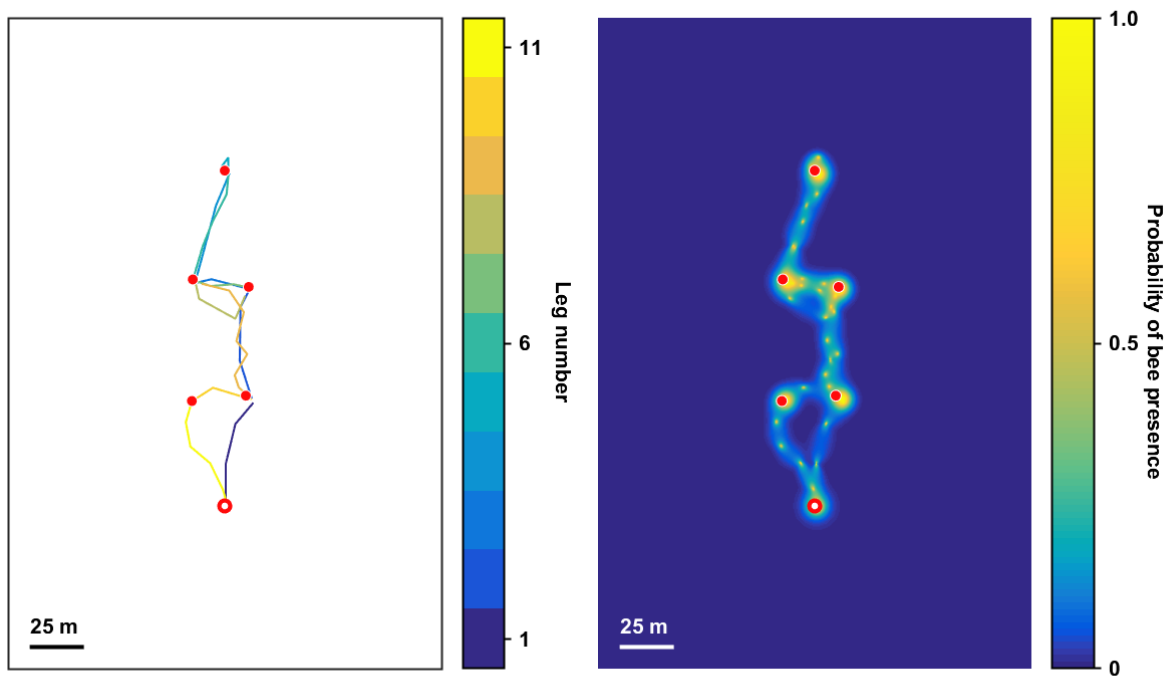


Fig S94

Bee 2, Bout 47, 18/09/2014  
Duration: 00:04:00

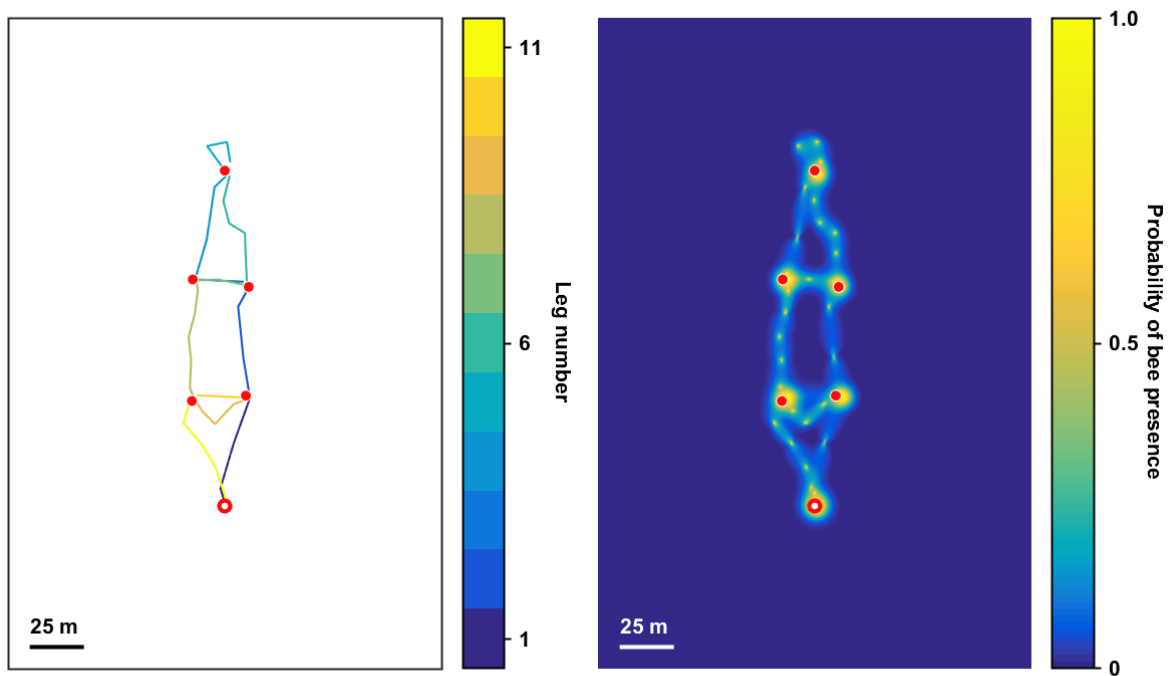


Fig S95

Bee 2, Bout 48, 18/09/2014  
Duration: 00:43:16

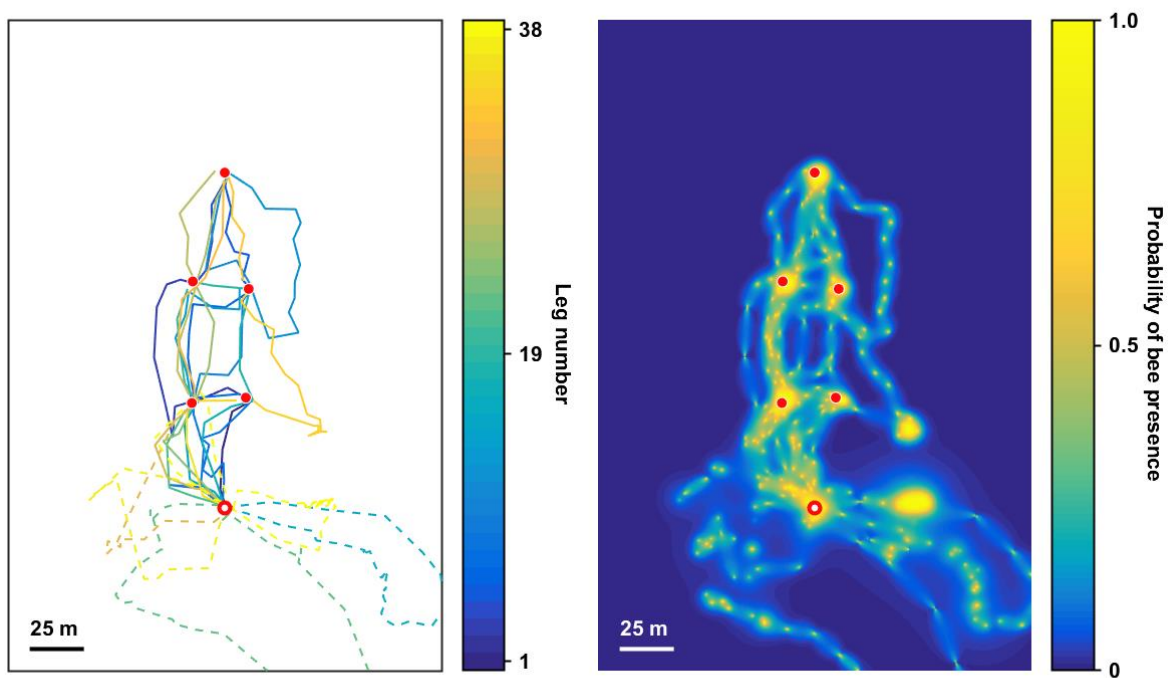


Fig S96

Bee 2, Bout 49, 18/09/2014  
Duration: 00:10:29

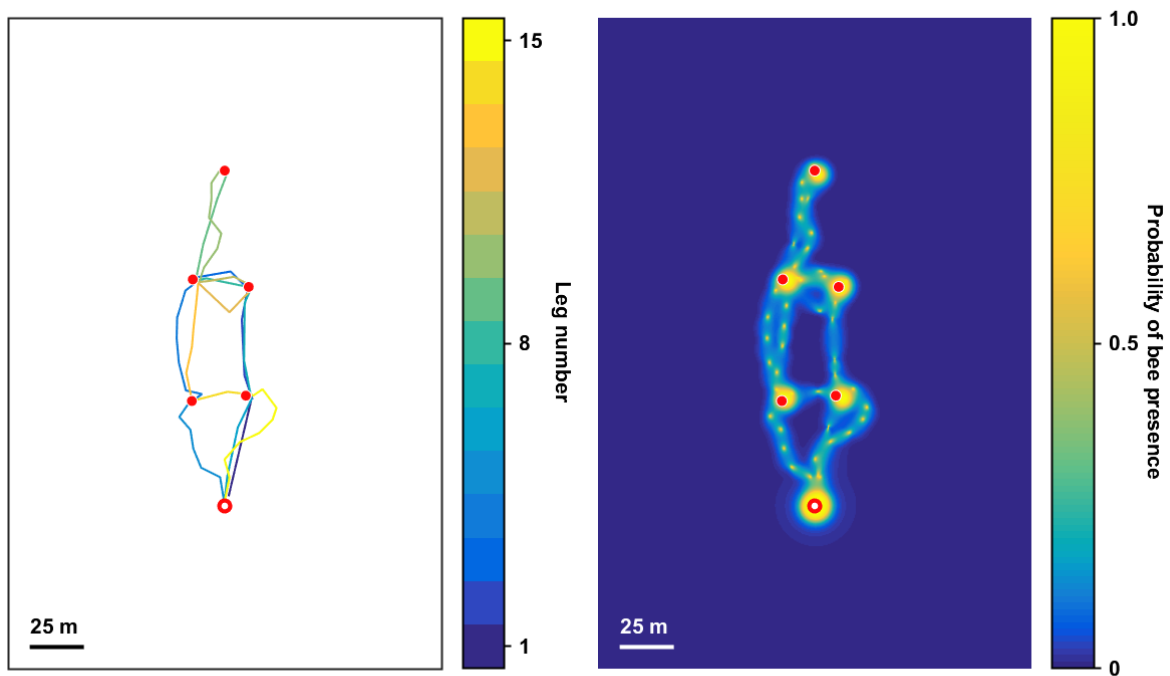


Fig S97

Bee 2, Bout 50, 18/09/2014  
Duration: 00:05:41

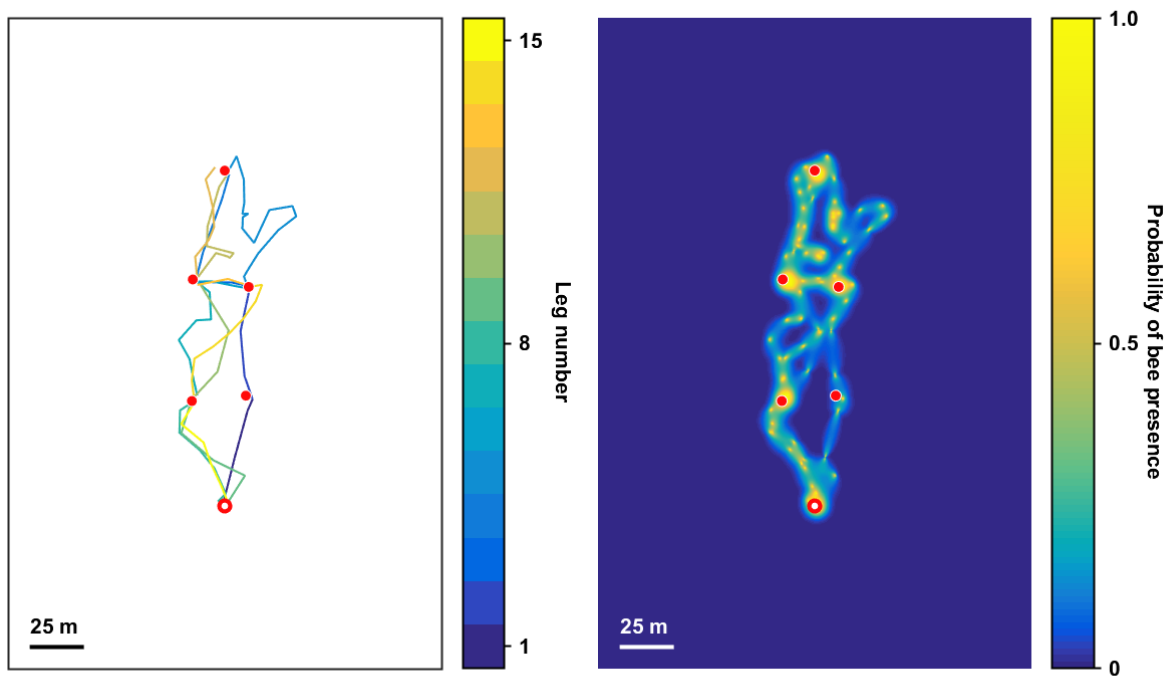




Fig S98

Bee 2, Bout 51, 18/09/2014  
Duration: 01:52:04

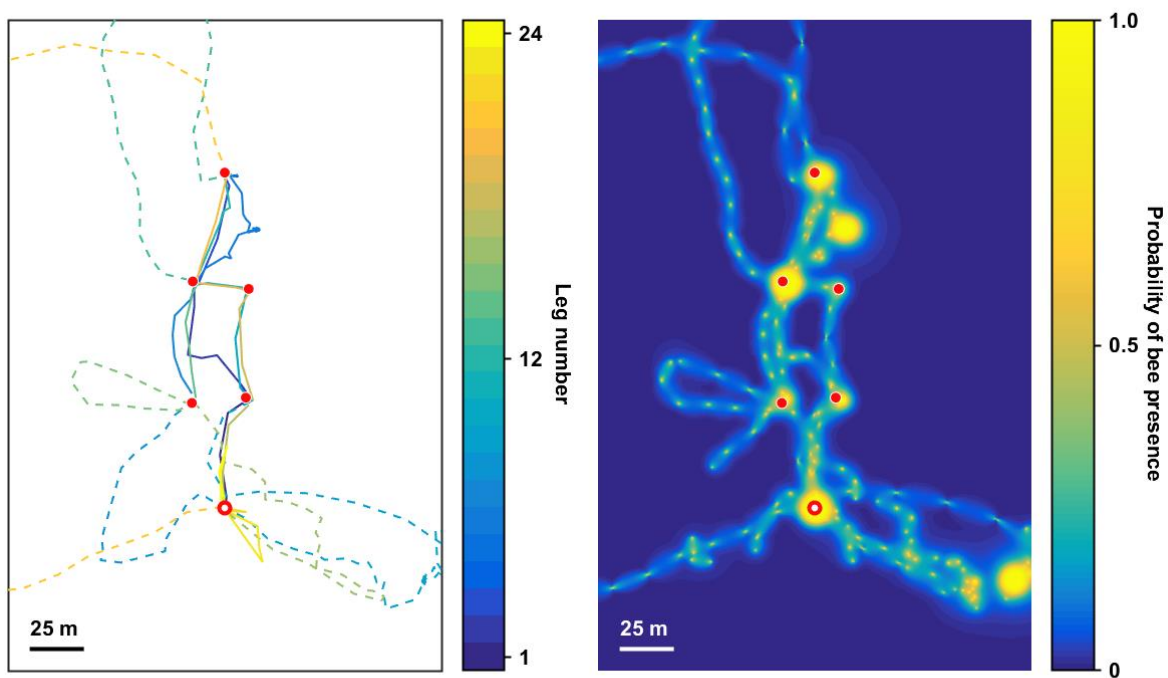


Fig S99

Bee 3, Bout 1, 25/09/2014  
Duration: 01:14:54

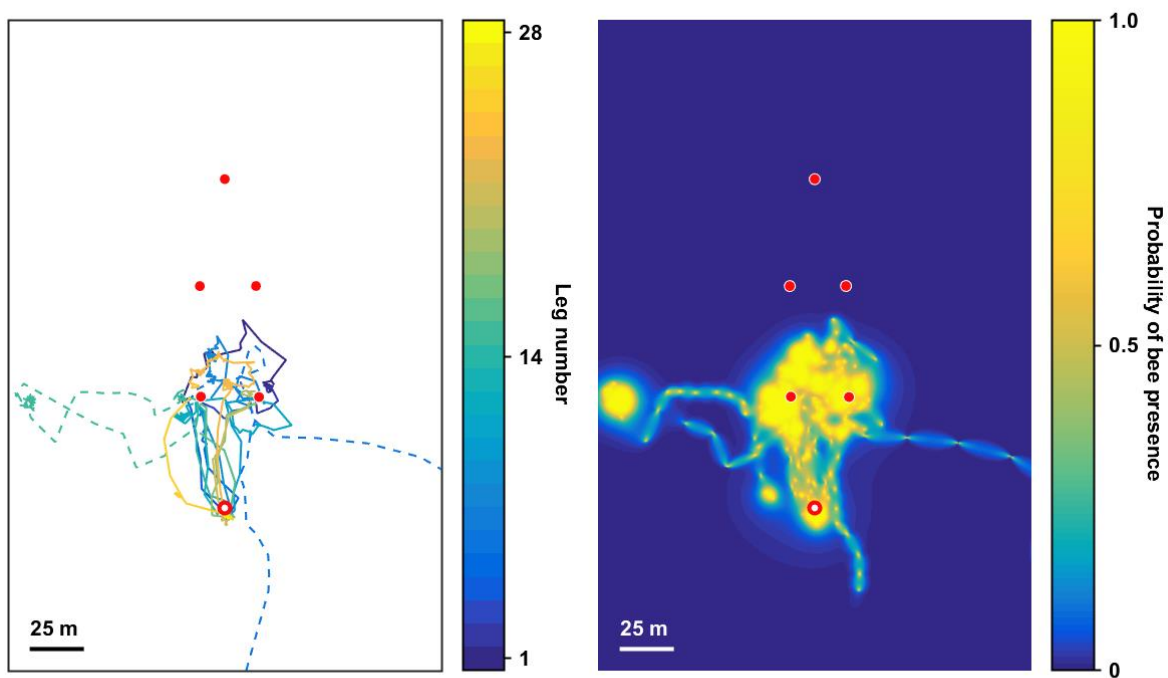


Fig S100

Bee 3, Bout 2, 25/09/2014  
Duration: 00:34:00

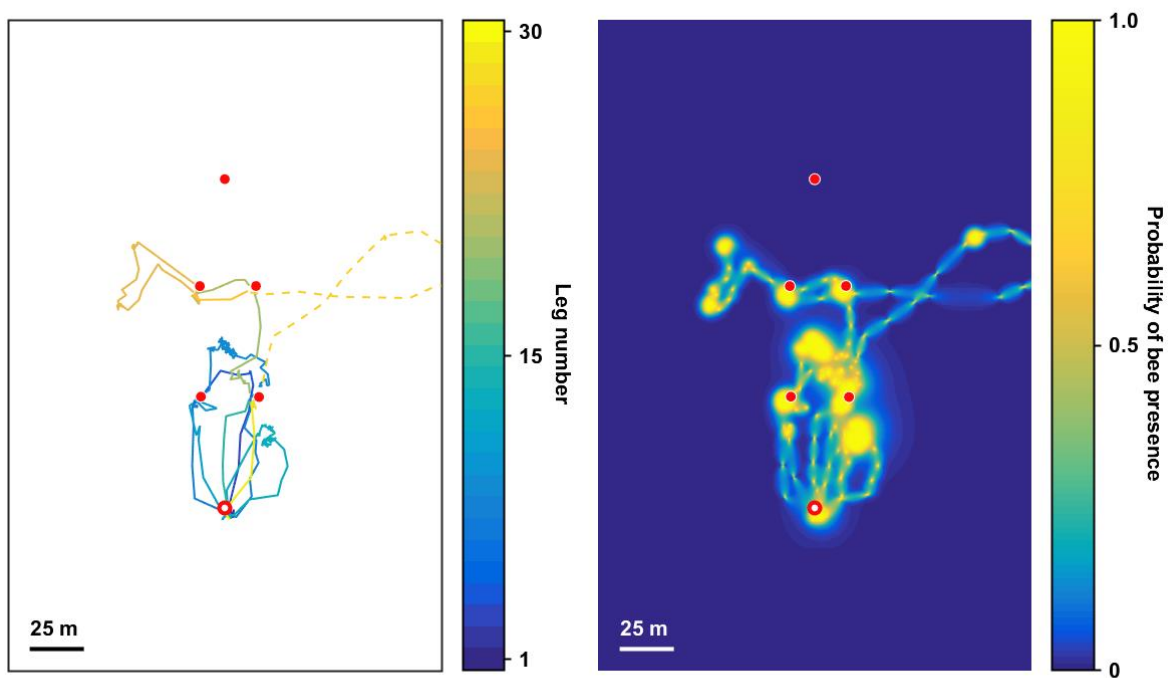


Fig S101

Bee 3, Bout 3, 26/09/2014  
Duration: 00:08:07

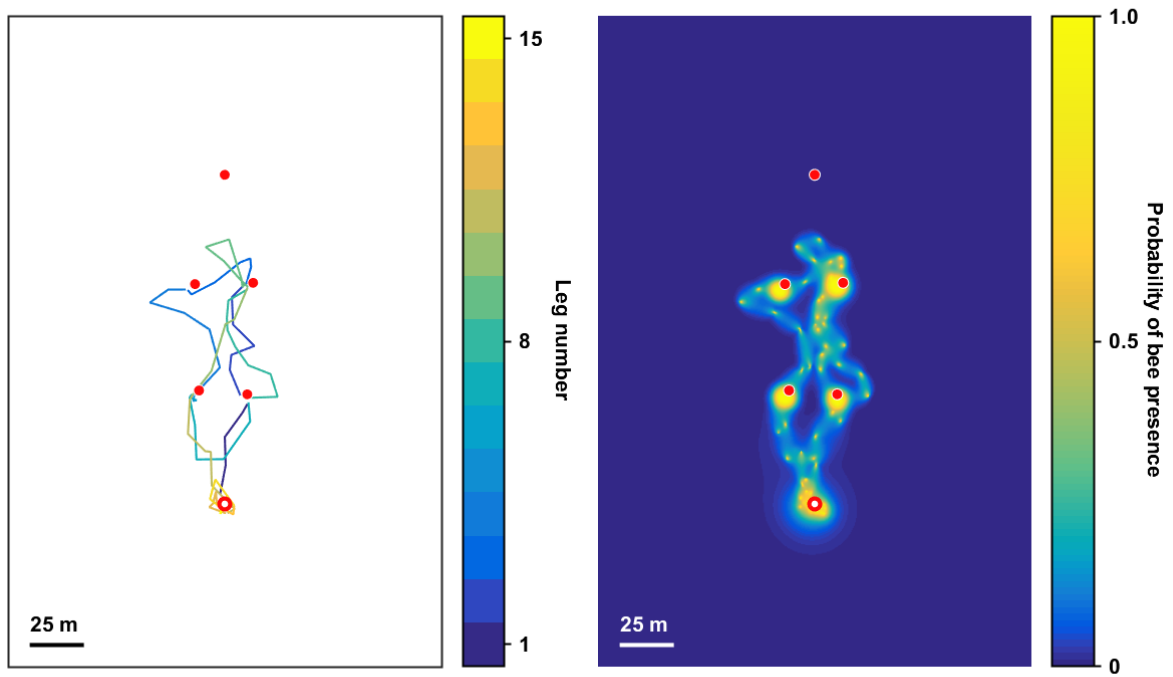


Fig S102

Bee 3, Bout 4, 26/09/2014  
Duration: 00:08:49

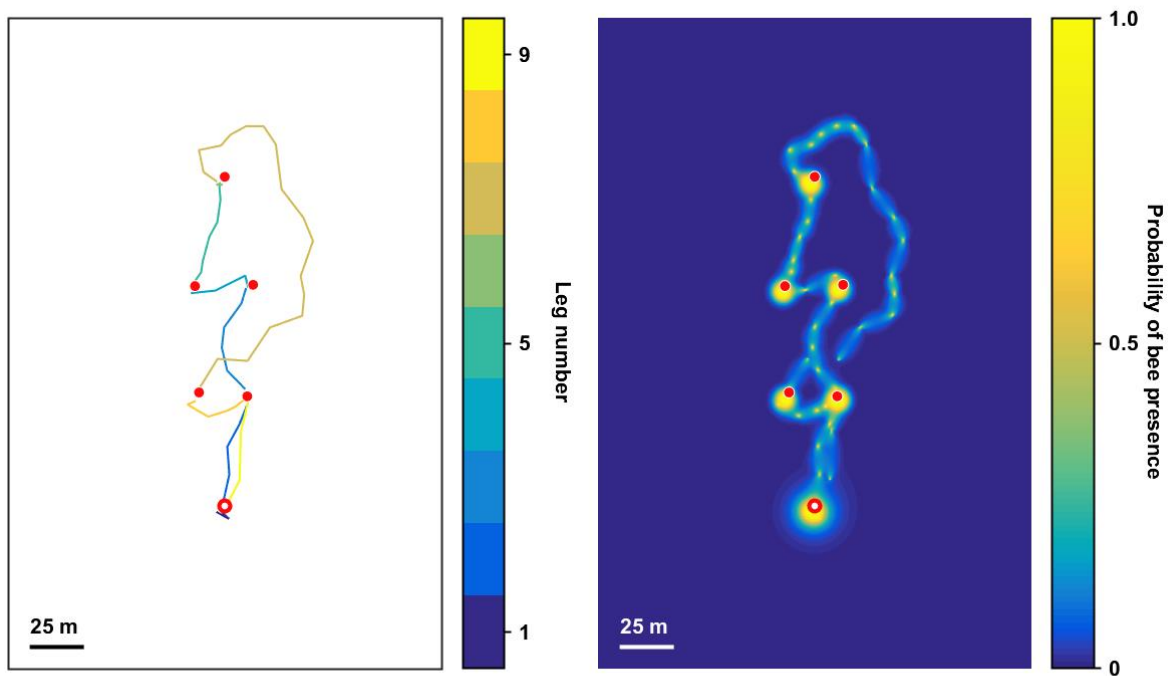


Fig S103

Bee 3, Bout 5, 26/09/2014  
Duration: 00:04:45

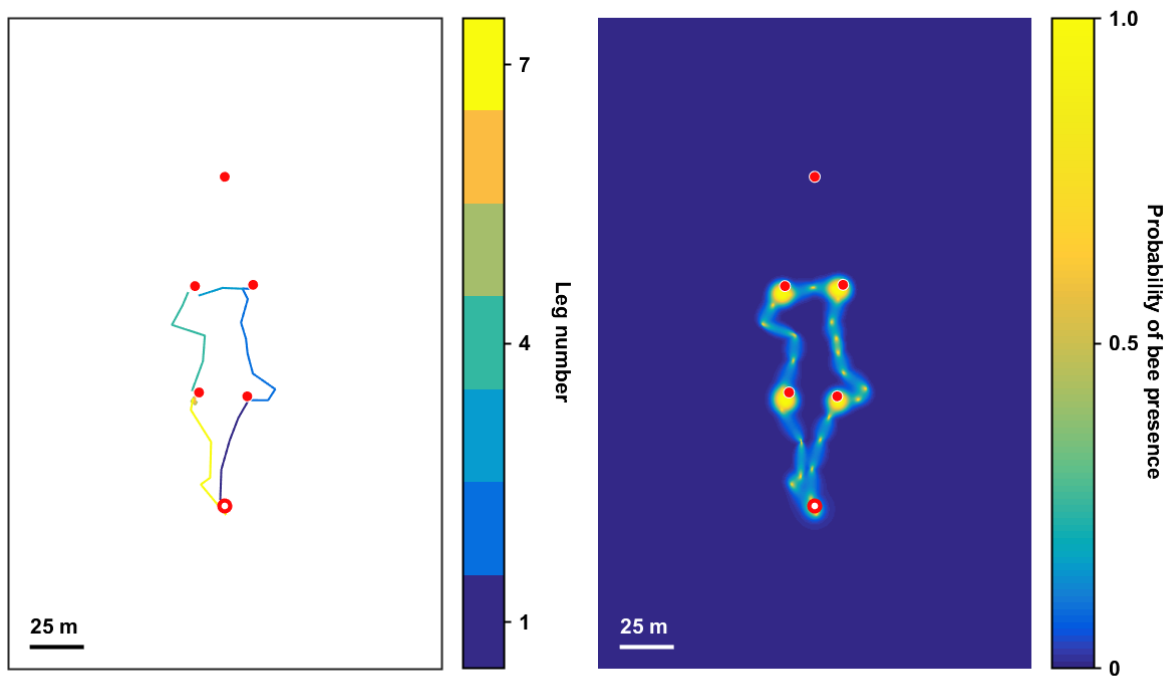


Fig S104

Bee 3, Bout 6, 26/09/2014  
Duration: 00:06:17

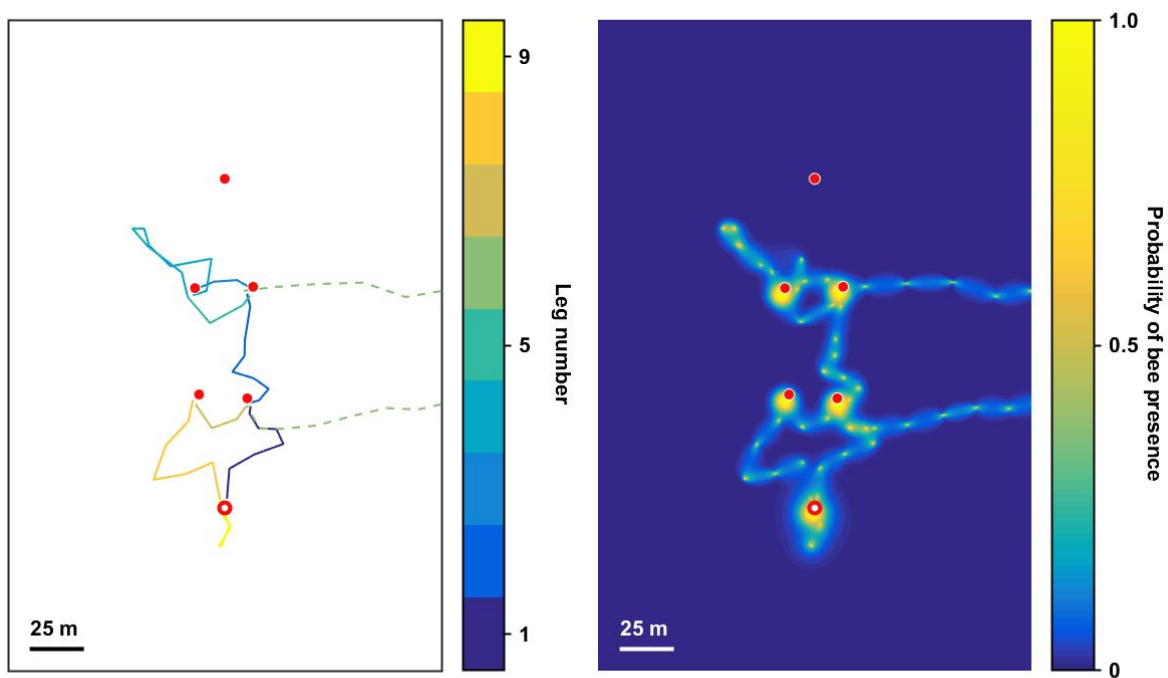


Fig S105

Bee 3, Bout 7, 26/09/2014  
Duration: 00:05:09

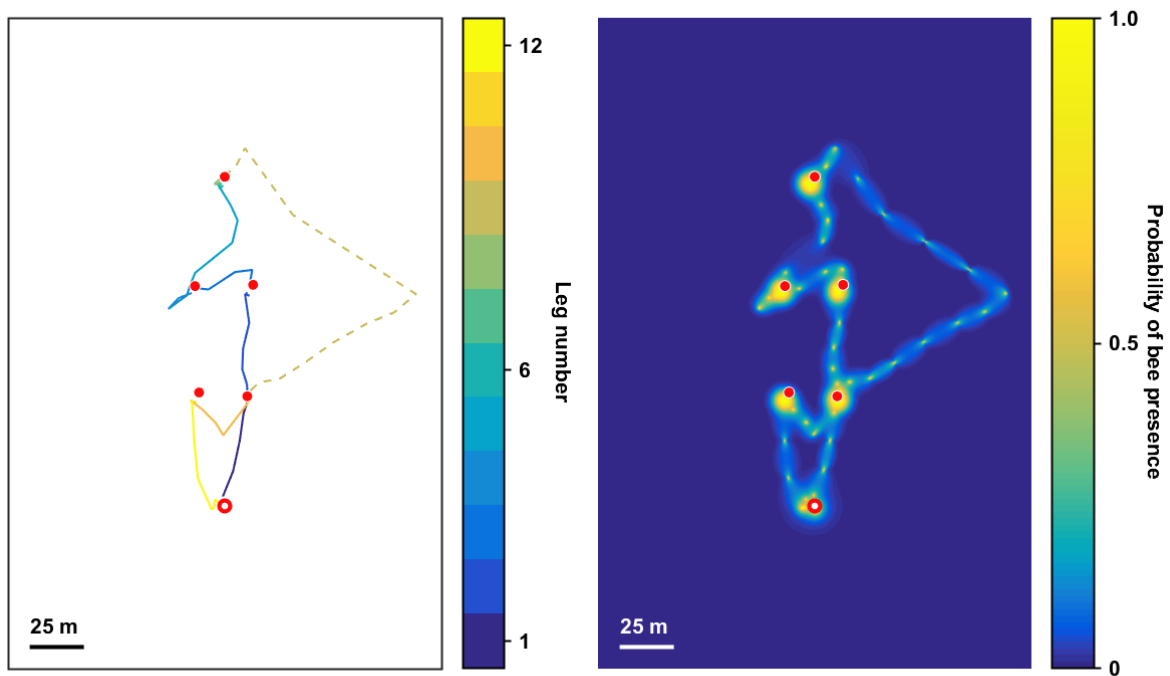




Fig S106

Bee 3, Bout 8, 26/09/2014  
Duration: 00:05:15

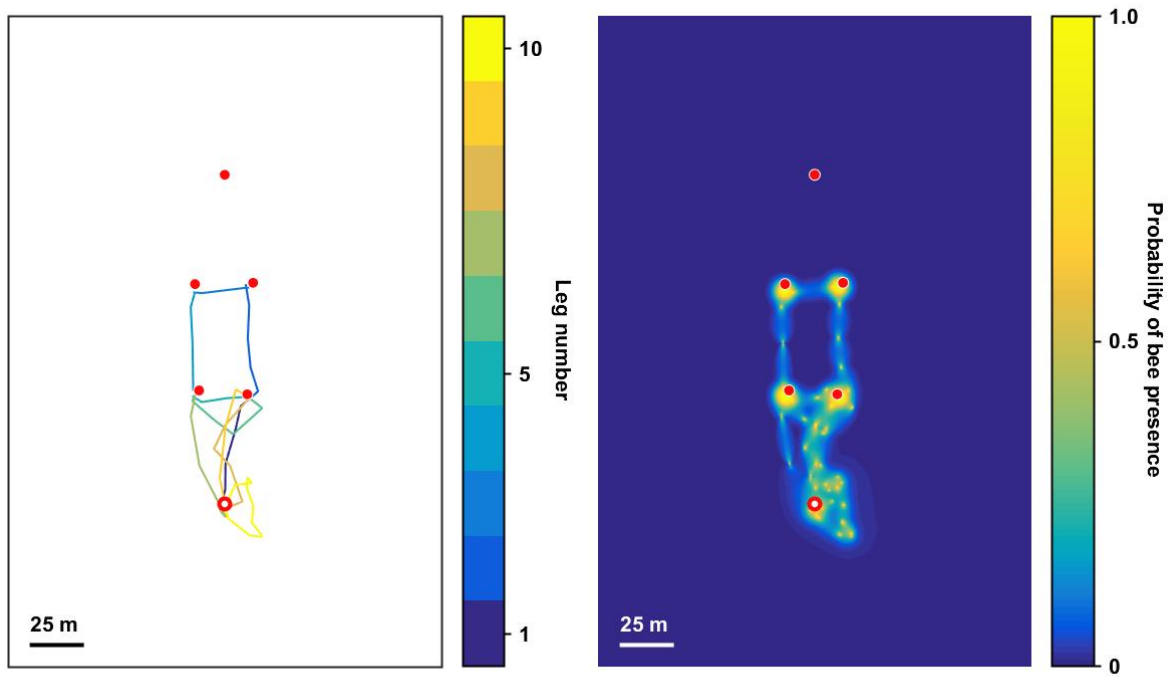


Fig S107

Bee 3, Bout 9, 26/09/2014  
Duration: 00:07:39

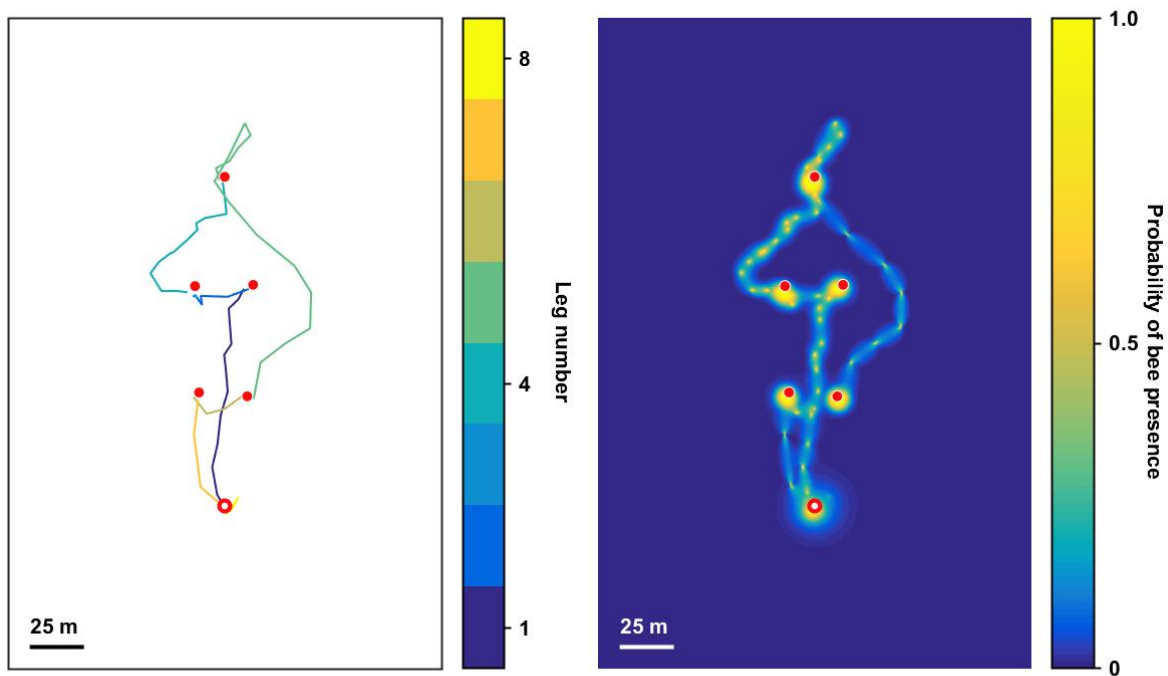


Fig S108

Bee 3, Bout 10, 26/09/2014  
Duration: 00:05:12

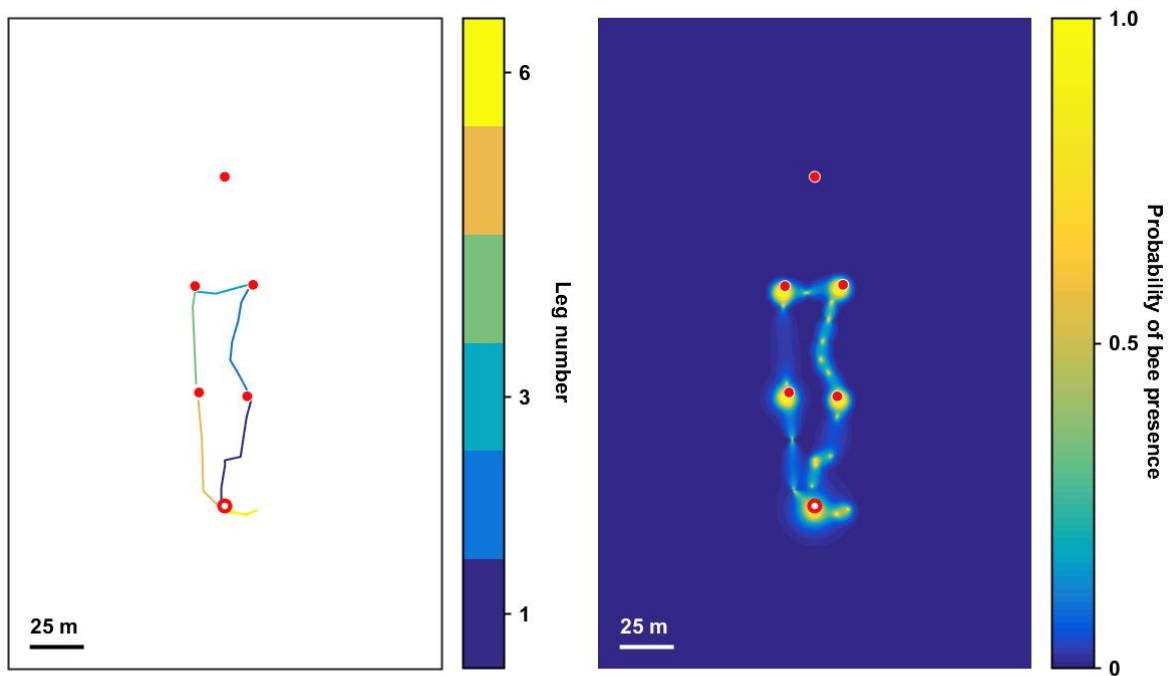


Fig S109

Bee 3, Bout 11, 26/09/2014  
Duration: 00:06:14

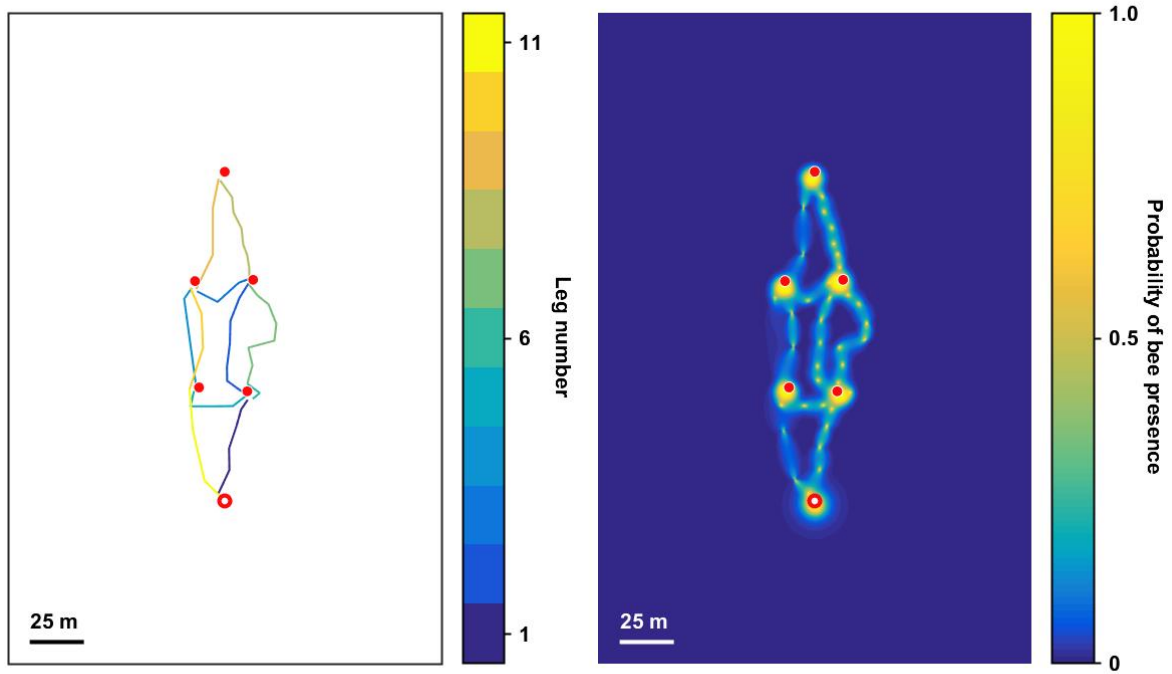


Fig S110

Bee 3, Bout 12, 26/09/2014  
Duration: 00:05:18

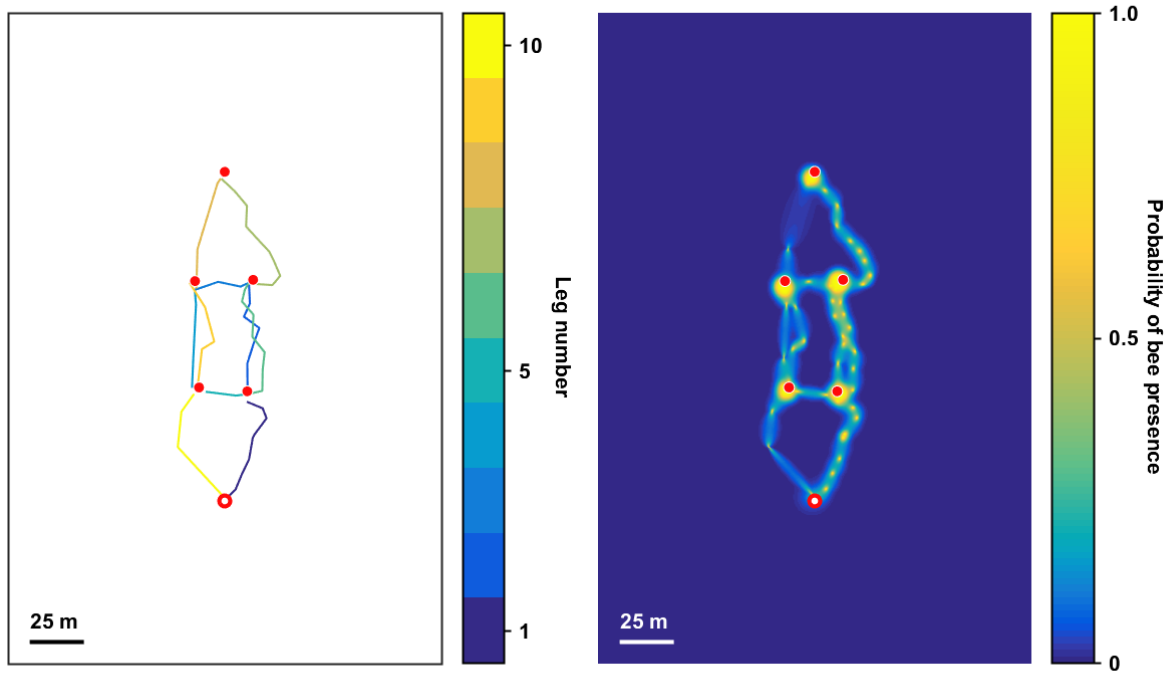


Fig S111

Bee 3, Bout 13, 26/09/2014  
Duration: 00:06:56

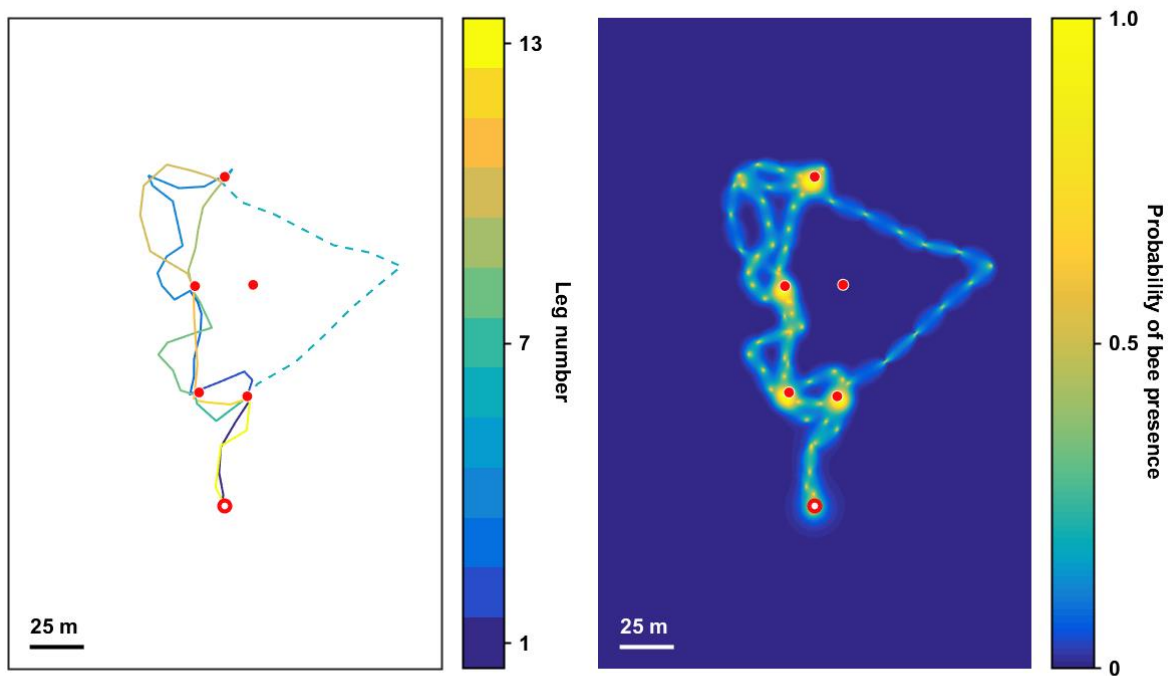


Fig S112

Bee 3, Bout 14, 26/09/2014  
Duration: 00:06:20

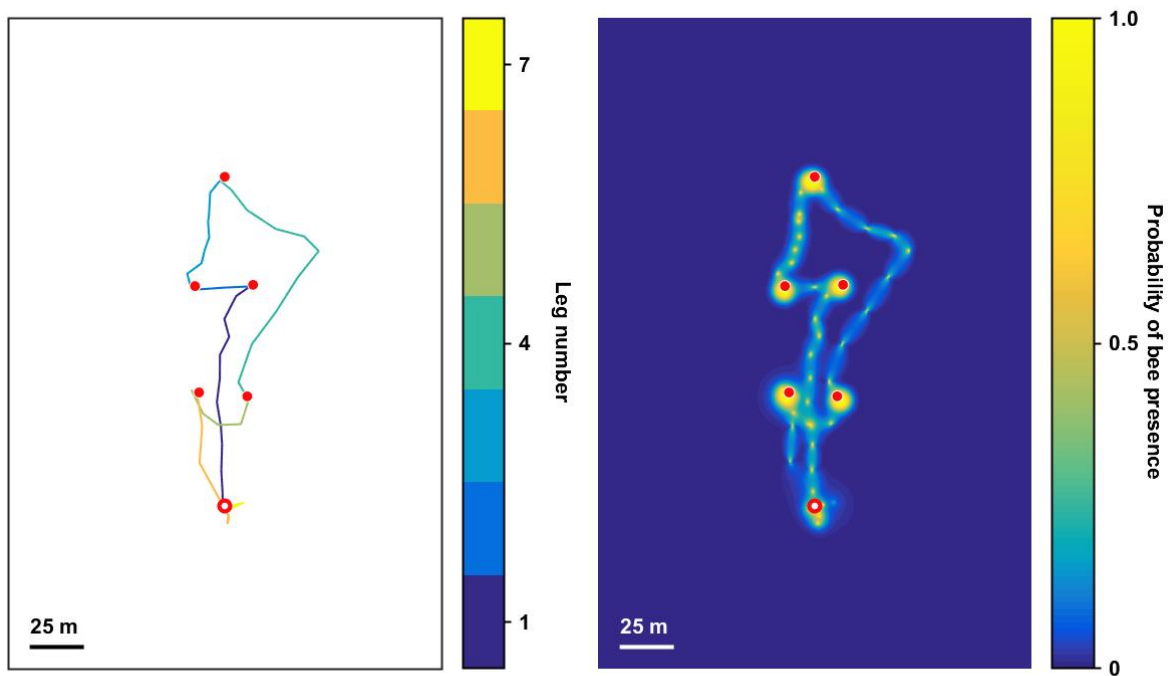


Fig S113

Bee 3, Bout 15, 26/09/2014  
Duration: 00:05:01

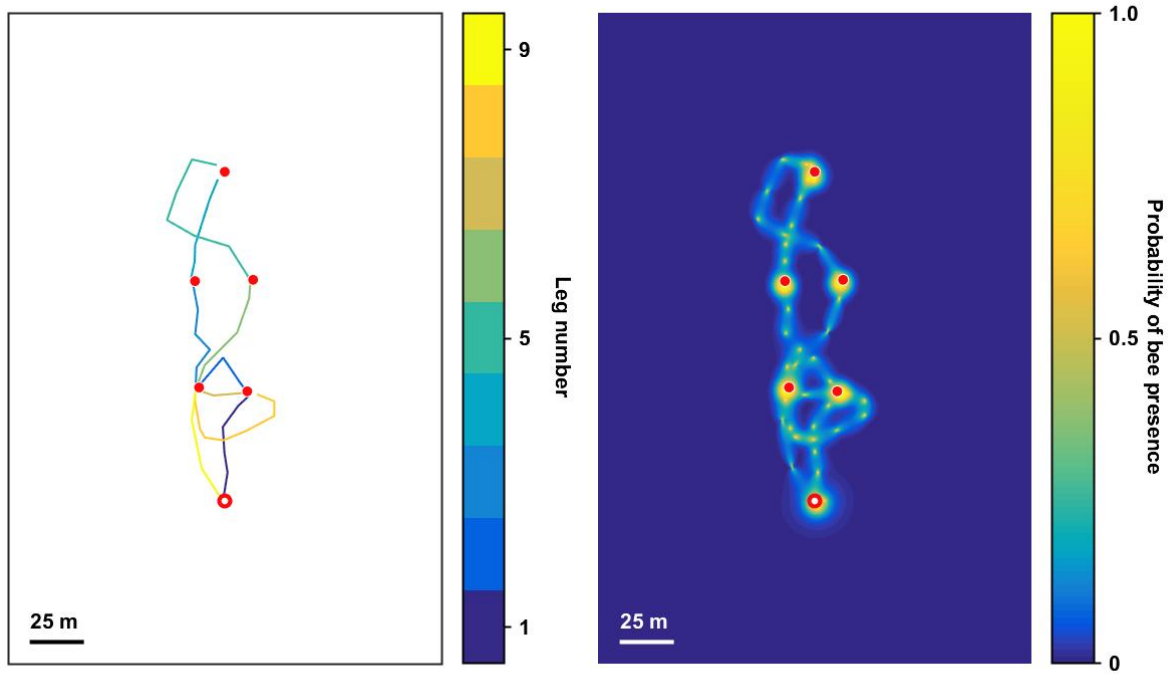




Fig S114

Bee 3, Bout 16, 26/09/2014  
Duration: 00:05:44

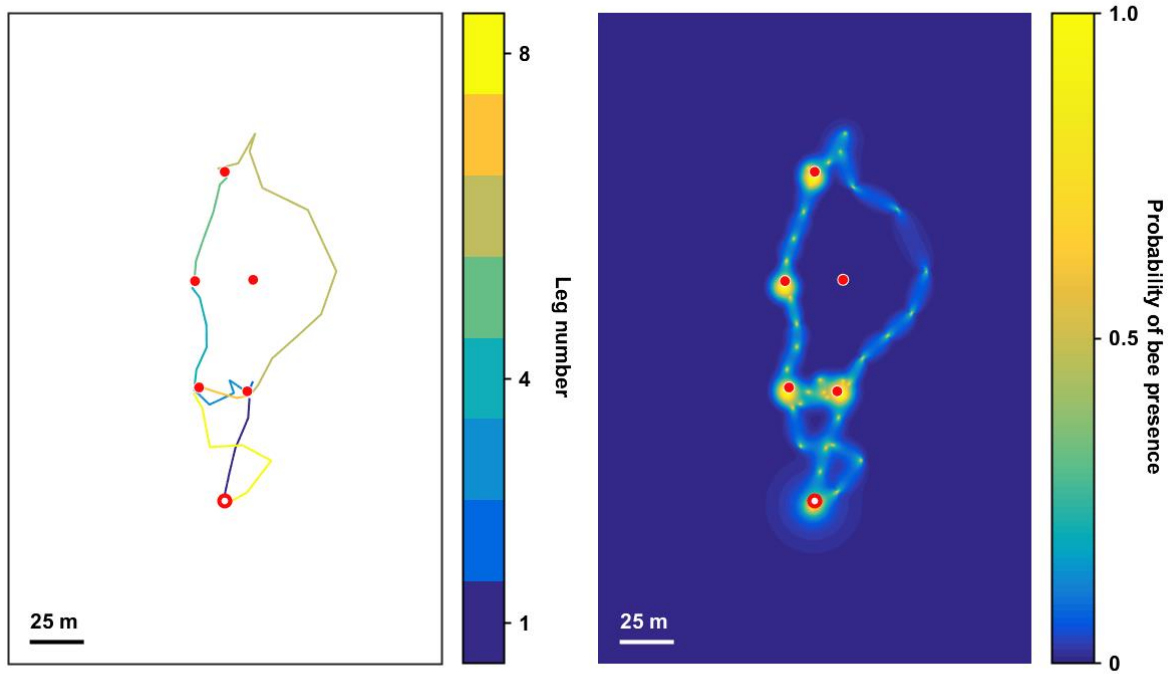


Fig S115

Bee 3, Bout 17, 26/09/2014  
Duration: 00:04:19

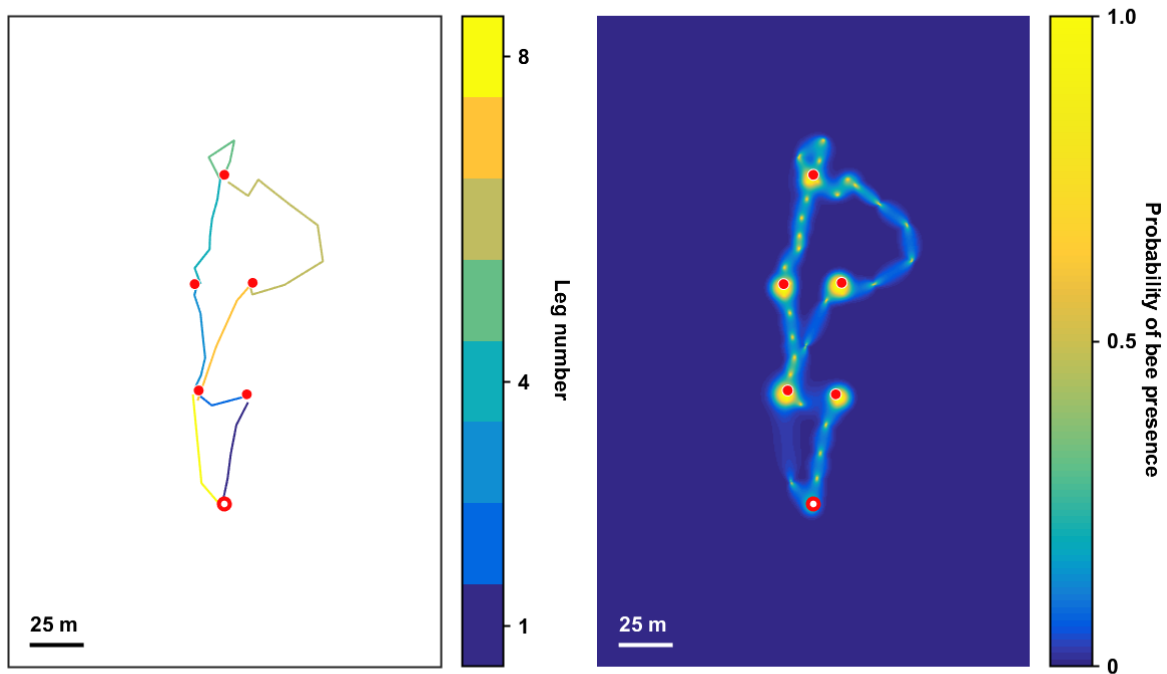


Fig S116

Bee 3, Bout 18, 26/09/2014  
Duration: 00:06:03

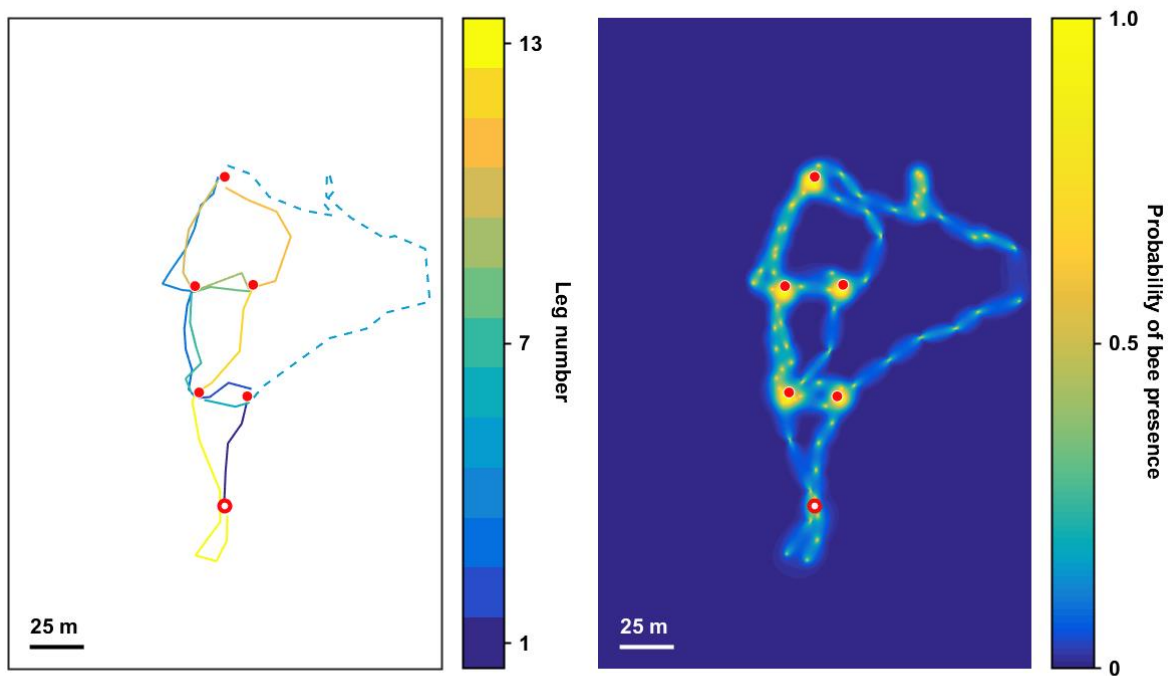


Fig S117

Bee 3, Bout 19, 26/09/2014  
Duration: 00:05:01

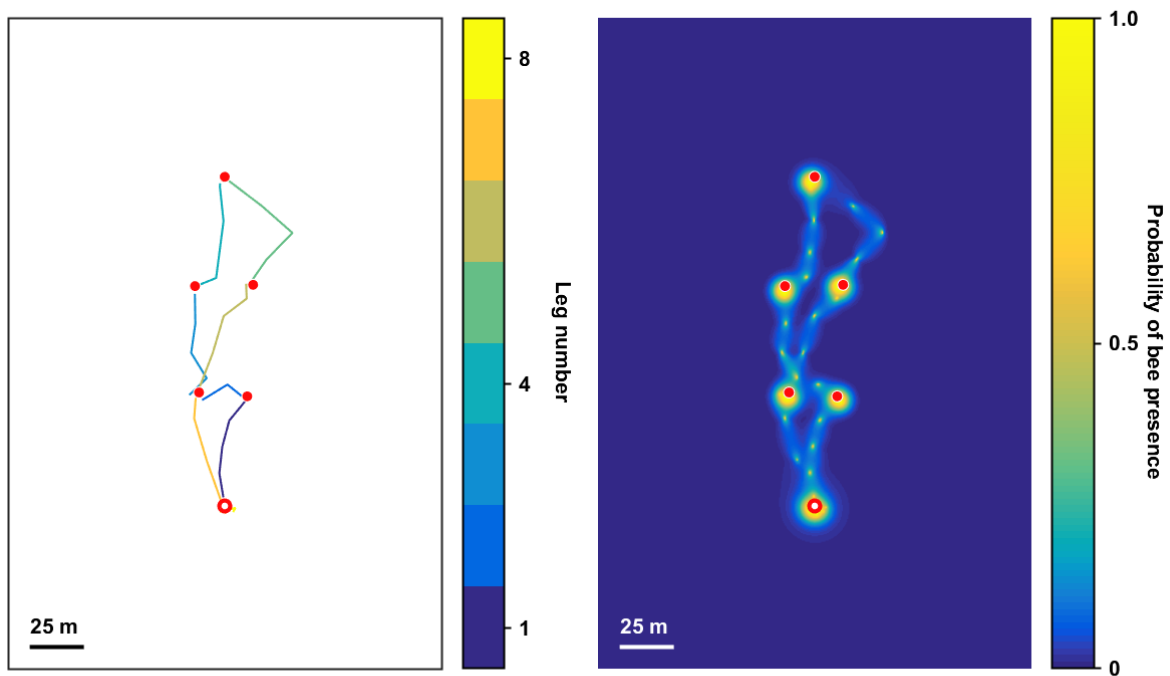


Fig S118

Bee 3, Bout 20, 26/09/2014  
Duration: 00:05:26

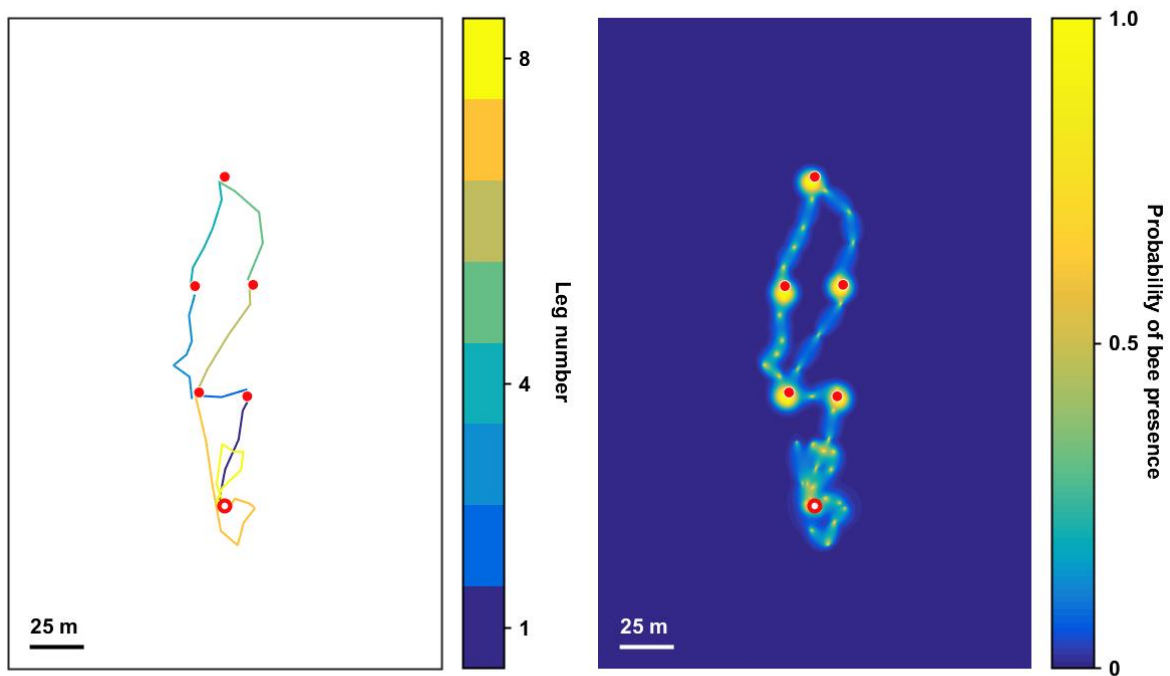


Fig S119

Bee 3, Bout 21, 26/09/2014  
Duration: 00:04:02

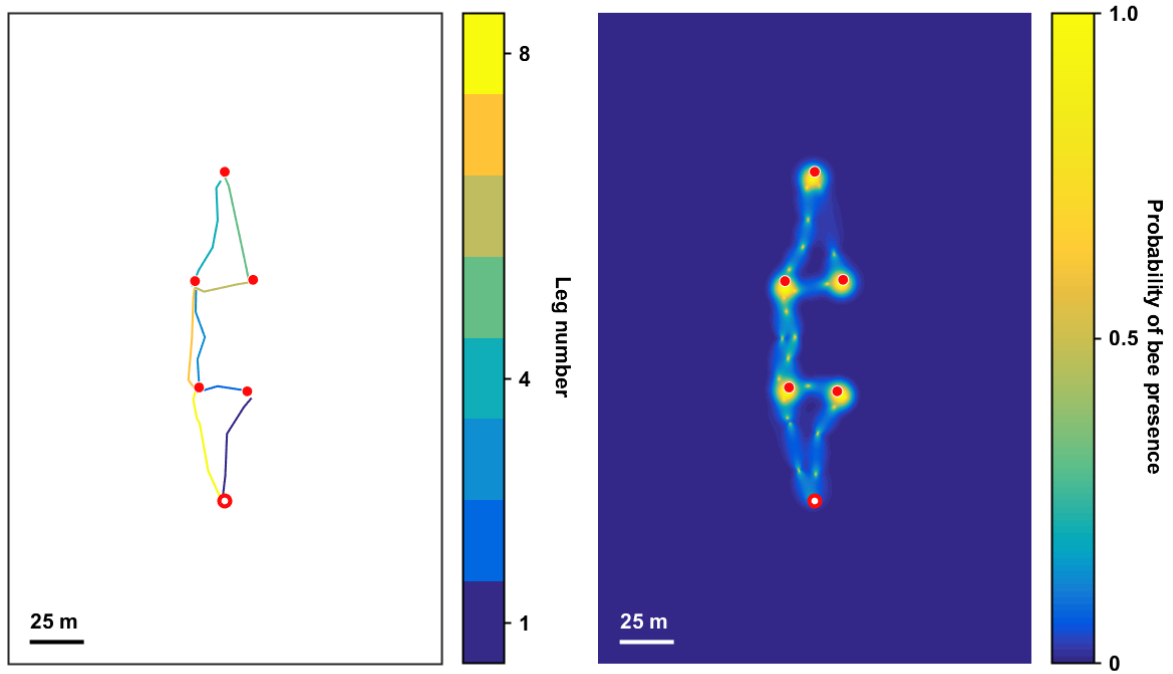


Fig S120

Bee 3, Bout 22, 26/09/2014  
Duration: 00:05:09

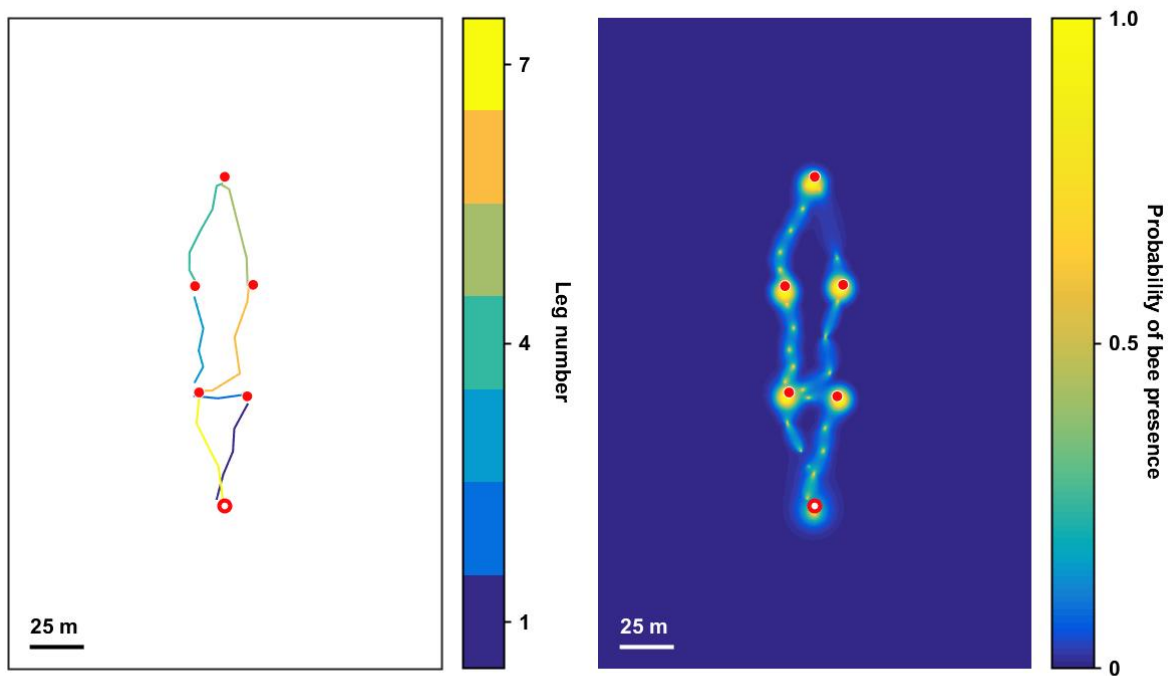


Fig S121

Bee 3, Bout 23, 26/09/2014  
Duration: 00:04:13

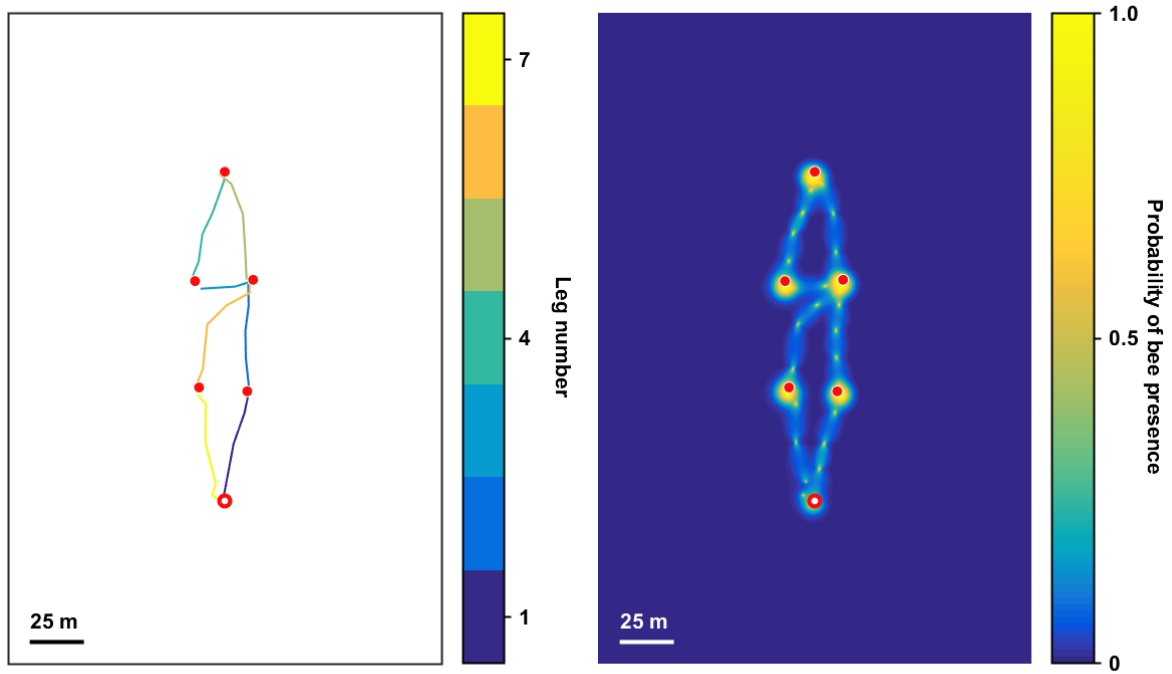




Fig S122

Bee 3, Bout 24, 26/09/2014  
Duration: 00:04:44

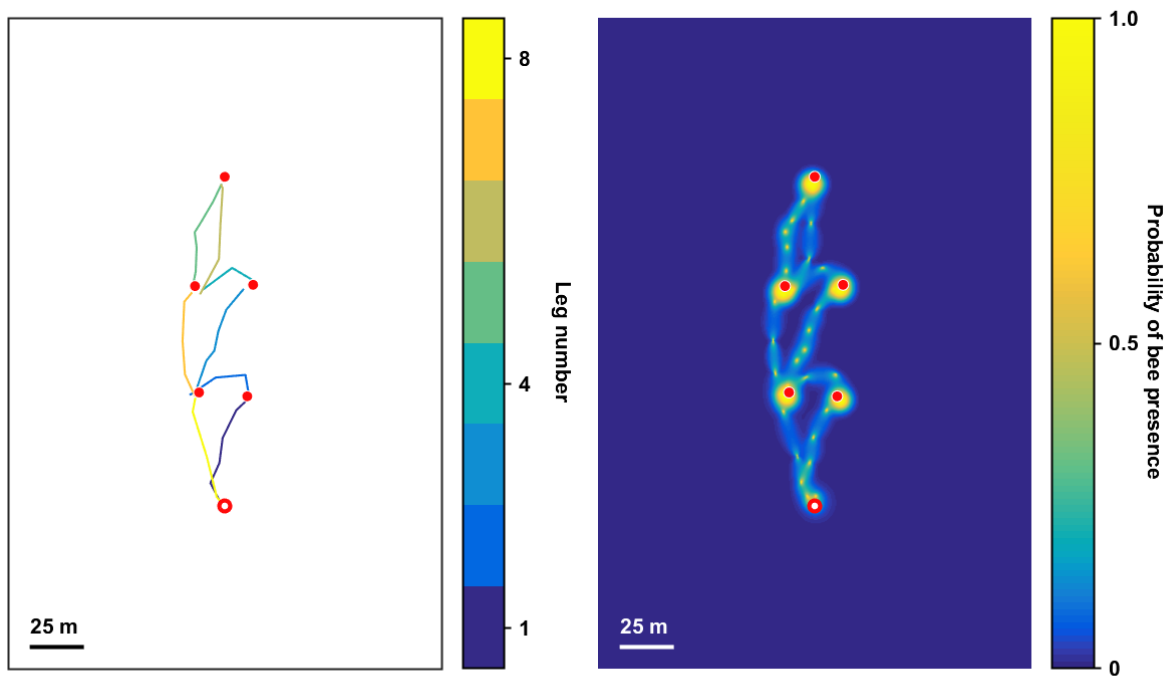


Fig S123

Bee 3, Bout 25, 26/09/2014  
Duration: 00:04:13

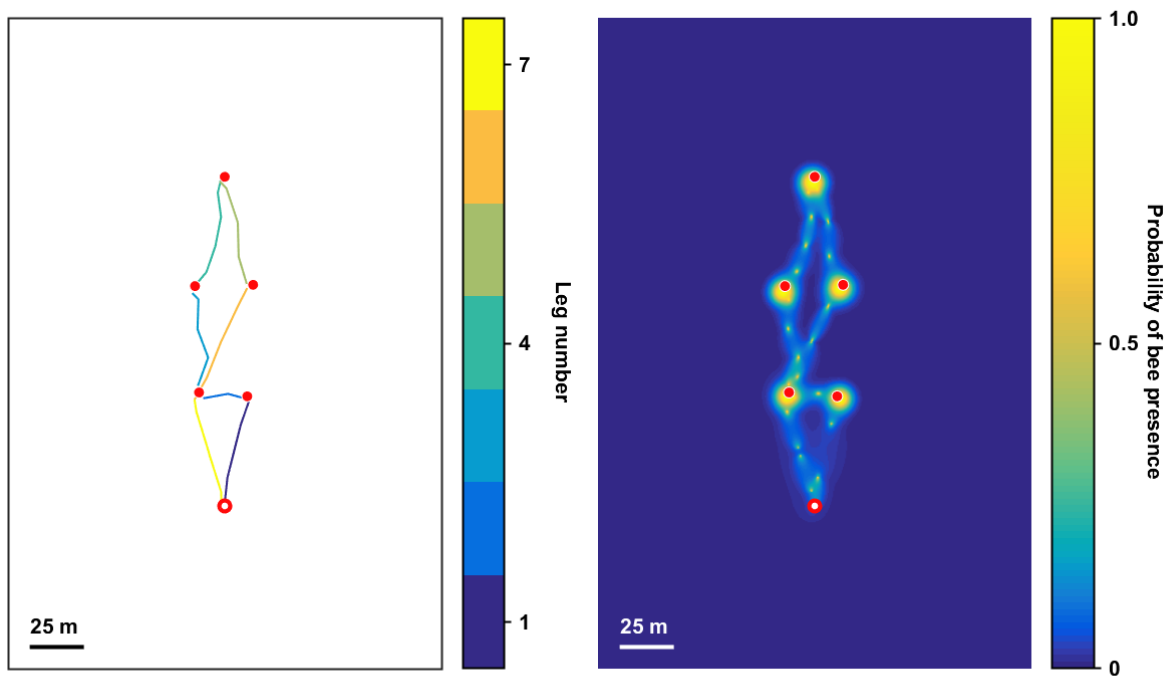


Fig S124

Bee 3, Bout 26, 26/09/2014  
Duration: 00:03:45

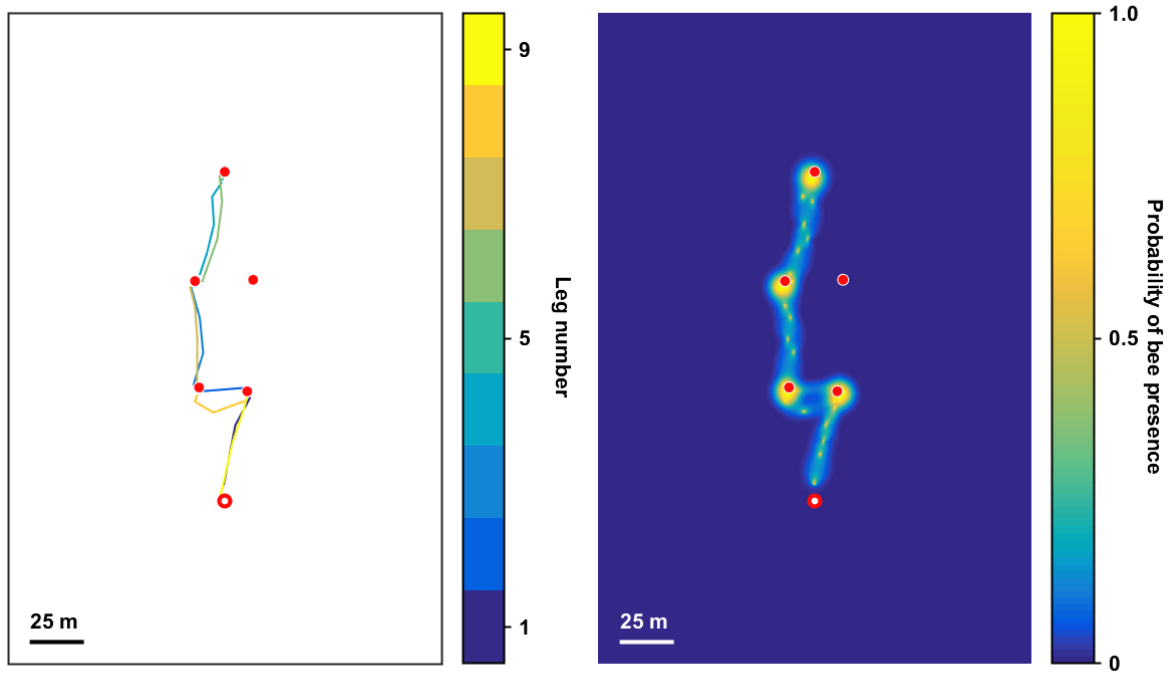


Fig S125

Bee 3, Bout 27, 26/09/2014  
Duration: 00:03:39

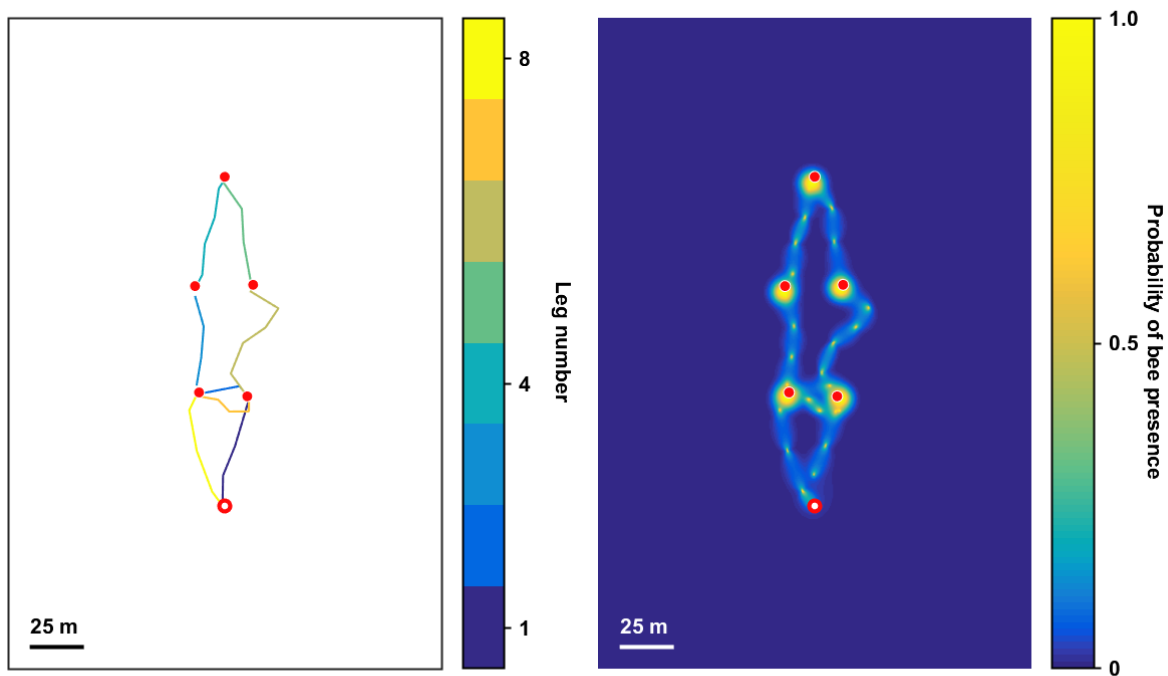


Fig S126

Bee 3, Bout 28, 26/09/2014  
Duration: 00:04:21

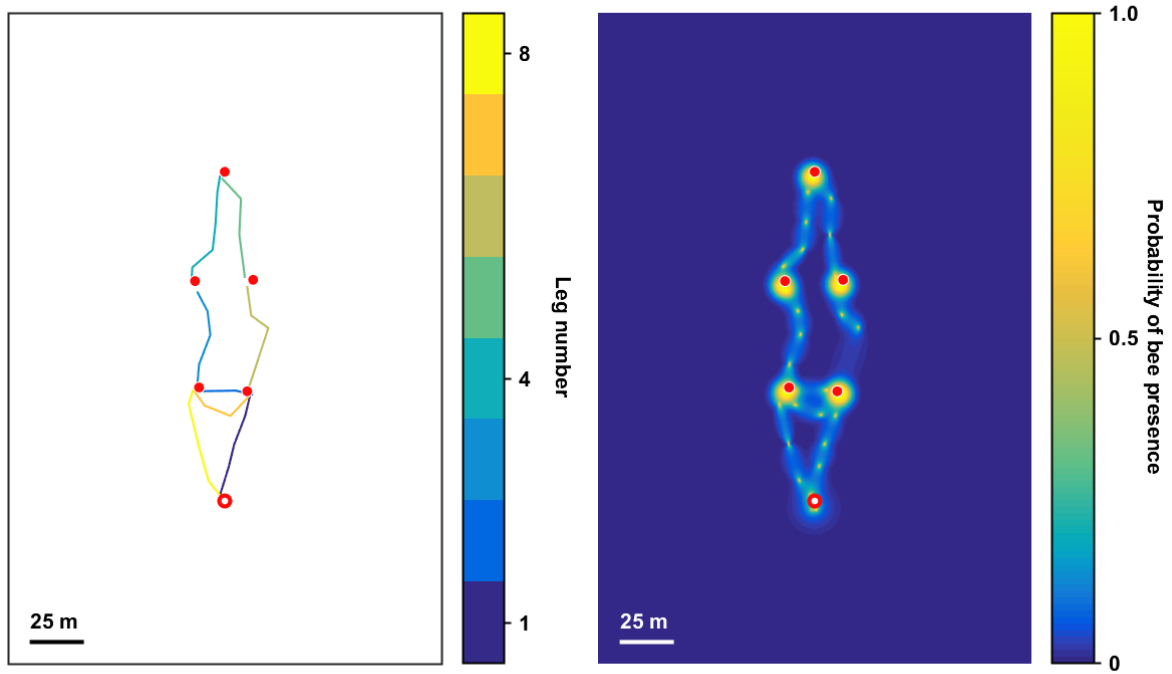


Fig S127

Bee 3, Bout 29, 26/09/2014  
Duration: 00:03:54

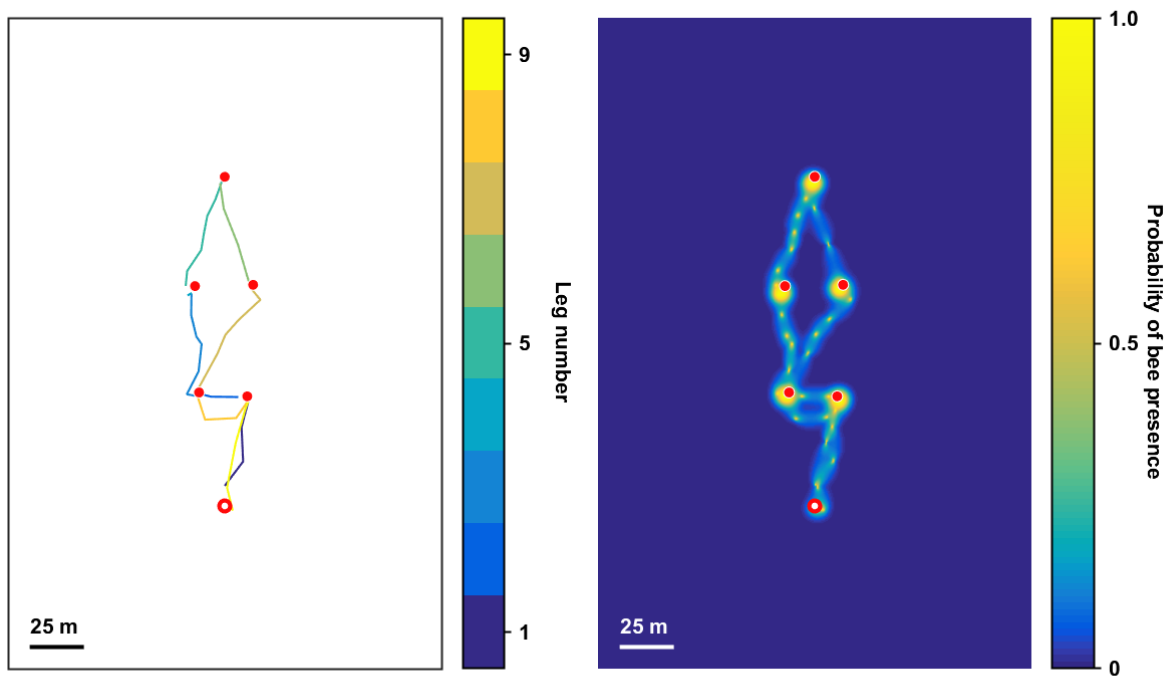


Fig S128

Bee 3, Bout 30, 26/09/2014  
Duration: 00:04:16

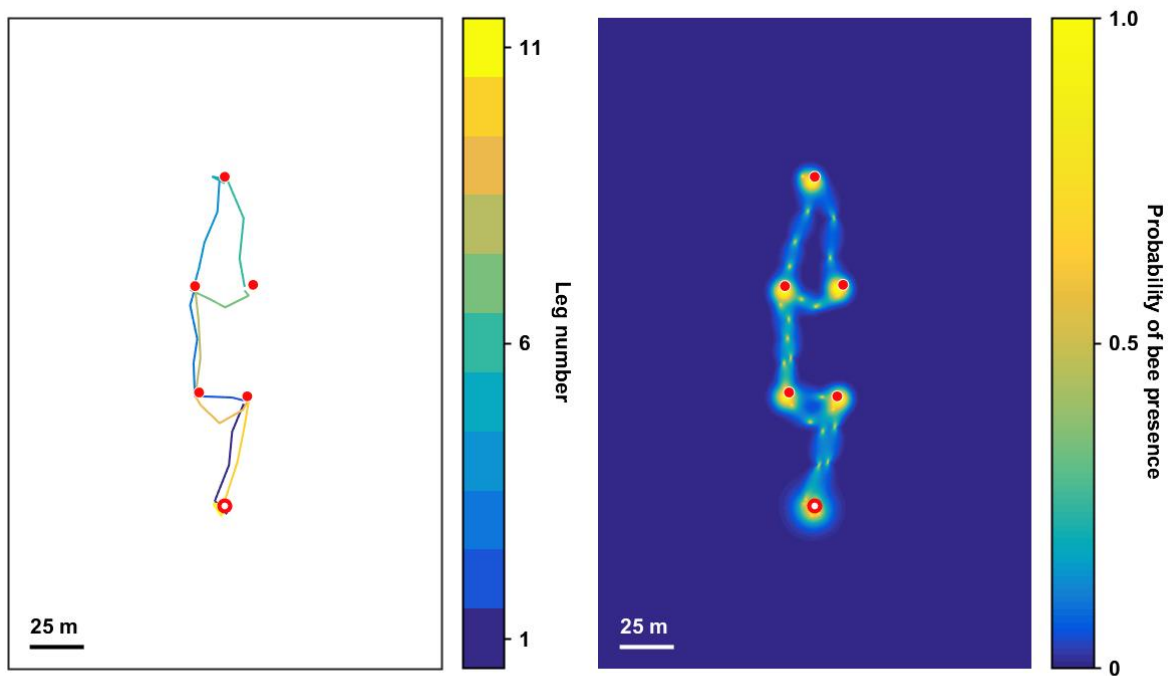


Fig S129

Bee 3, Bout 31, 26/09/2014  
Duration: 00:04:11

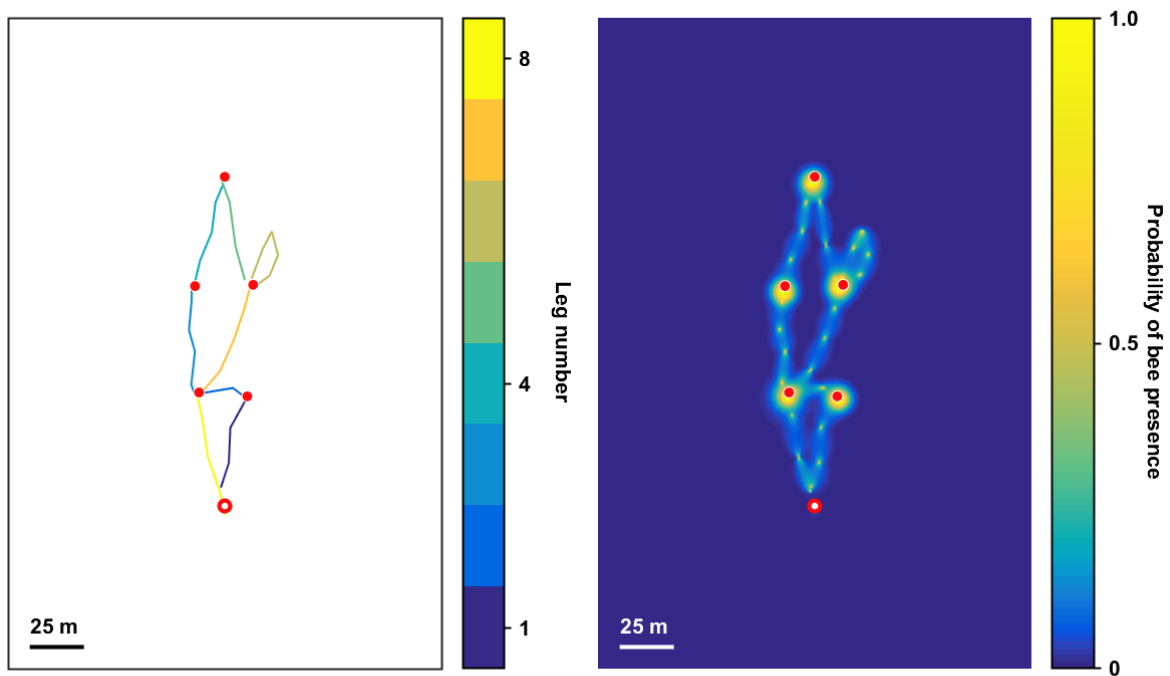




Fig S130

Bee 3, Bout 32, 26/09/2014  
Duration: 00:04:50

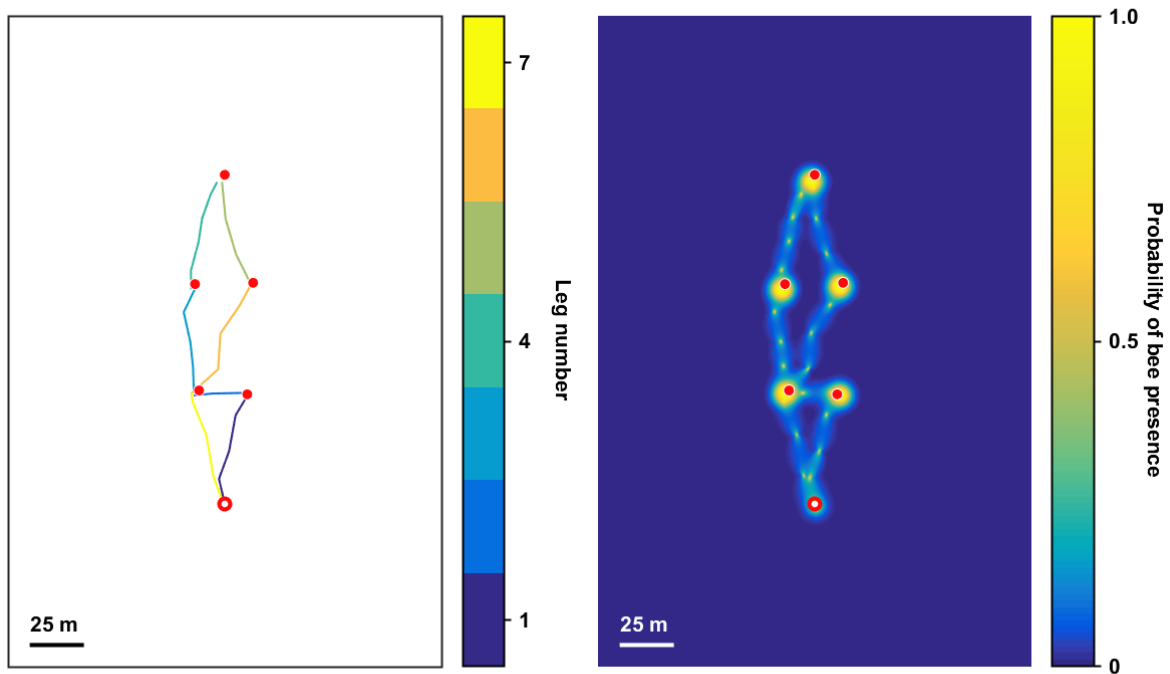


Fig S131

Bee 3, Bout 33, 26/09/2014  
Duration: 00:03:39

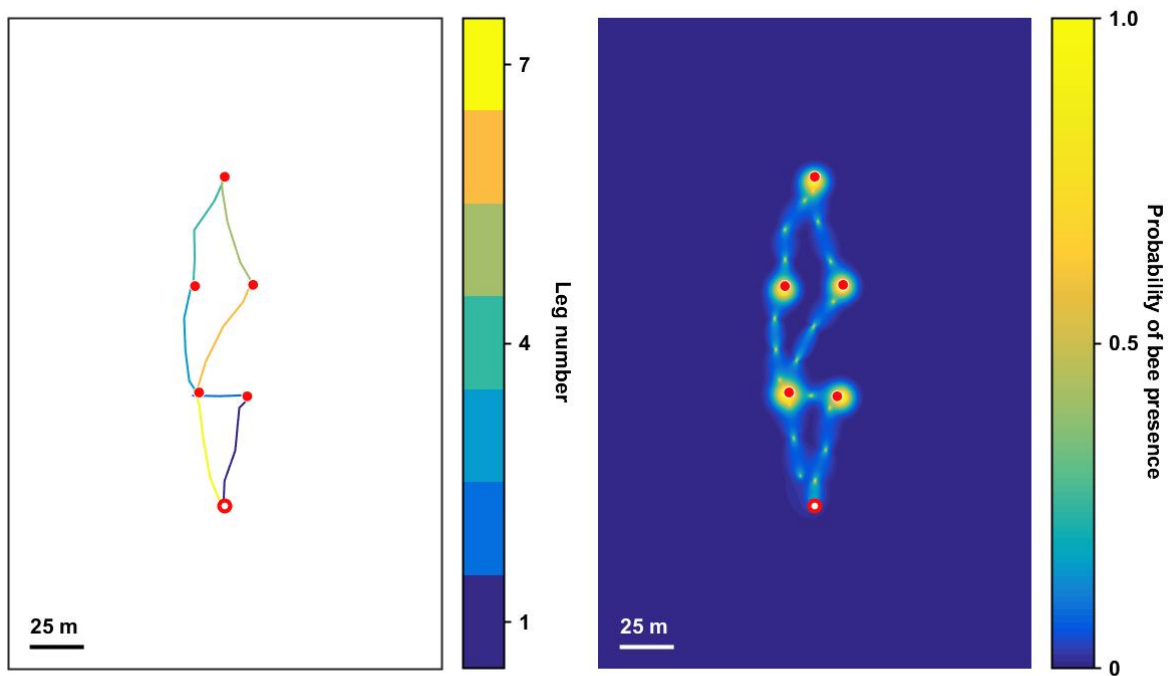


Fig S132

Bee 3, Bout 34, 26/09/2014  
Duration: 00:05:26

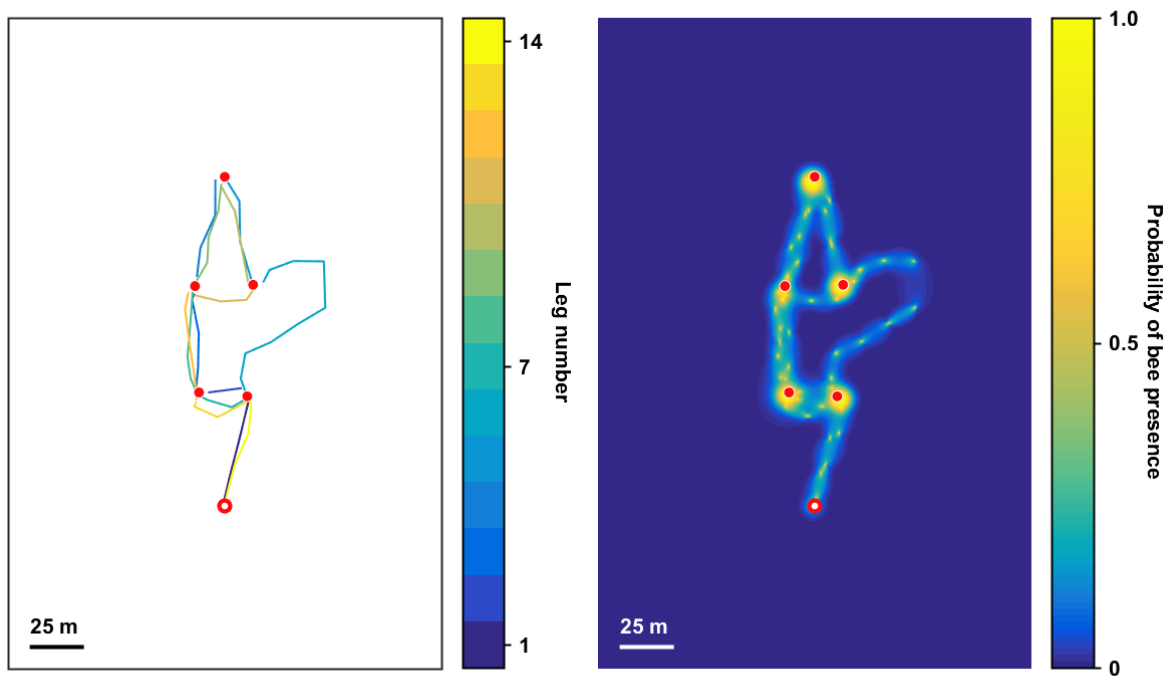


Fig S133

Bee 3, Bout 35, 26/09/2014  
Duration: 00:07:47

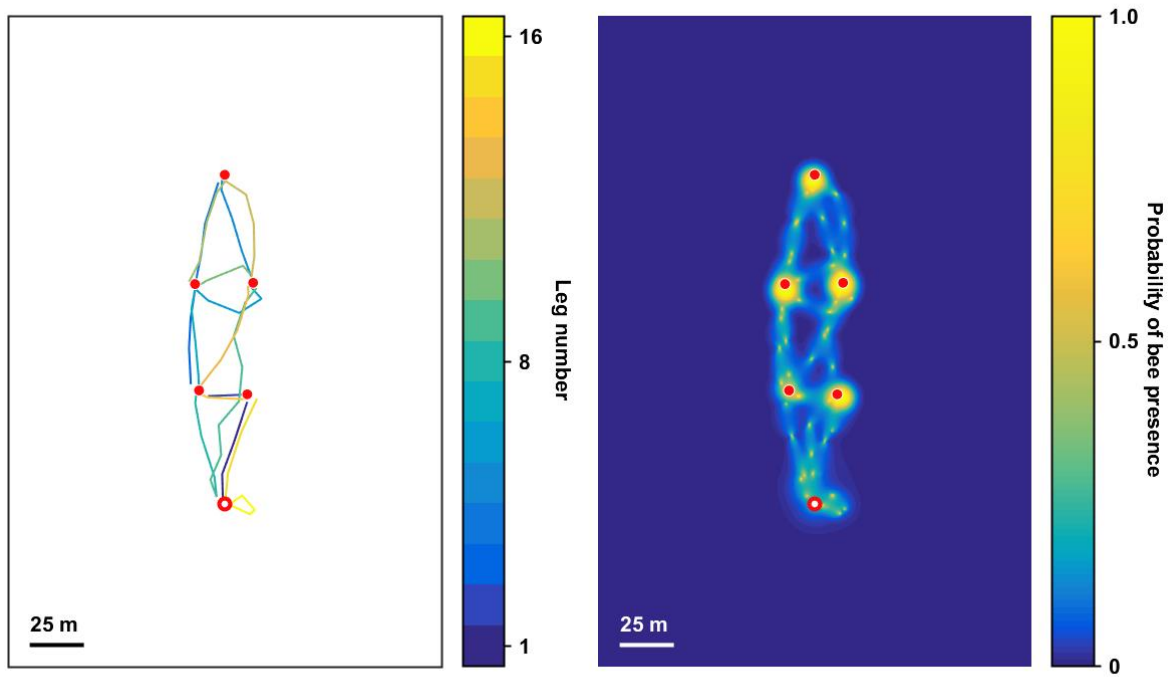


Fig S134

Bee 3, Bout 36, 26/09/2014  
Duration: 00:08:07

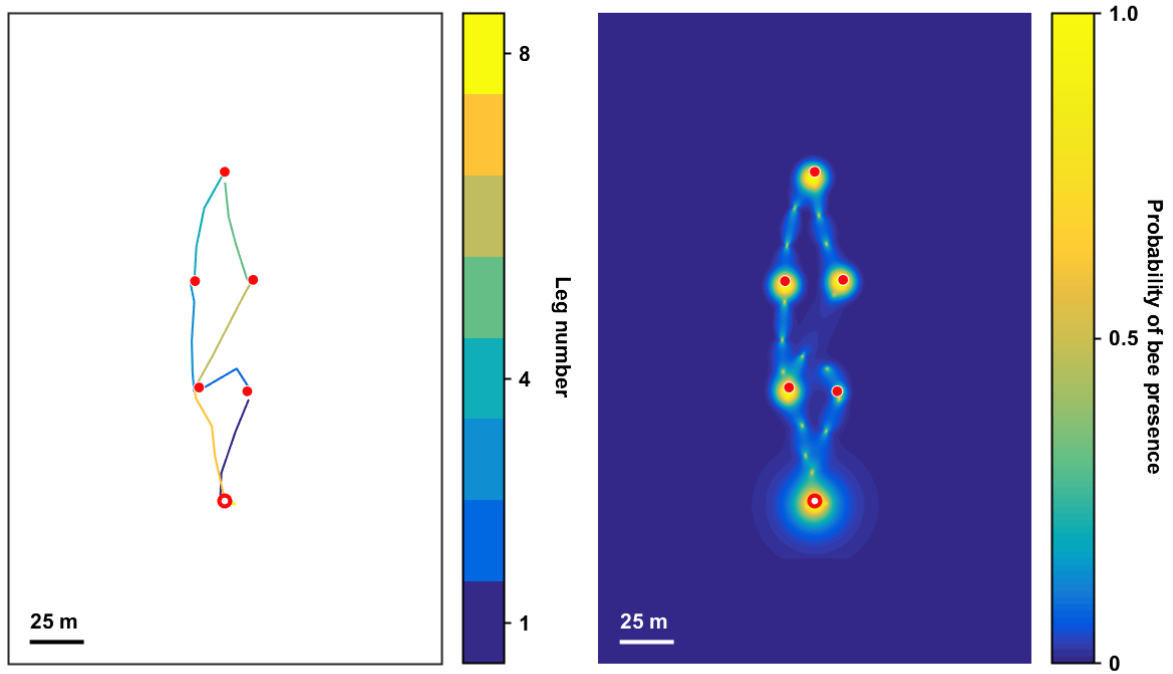


Fig S135

Bee 3, Bout 37, 26/09/2014  
Duration: 00:04:16

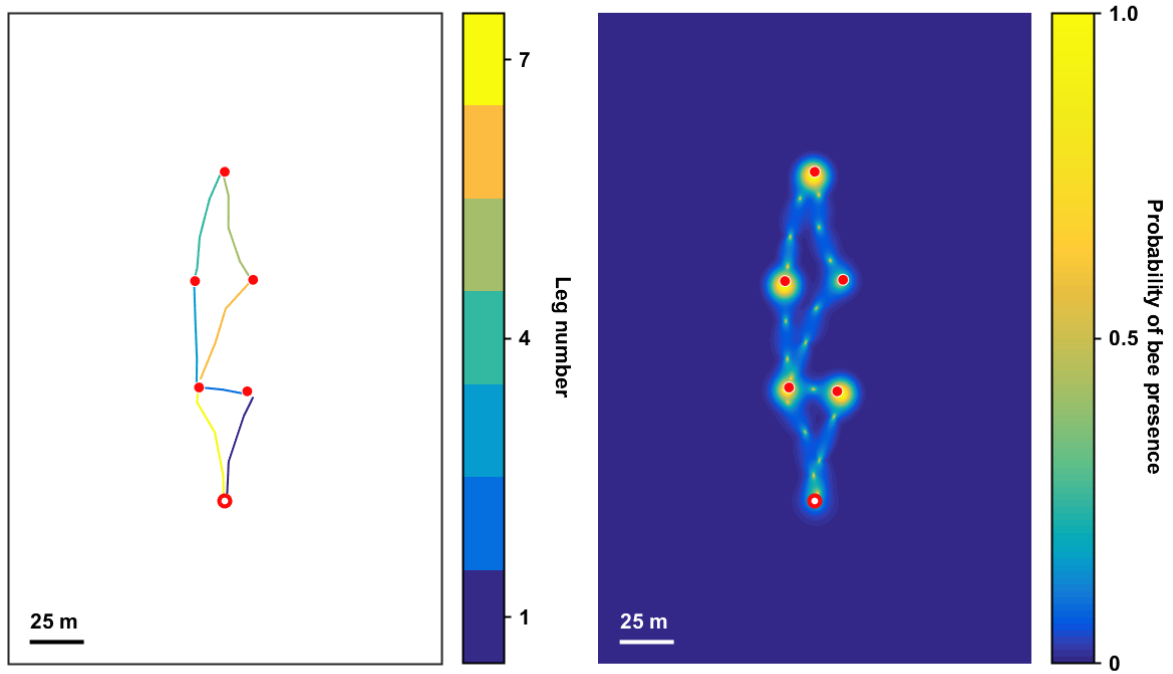


Fig S136

Bee 3, Bout 38, 26/09/2014  
Duration: 00:04:10

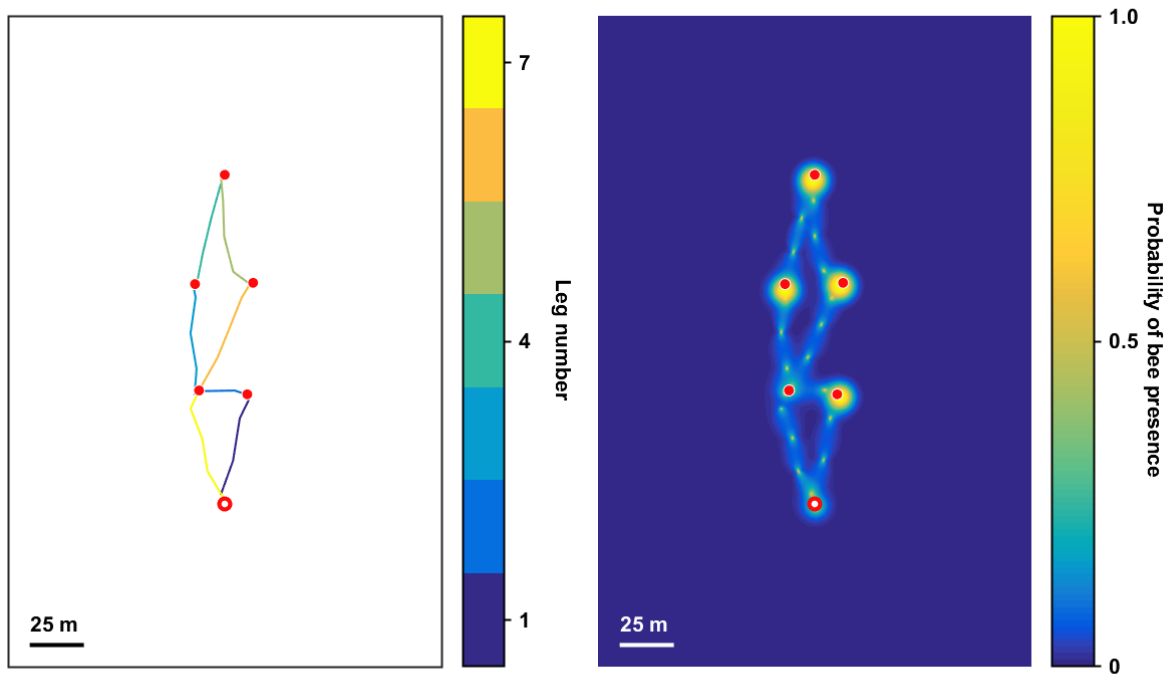


Fig S137

Bee 3, Bout 39, 27/09/2014  
Duration: 00:05:13

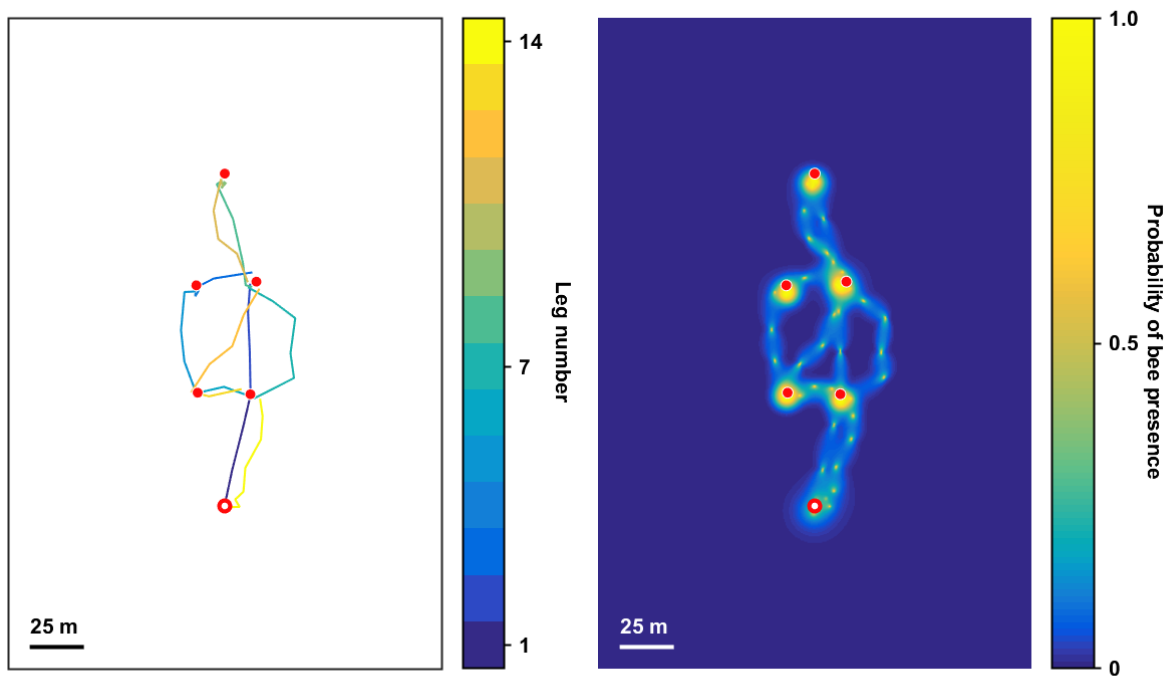




Fig S138

Bee 3, Bout 40, 27/09/2014  
Duration: 00:06:19

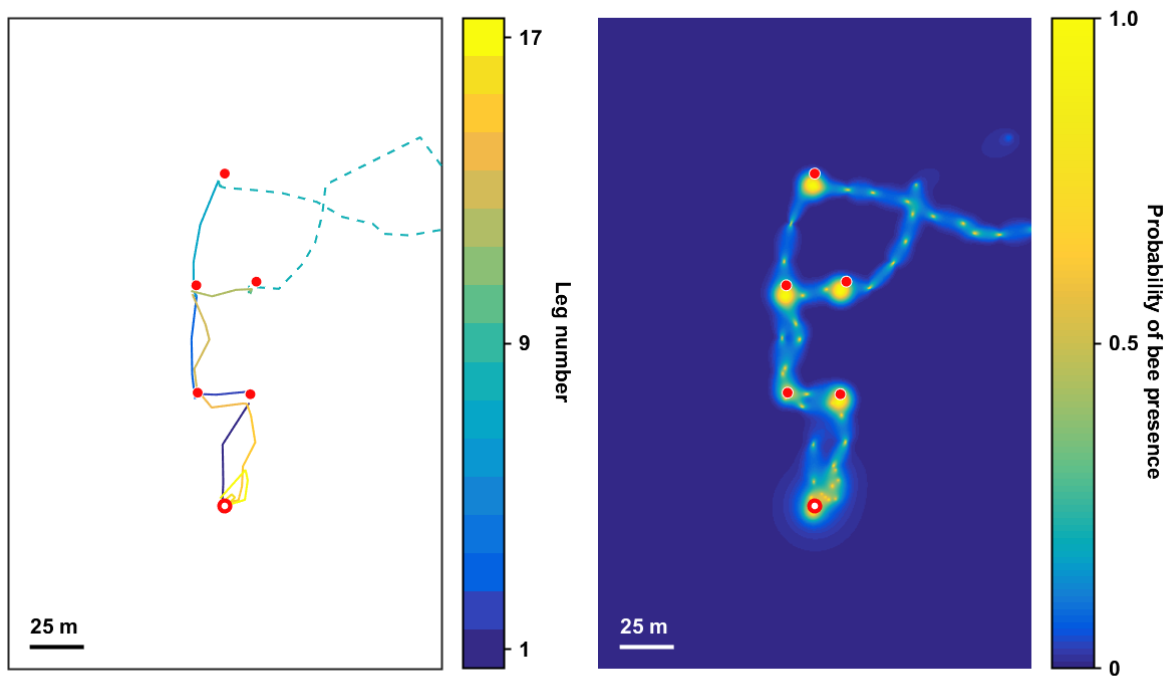


Fig S139

Bee 3, Bout 41, 27/09/2014  
Duration: 00:03:37

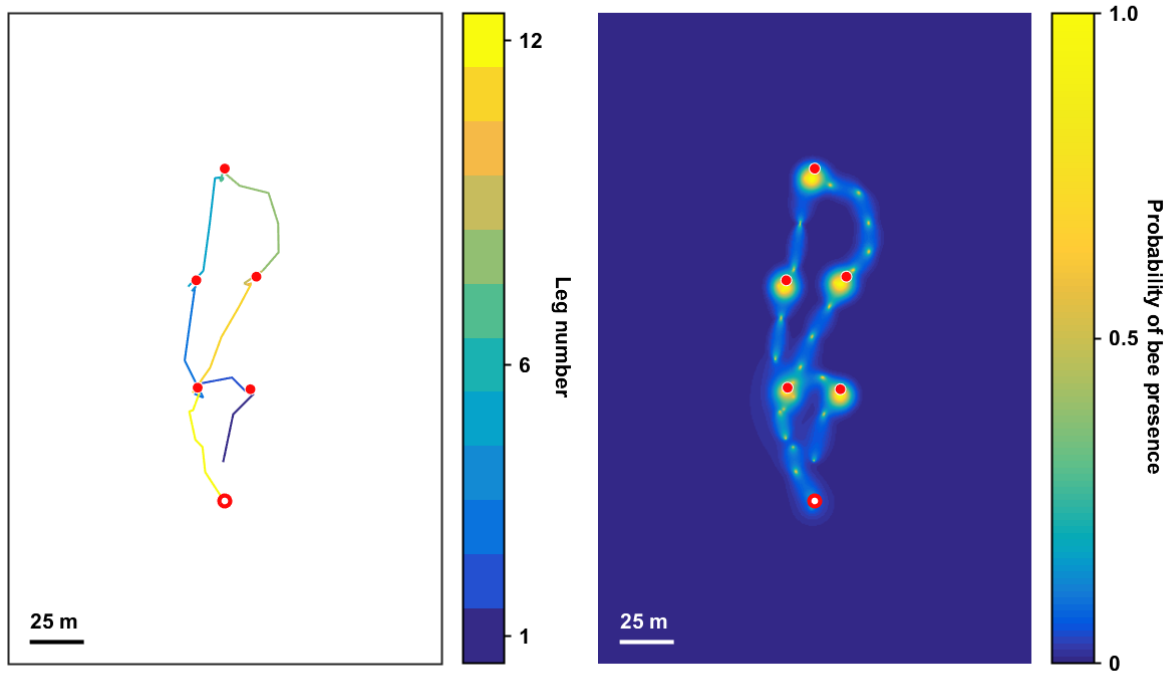


Fig S140

Bee 3, Bout 42, 27/09/2014  
Duration: 00:04:07

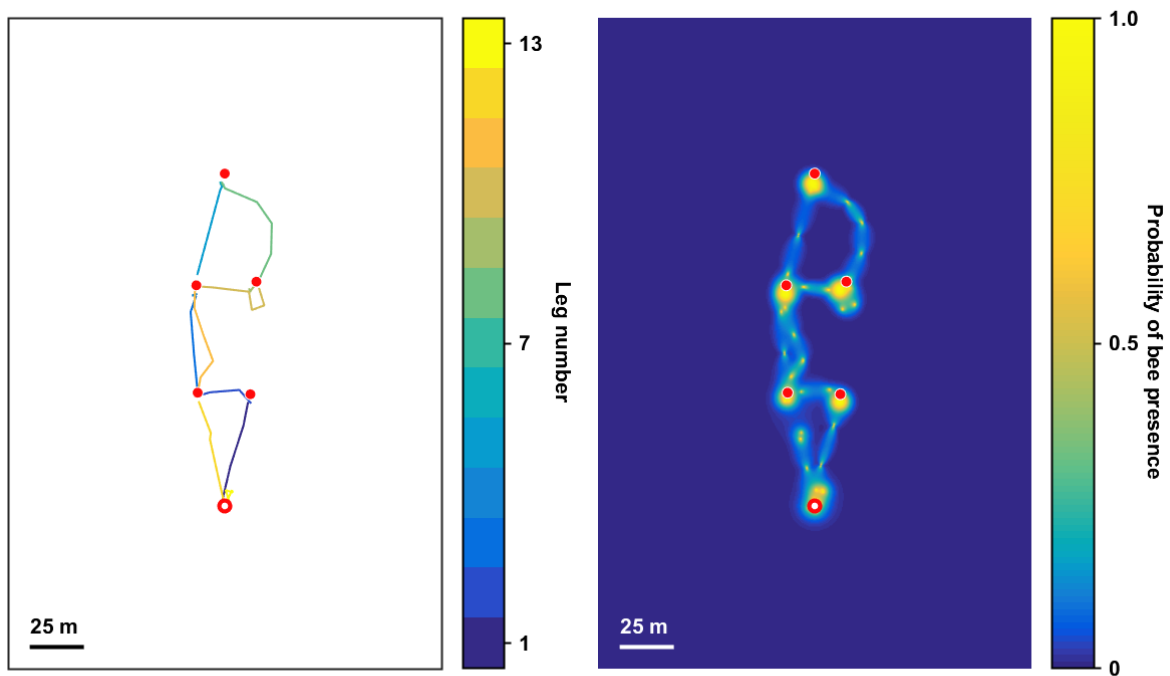


Fig S141

Bee 3, Bout 43, 27/09/2014  
Duration: 00:04:52

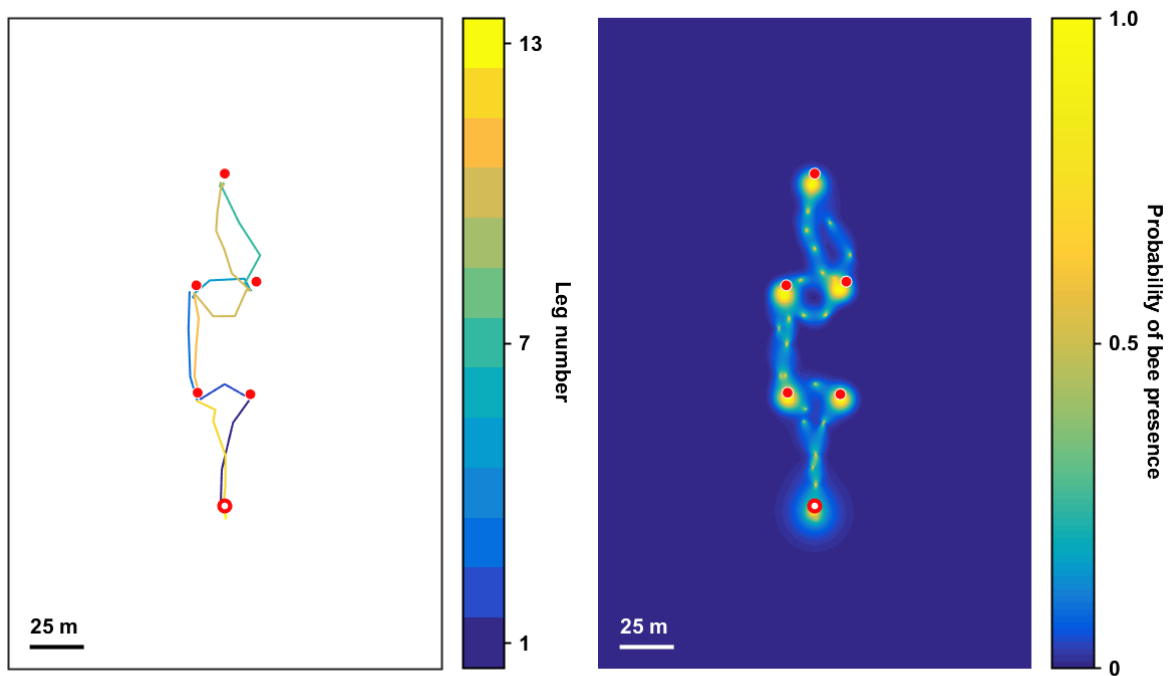


Fig S142

Bee 3, Bout 44, 27/09/2014  
Duration: 00:03:36

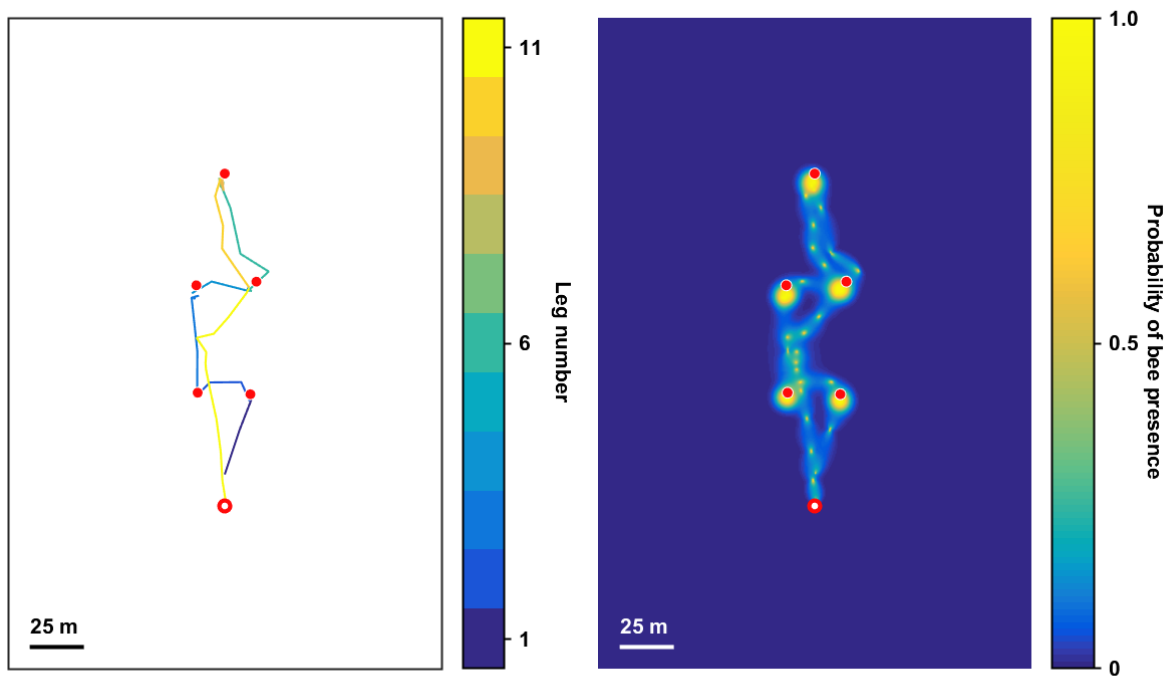


Fig S143

Bee 3, Bout 45, 27/09/2014  
Duration: 00:06:50

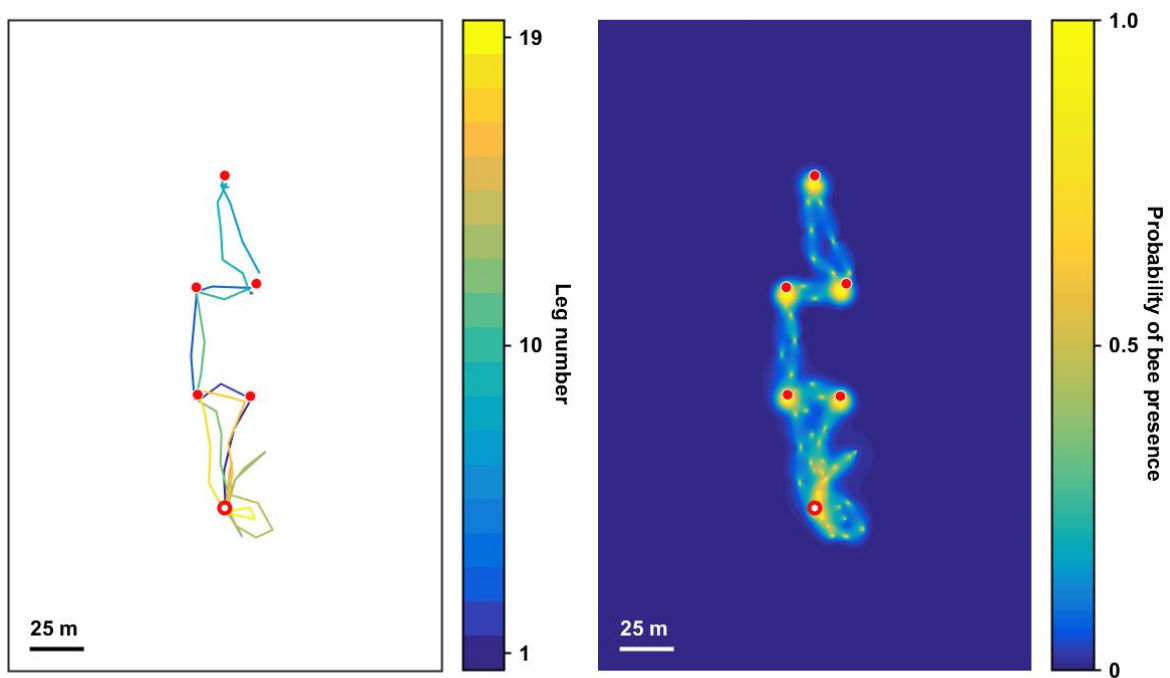


Fig S144

Bee 3, Bout 46, 27/09/2014  
Duration: 00:07:41

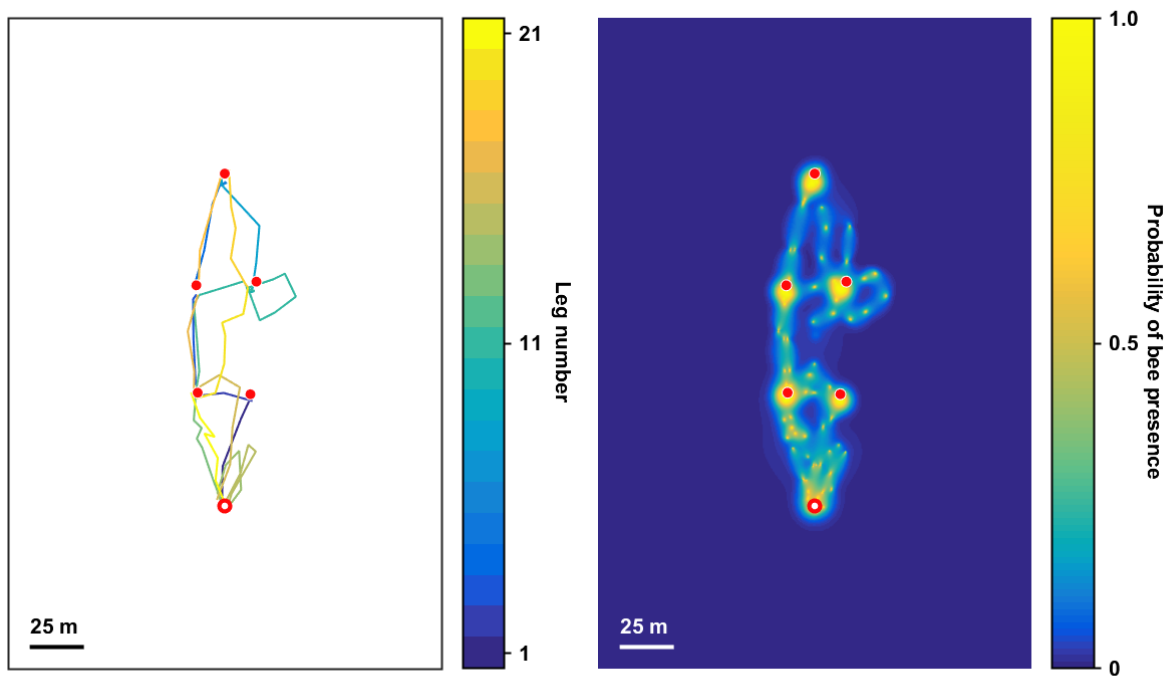


Fig S145

Bee 3, Bout 47, 27/09/2014  
Duration: 00:06:59

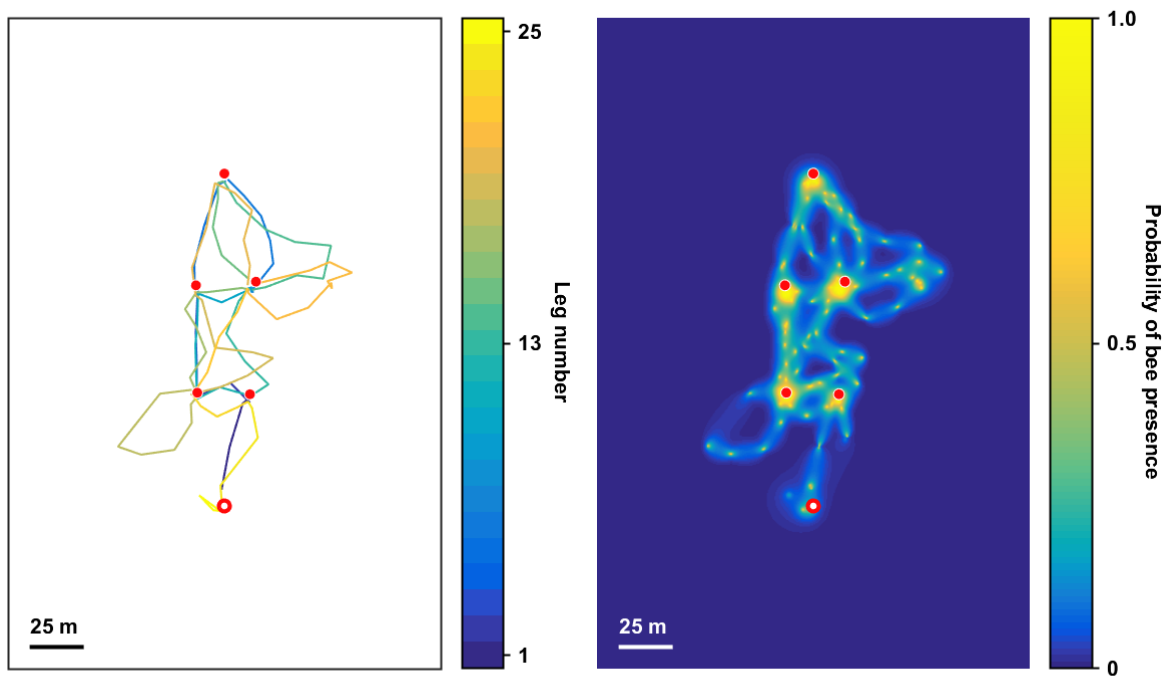




Fig S146

Bee 3, Bout 48, 27/09/2014  
Duration: 00:03:45

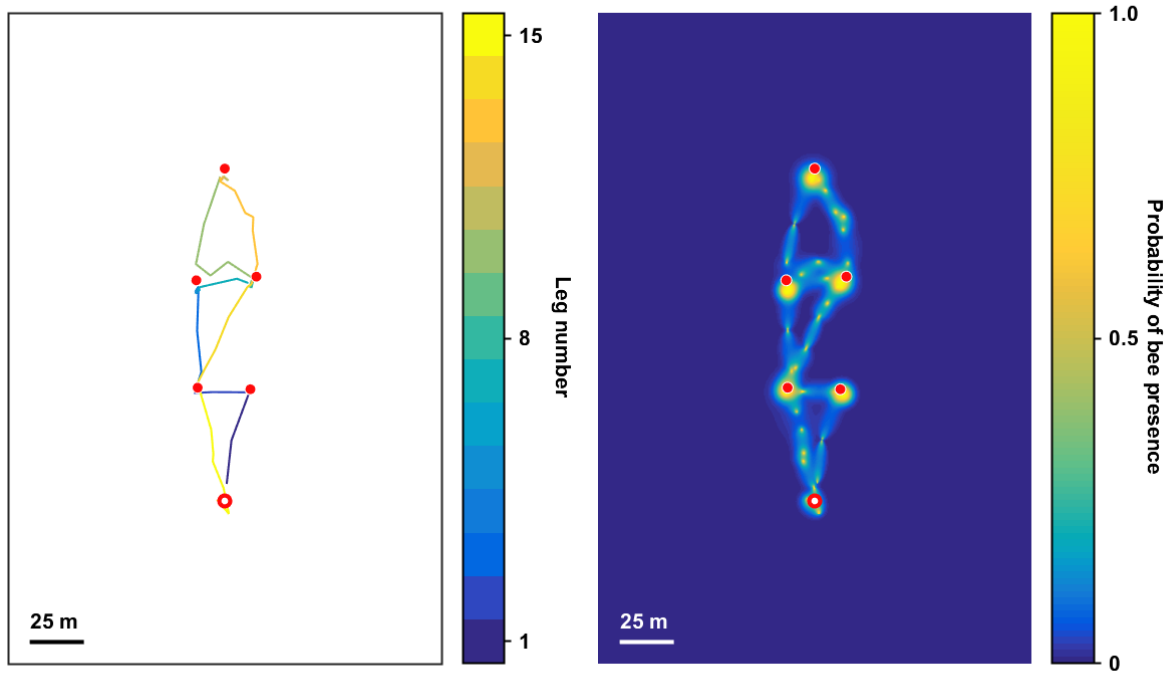
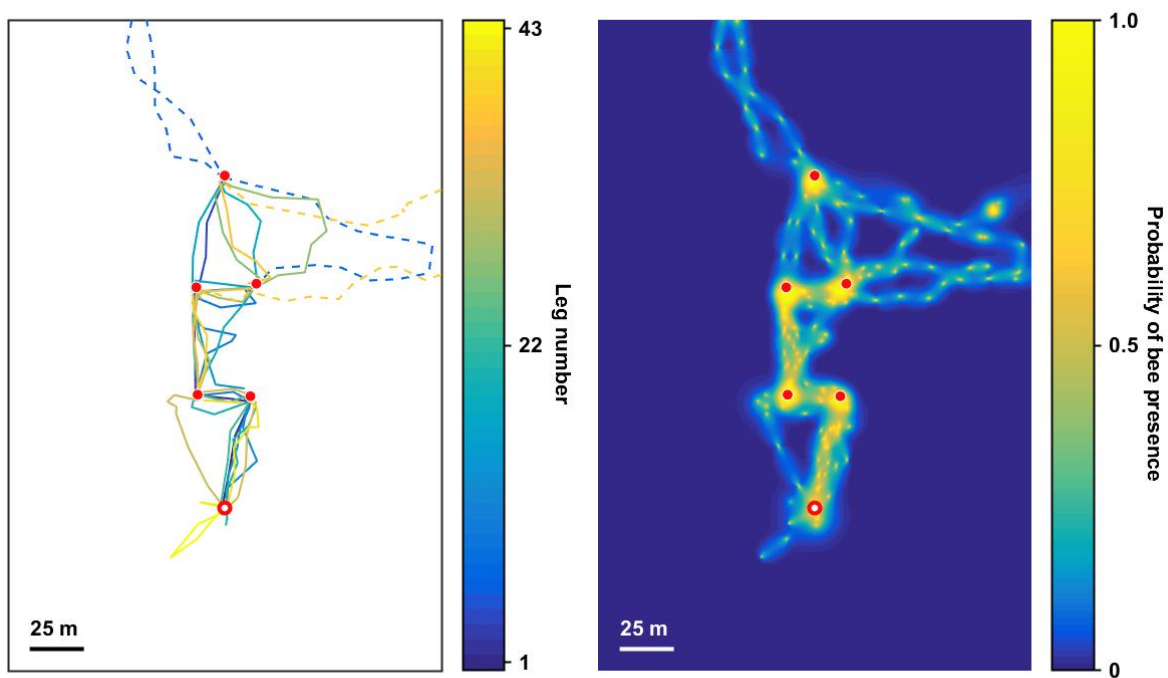


Fig S147

Bee 3, Bout 49, 27/09/2014  
Duration: 00:15:46



**Bee 3, Bout 50, 27/09/2014**  
**Duration: 00:03:57**

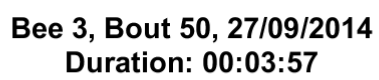


Fig S149

Bee 3, Bout 51, 27/09/2014  
Duration: 00:03:45

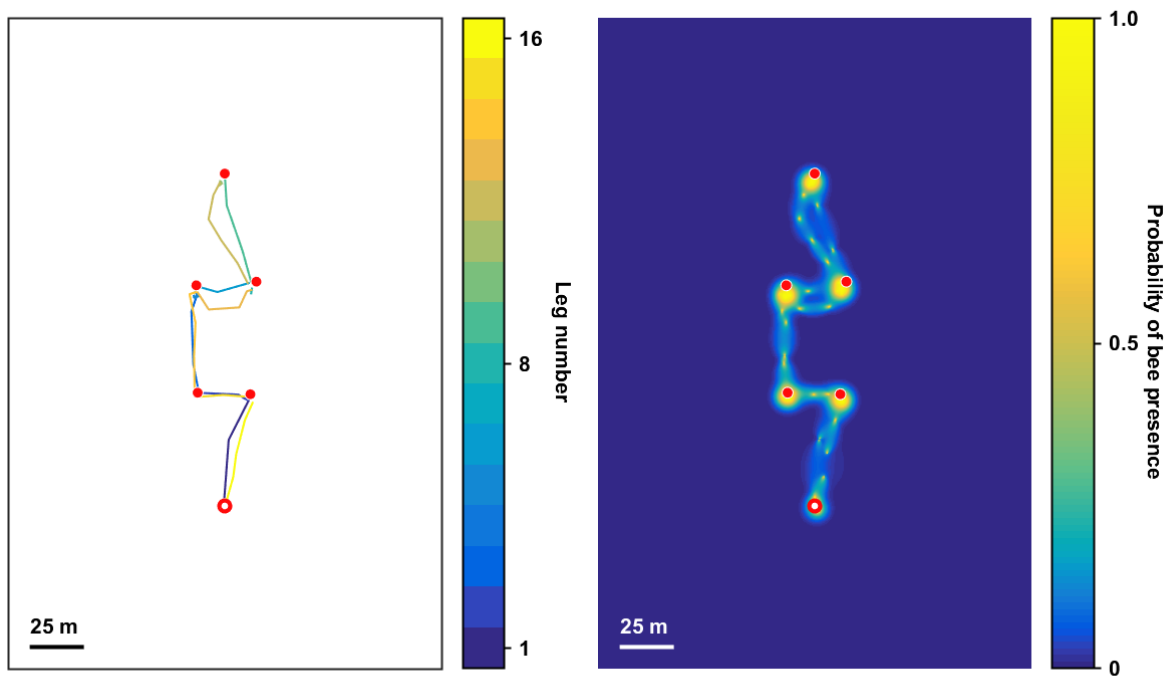


Fig S150

Bee 3, Bout 52, 27/09/2014  
Duration: 00:03:51

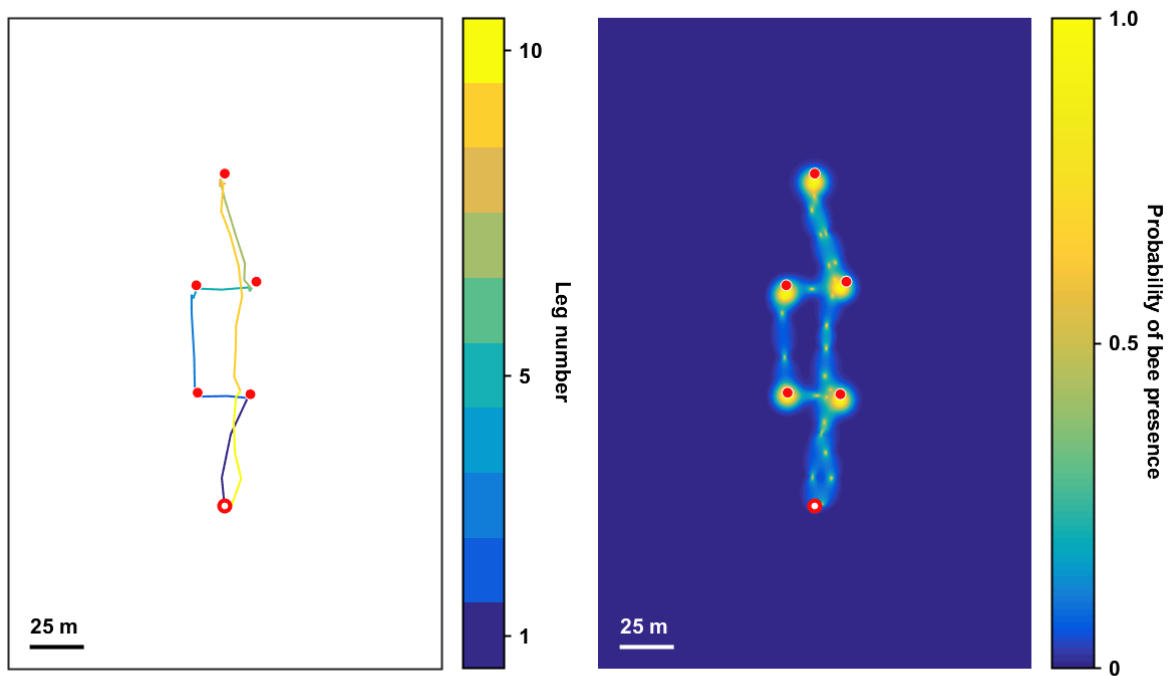


Fig S151

Bee 3, Bout 53, 27/09/2014  
Duration: 00:03:31

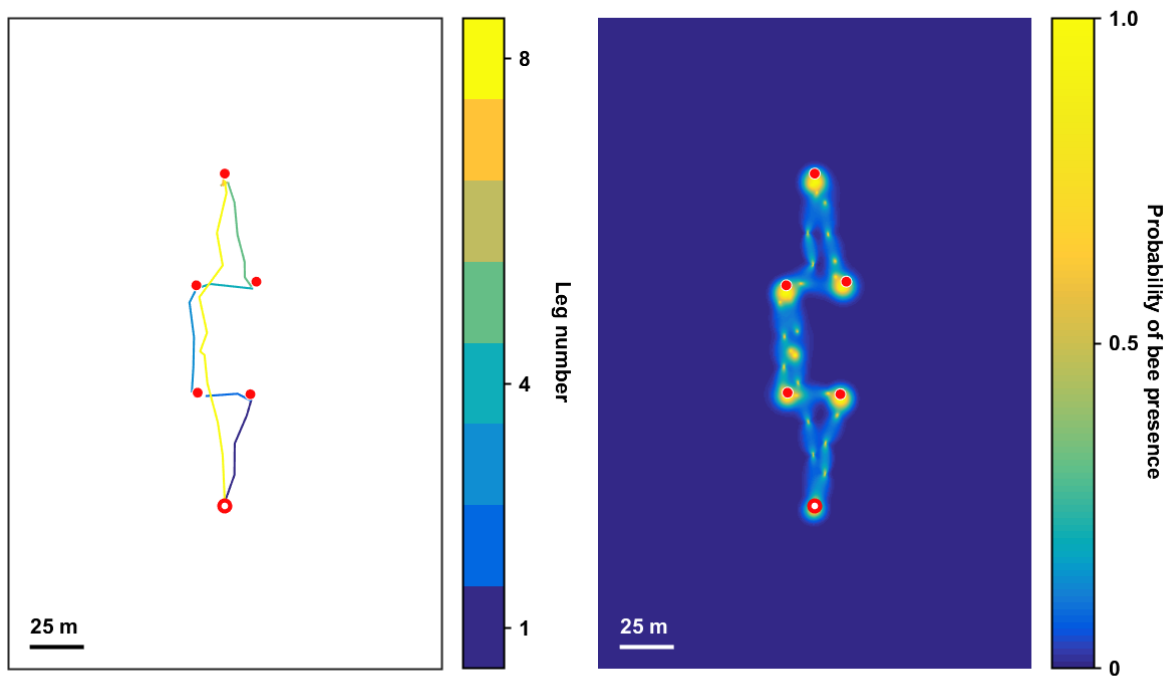


Fig S152

Bee 3, Bout 54, 27/09/2014  
Duration: 00:03:40

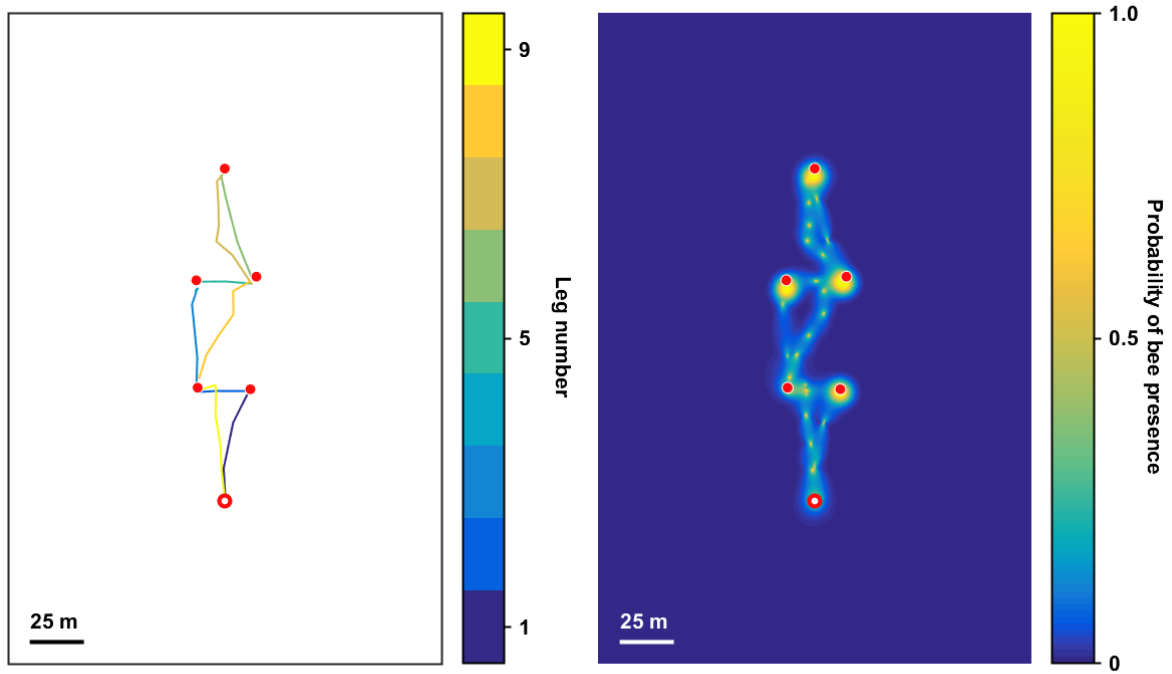


Fig S153

Bee 3, Bout 55, 27/09/2014  
Duration: 00:03:48

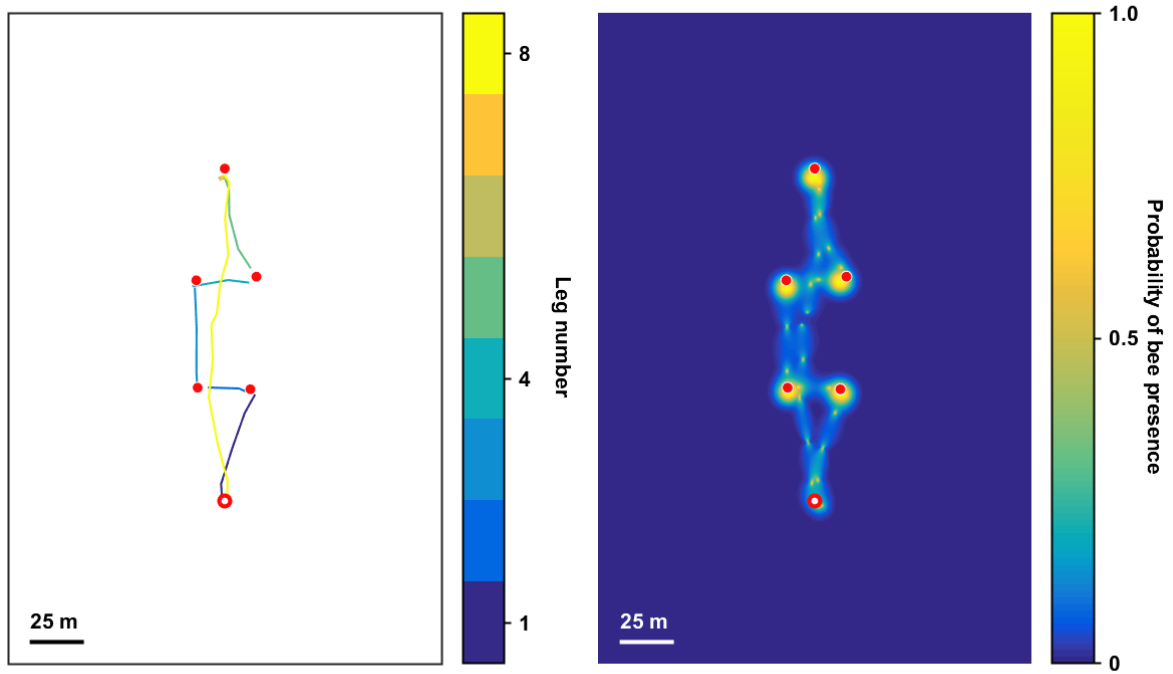




Fig S154

Bee 3, Bout 56, 27/09/2014  
Duration: 00:05:16

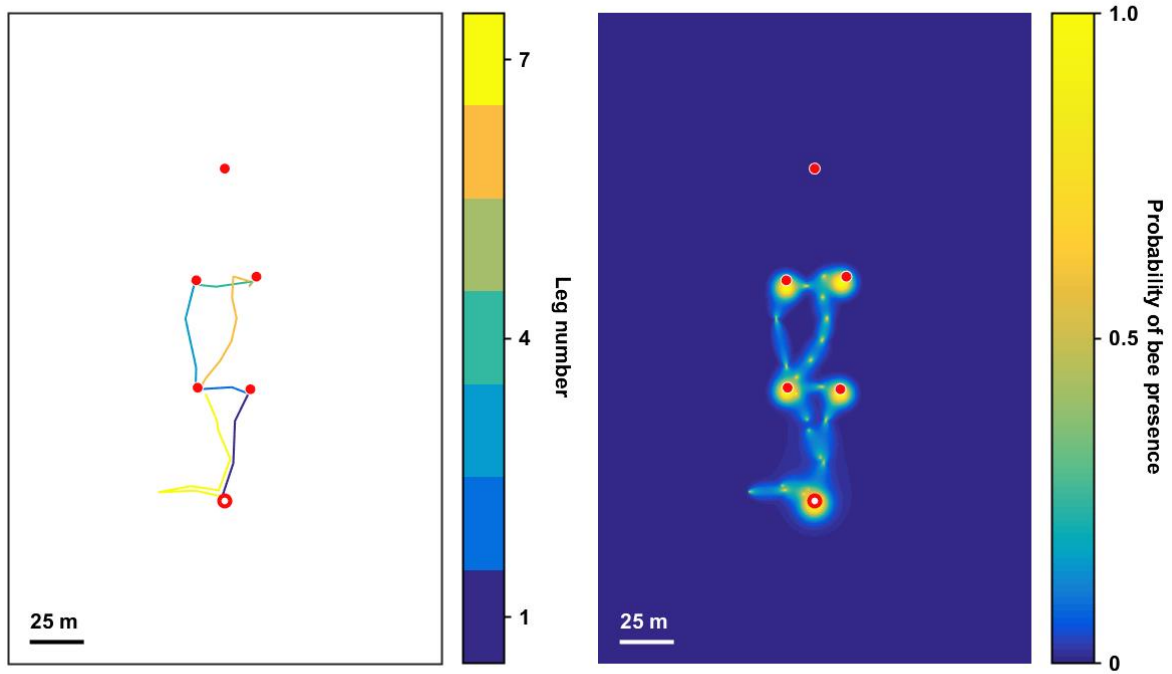


Fig S155

Bee 3, Bout 57, 27/09/2014  
Duration: 00:03:31

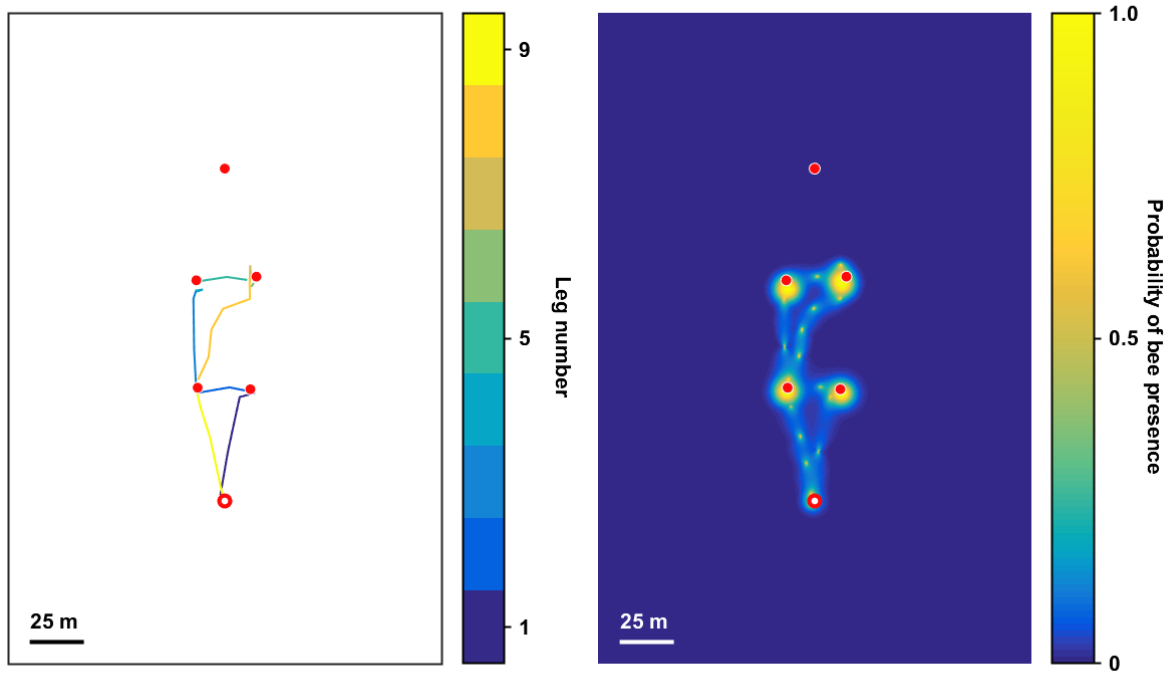


Fig S156

Bee 3, Bout 58, 27/09/2014  
Duration: 00:03:39

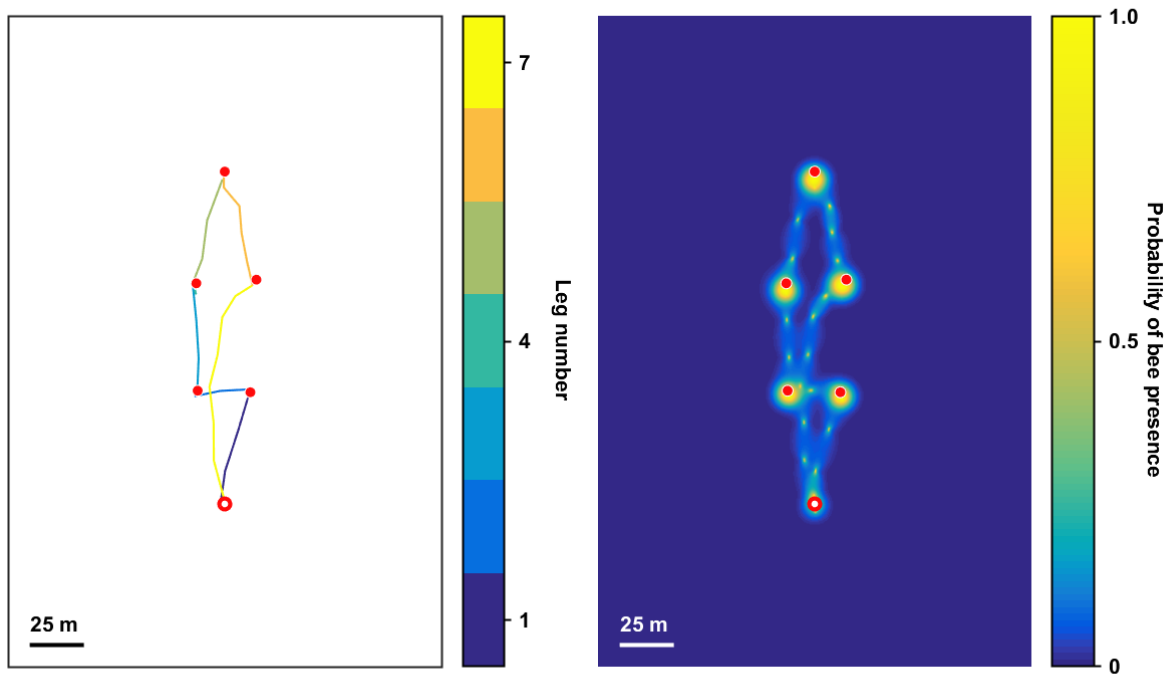


Fig S157

Bee 3, Bout 59, 27/09/2014  
Duration: 00:11:23

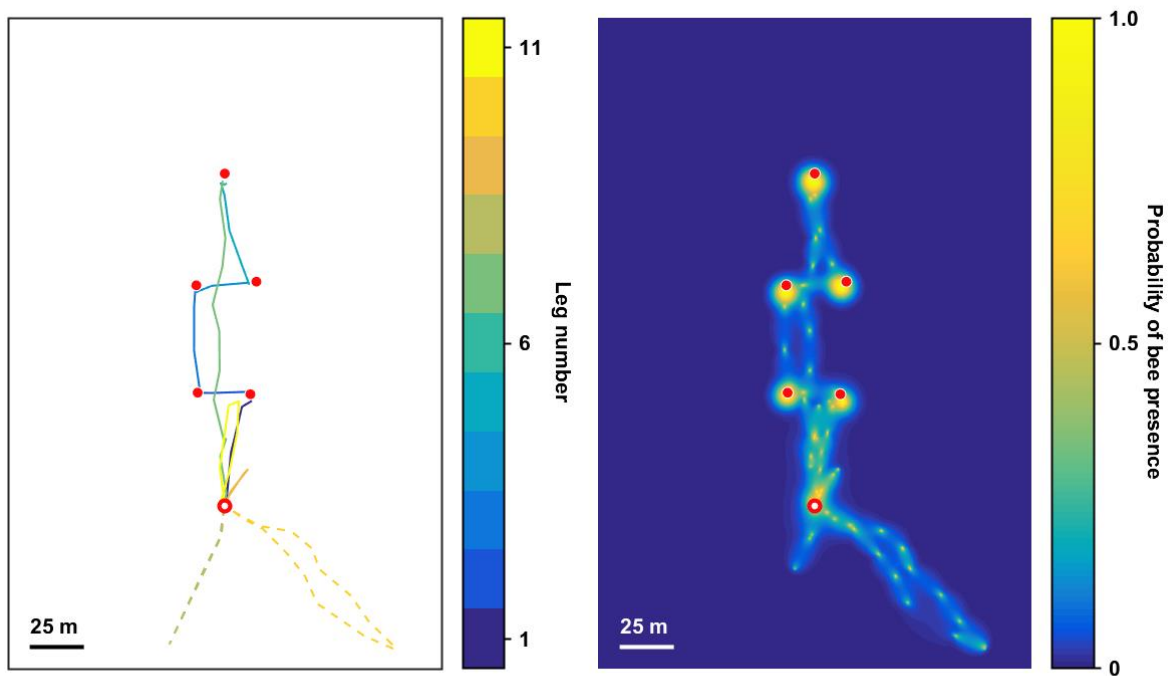


Fig S158

Bee 3, Bout 60, 27/09/2014  
Duration: 00:03:17

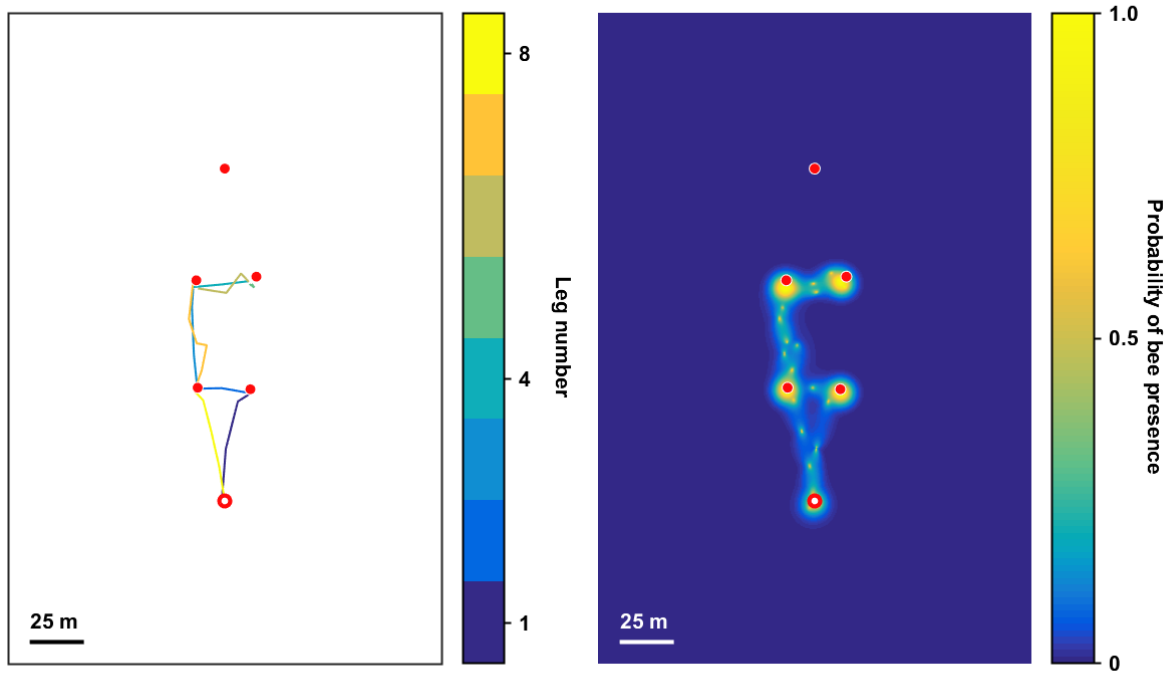


Fig S159

Bee 3, Bout 61, 27/09/2014  
Duration: 00:03:54

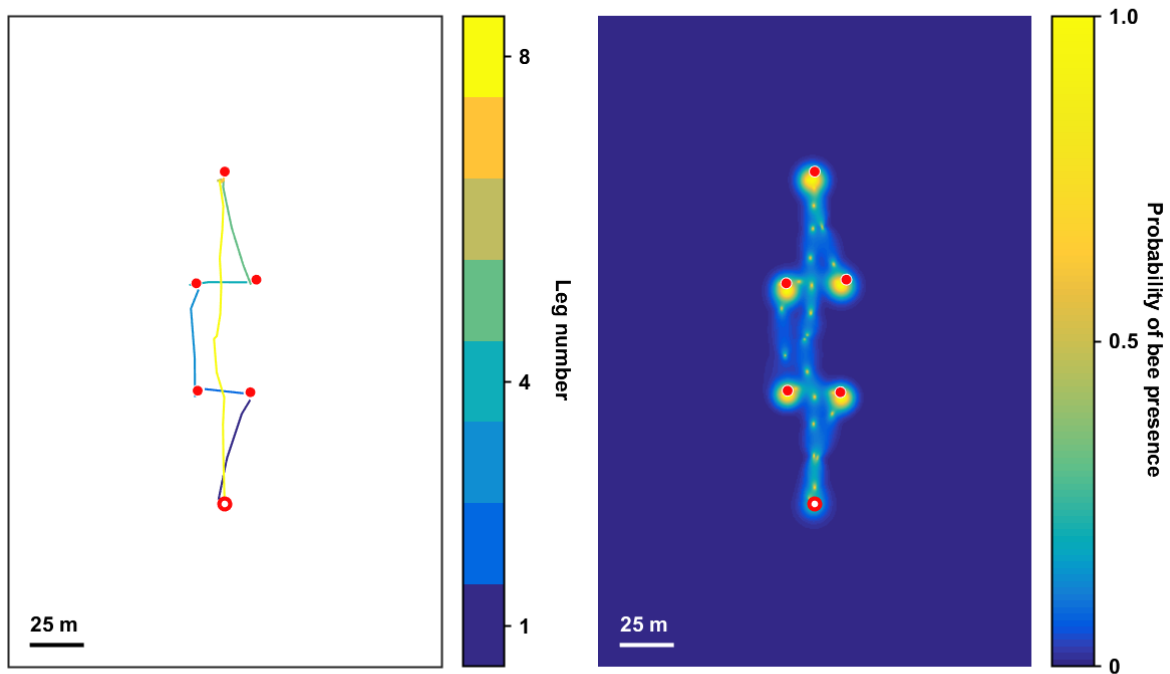


Fig S160

Bee 4, Bout 1, 28/09/2014  
Duration: 00:25:29

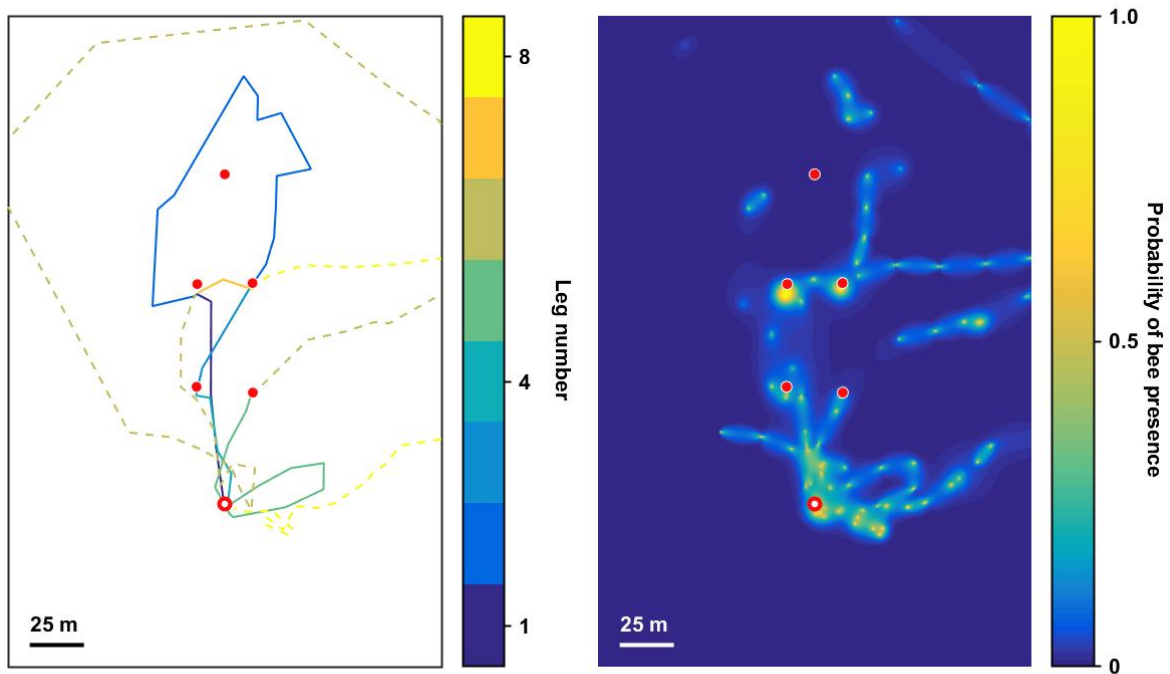


Fig S162

Bee 4, Bout 2, 28/09/2014  
Duration: 00:18:06

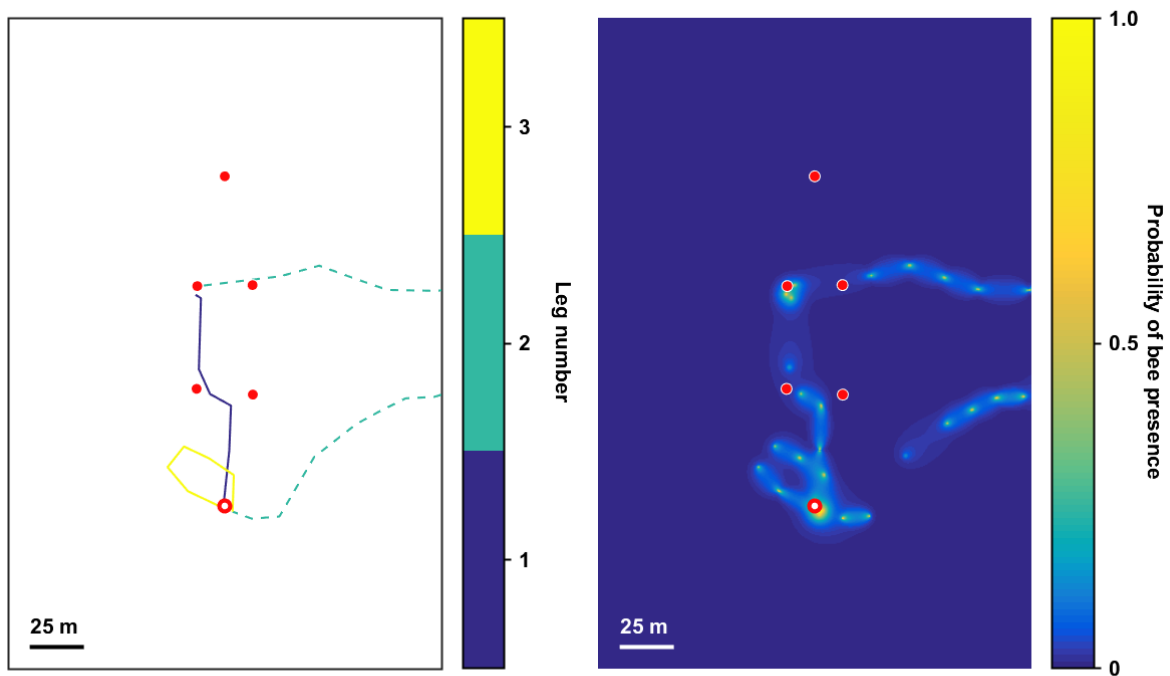




Fig S163

Bee 4, Bout 3, 28/09/2014  
Duration: 00:17:22

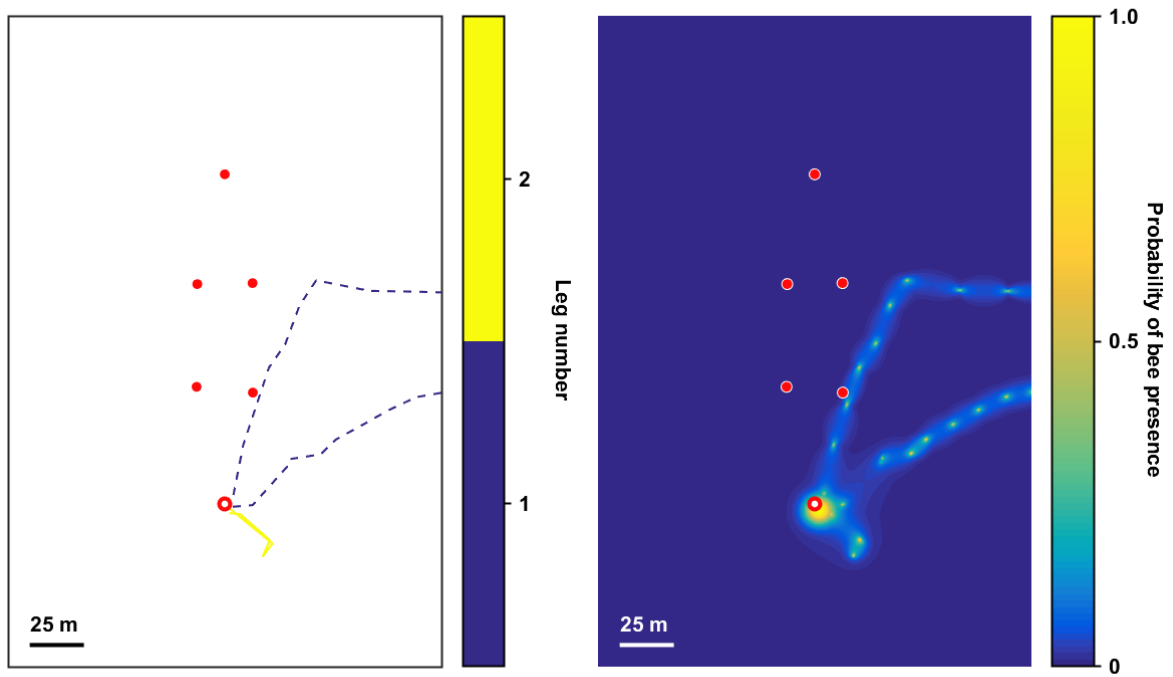


Fig S164

Bee 4, Bout 4, 28/09/2014  
Duration: 00:16:48

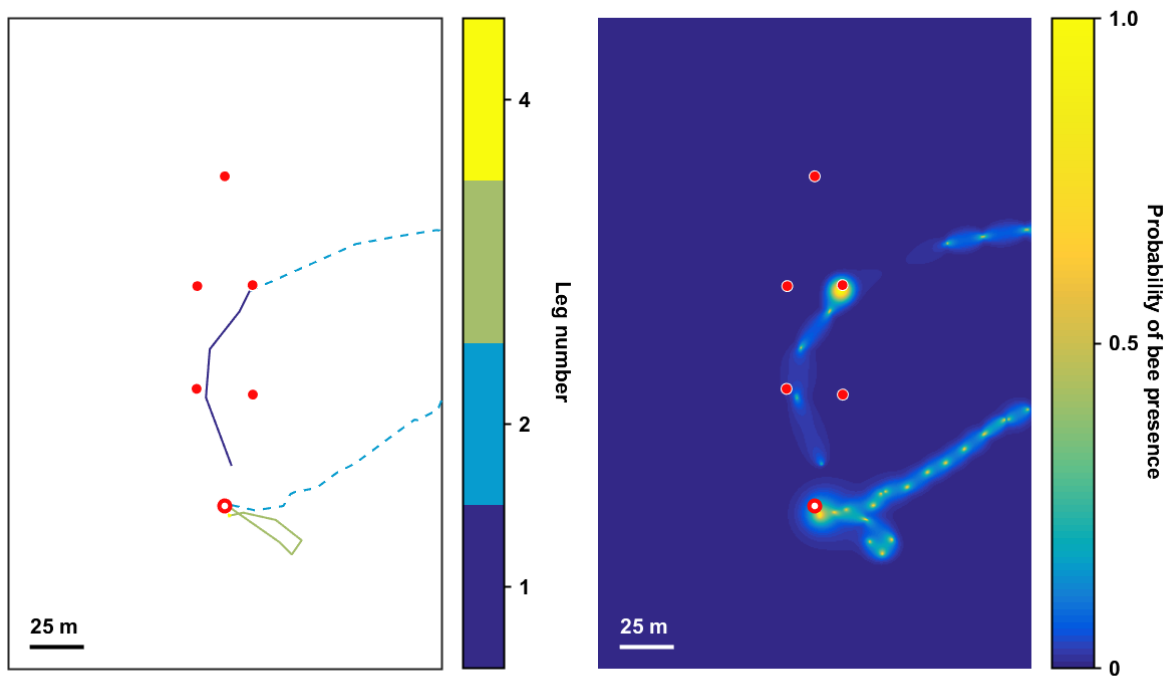


Fig S165

Bee 4, Bout 5, 28/09/2014  
Duration: 00:18:46

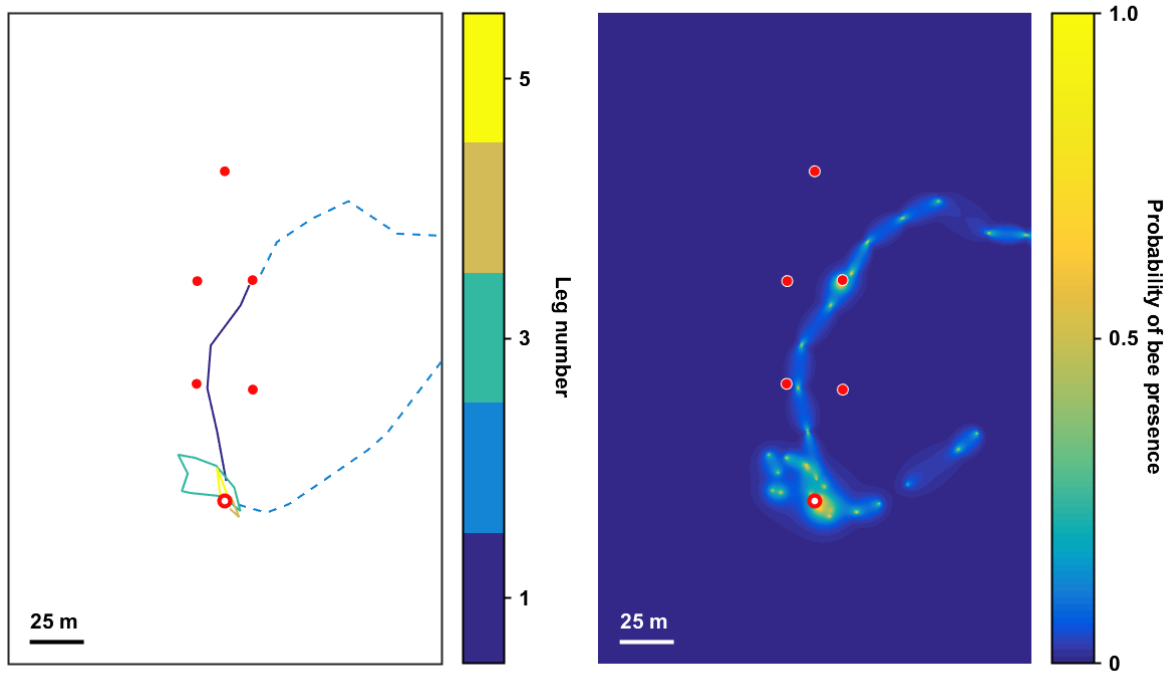


Fig S166

Bee 4, Bout 6, 28/09/2014  
Duration: 00:23:50

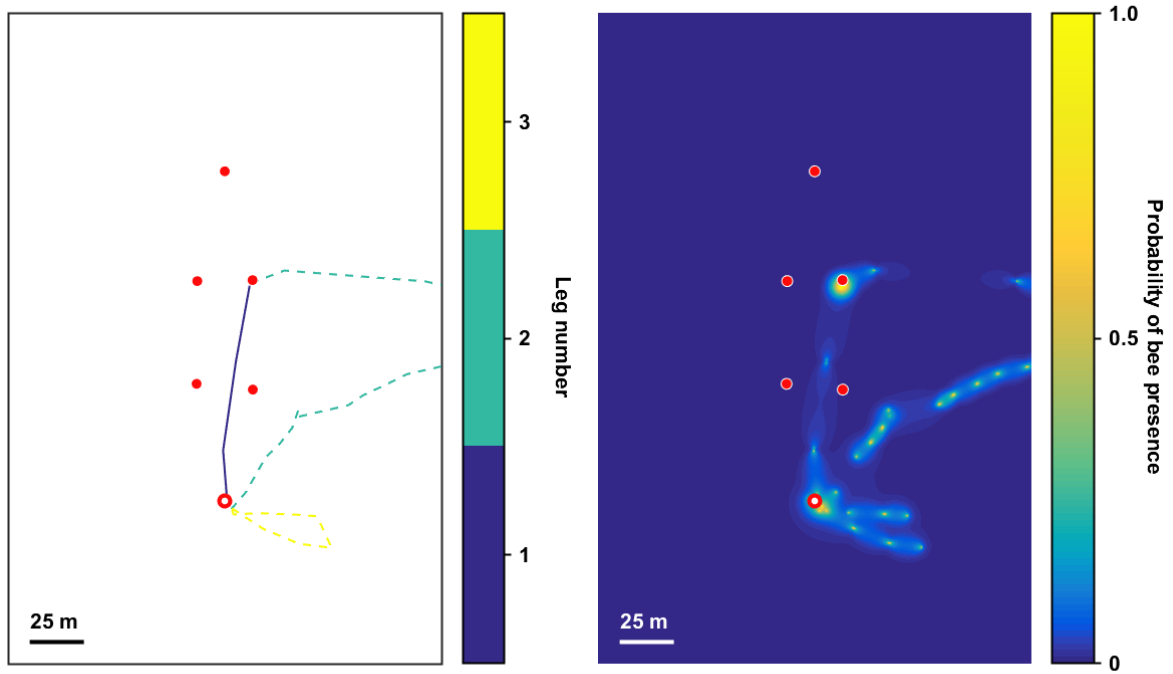


Fig S167

Bee 5, Bout 1, 03/10/2014  
Duration: 00:18:56

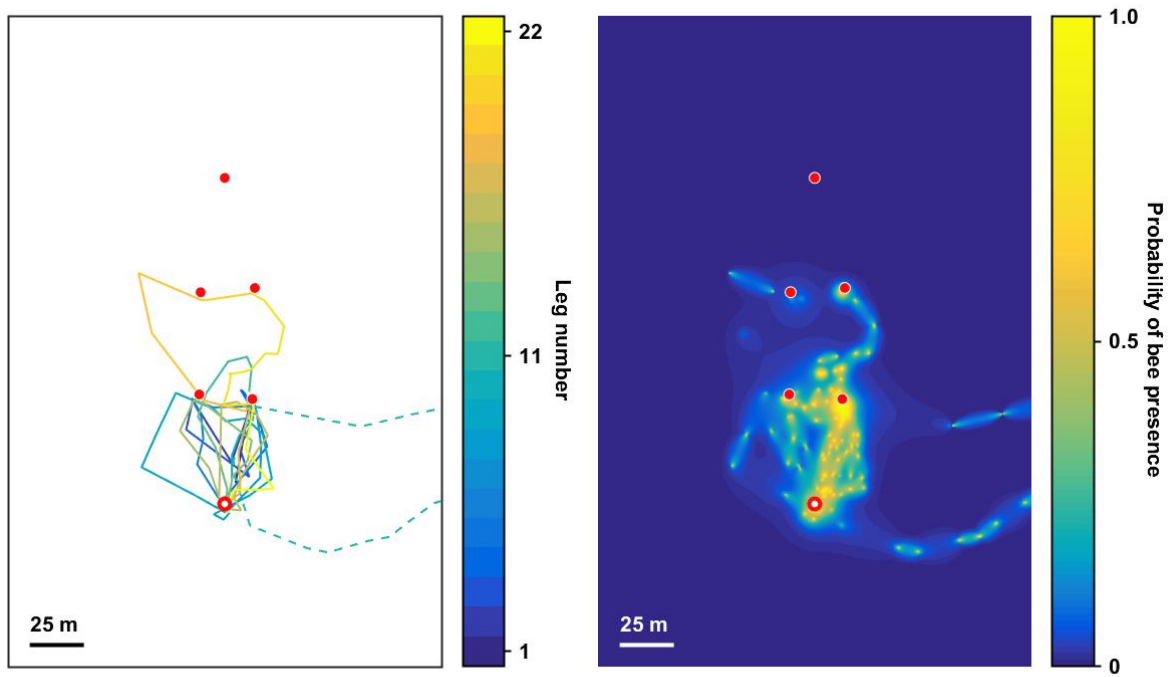


Fig S168

Bee 5, Bout 2, 03/10/2014  
Duration: 00:07:54

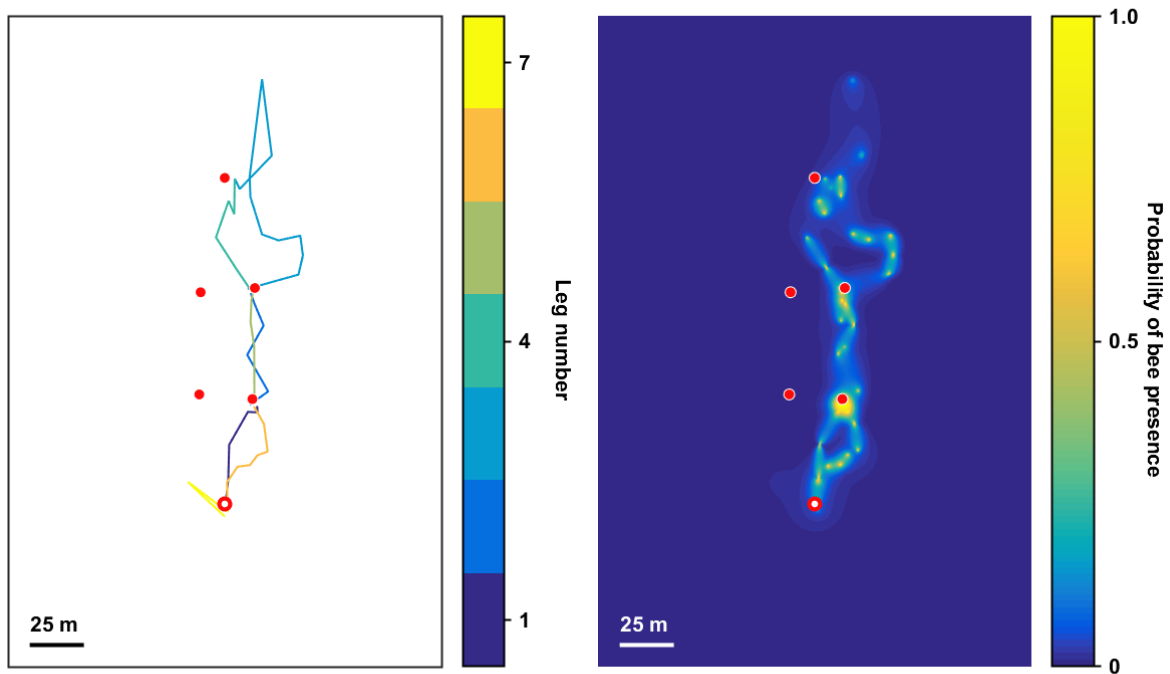


Fig S169

Bee 5, Bout 3, 03/10/2014  
Duration: 00:07:01

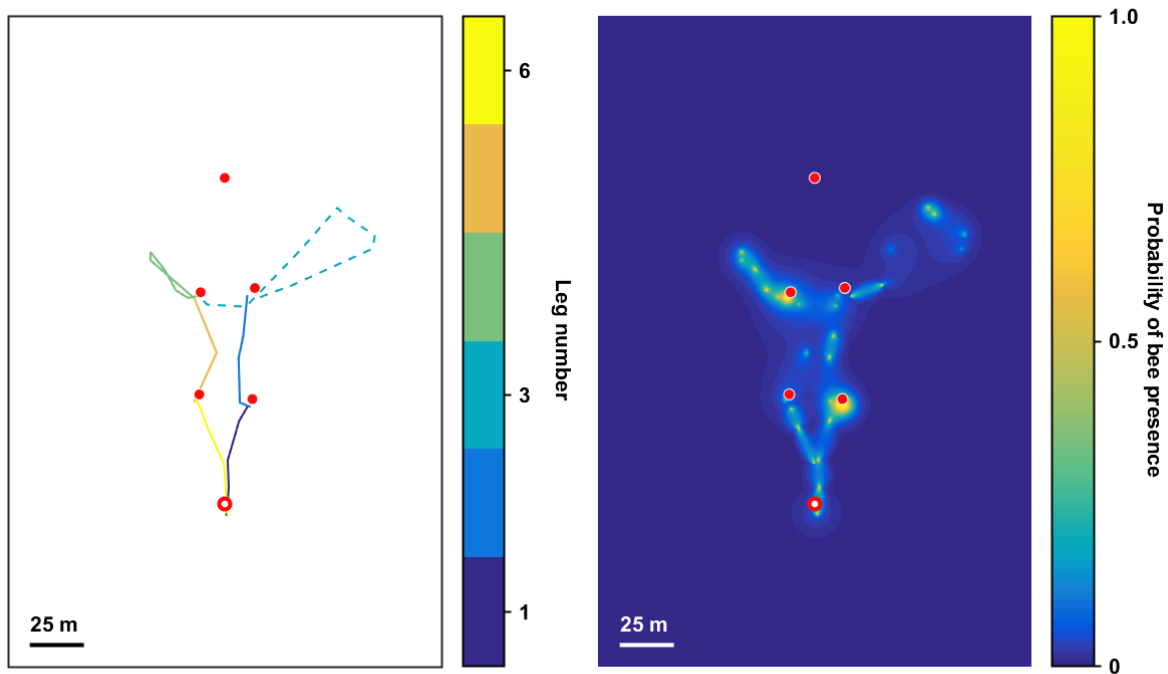


Fig S170

Bee 5, Bout 4, 03/10/2014  
Duration: 00:04:18

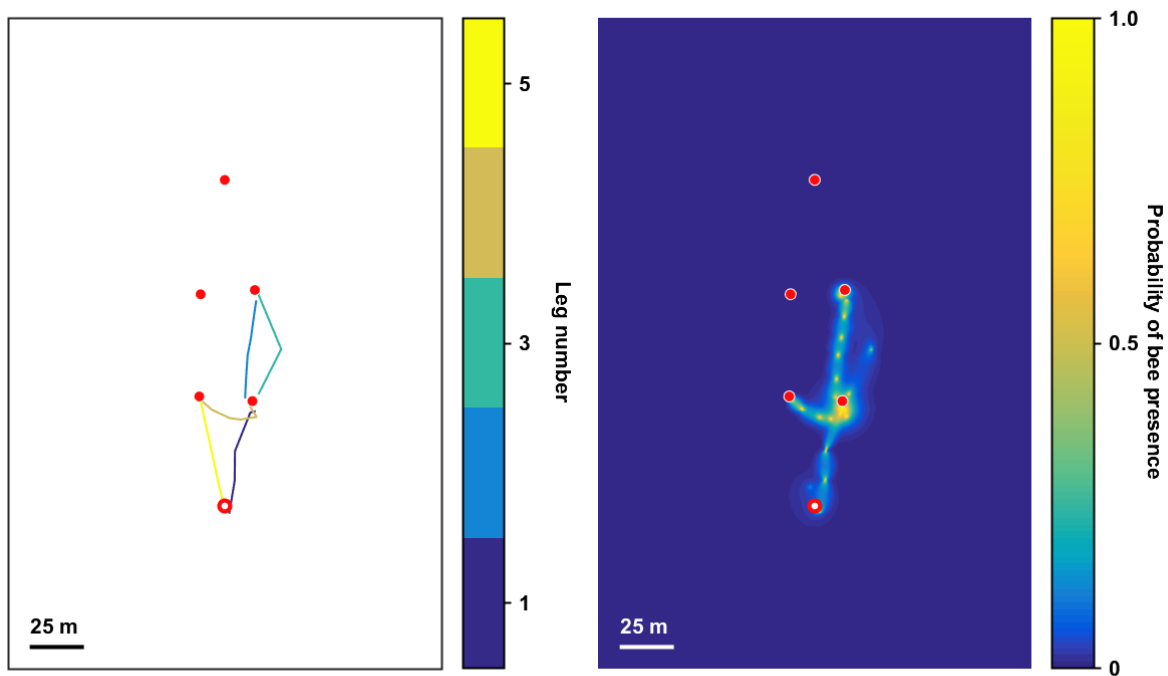




Fig S171

Bee 5, Bout 5, 03/10/2014  
Duration: 00:06:13

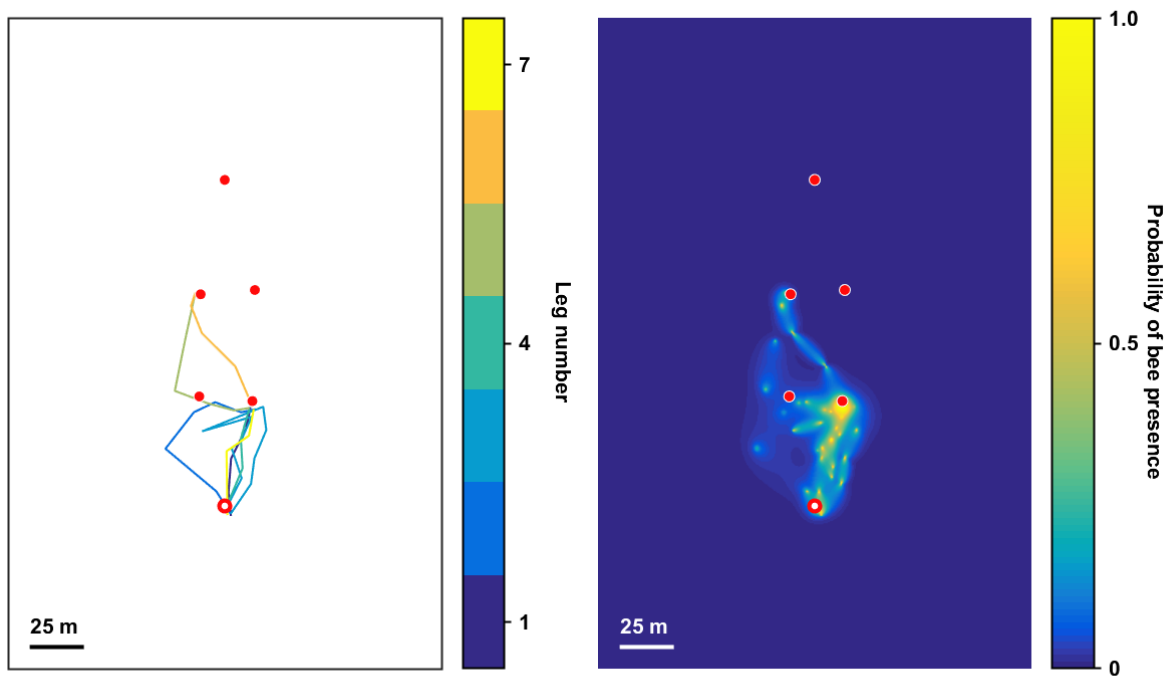


Fig S172

Bee 5, Bout 6, 03/10/2014  
Duration: 00:08:28

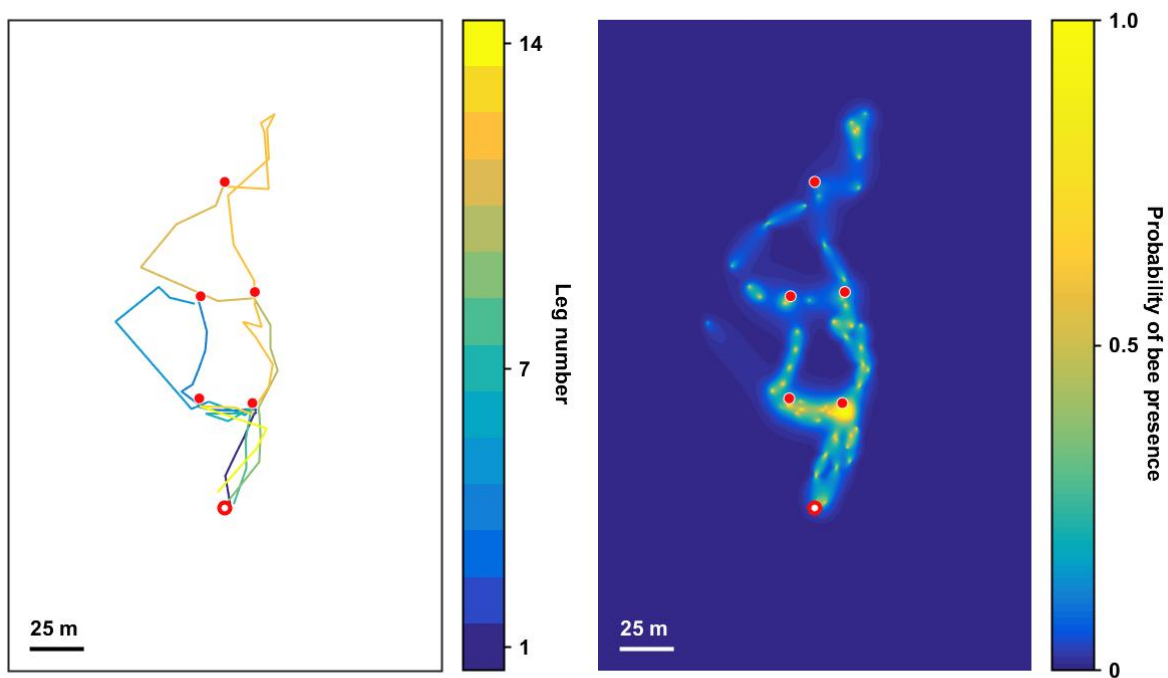


Fig S173

Bee 5, Bout 7, 03/10/2014  
Duration: 00:04:04

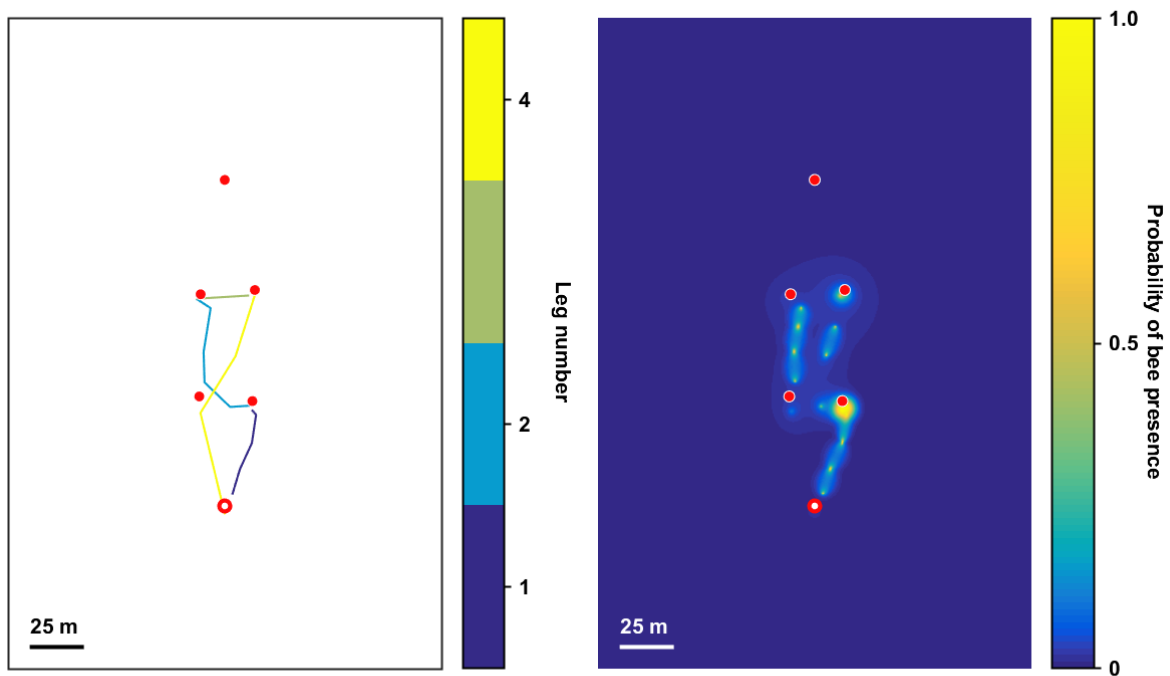


Fig S174

Bee 5, Bout 8, 03/10/2014  
Duration: 00:04:58

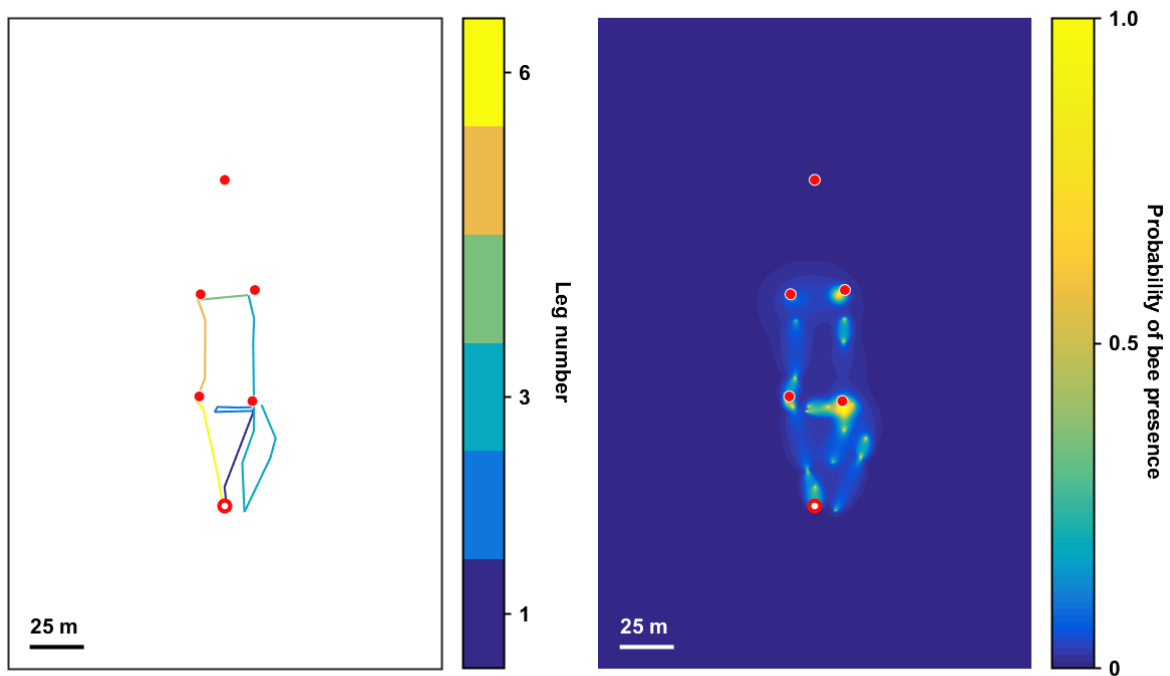


Fig S175

Bee 5, Bout 9, 03/10/2014  
Duration: 00:05:54

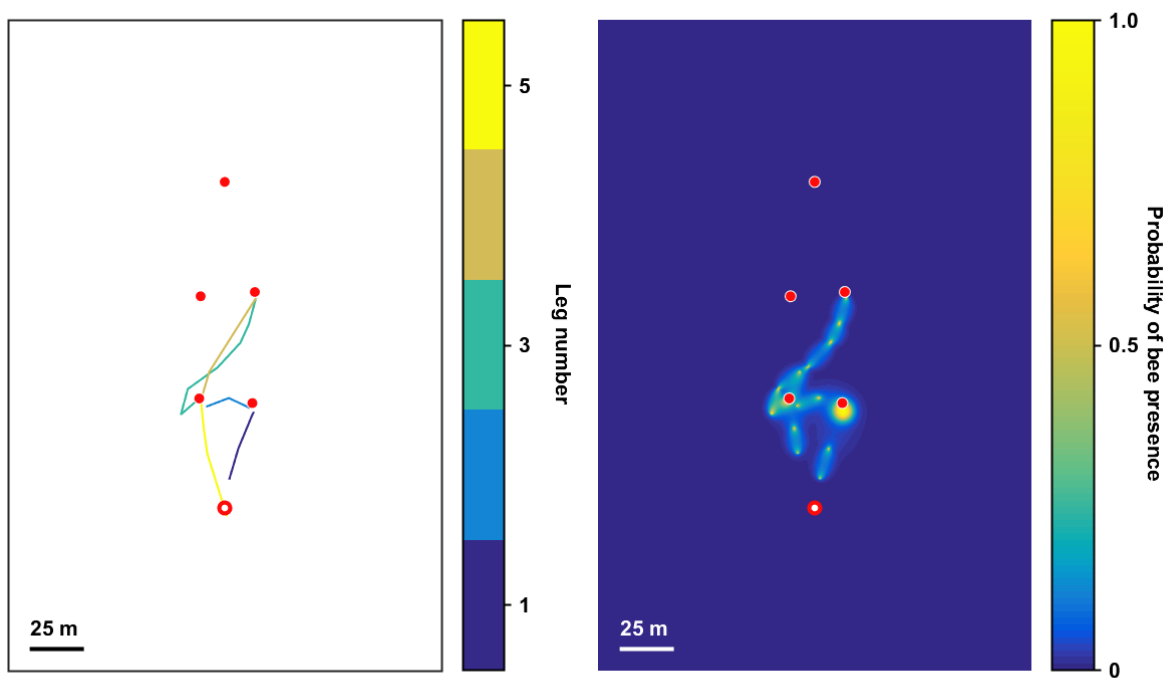


Fig S176

Bee 5, Bout 10, 03/10/2014  
Duration: 00:05:48

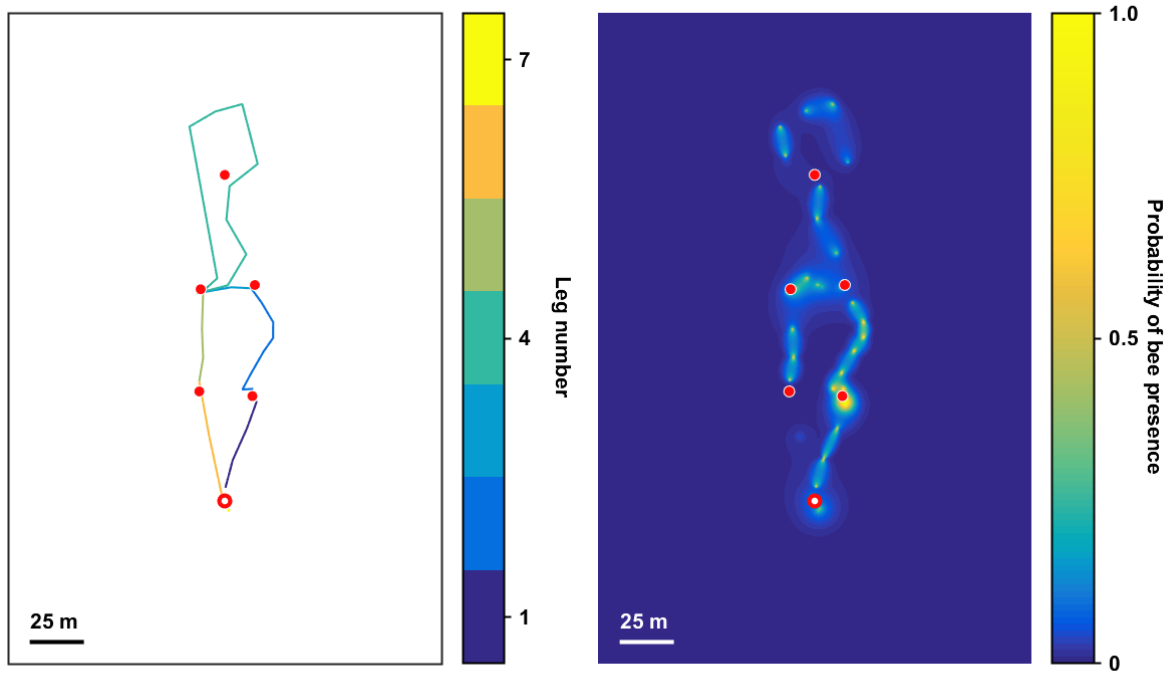


Fig S177

Bee 5, Bout 11, 03/10/2014  
Duration: 00:08:54

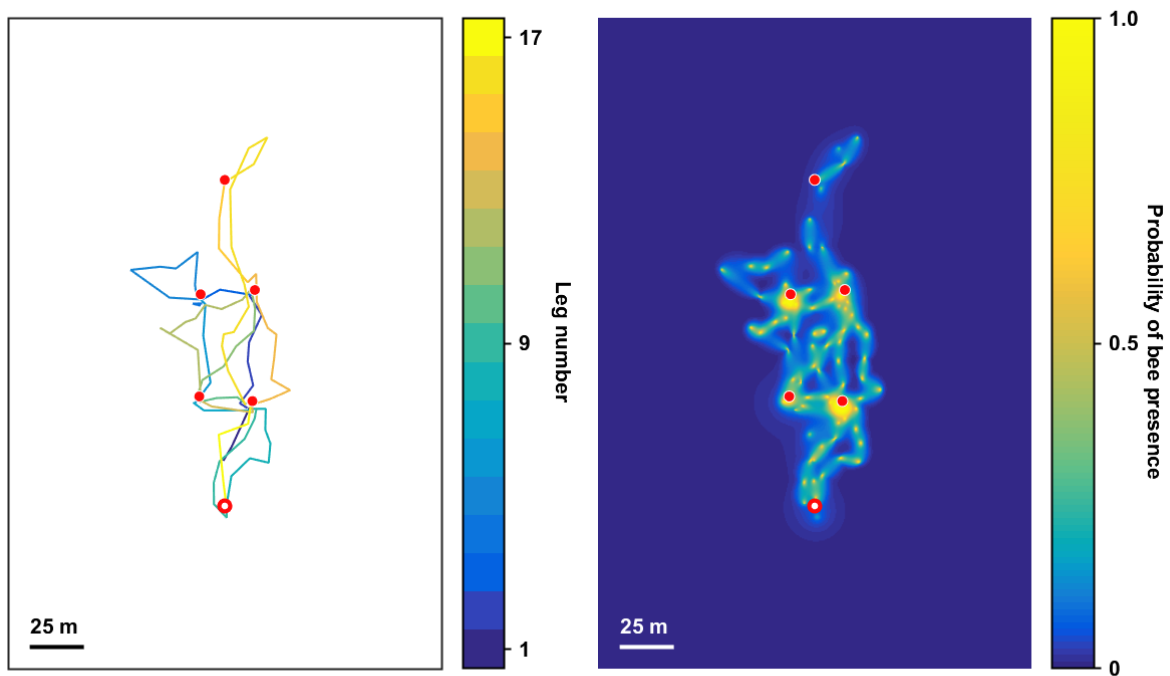


Fig S178

Bee 5, Bout 12, 03/10/2014  
Duration: 00:04:13

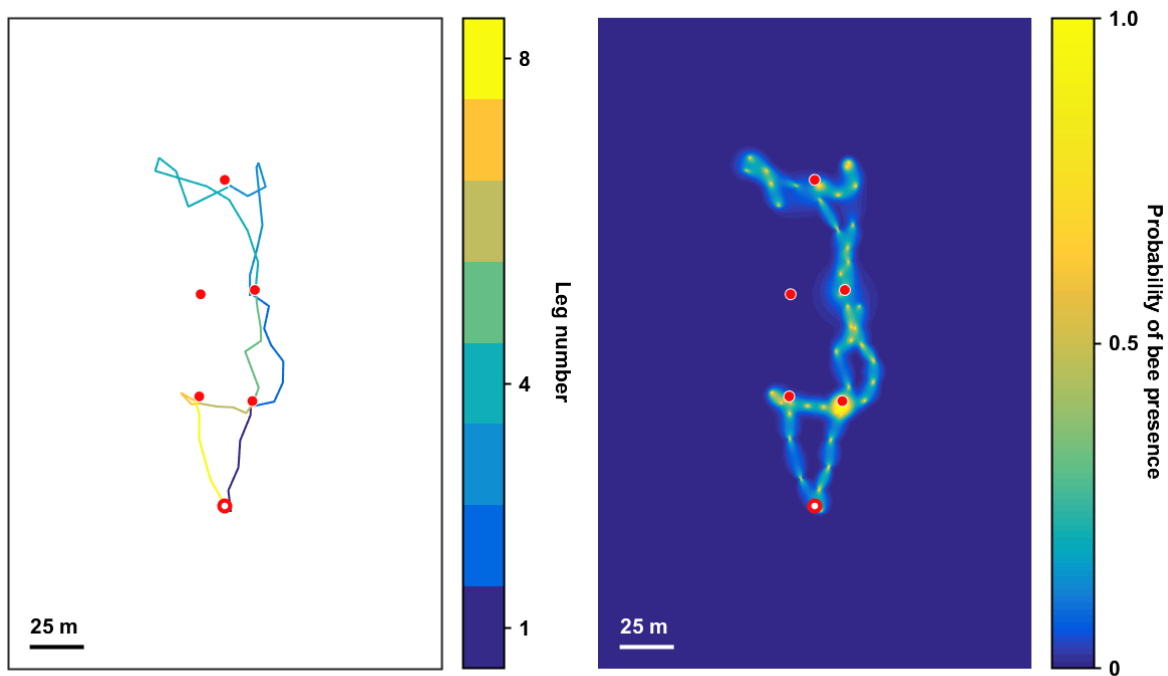




Fig S179

Bee 5, Bout 13, 03/10/2014  
Duration: 00:05:24

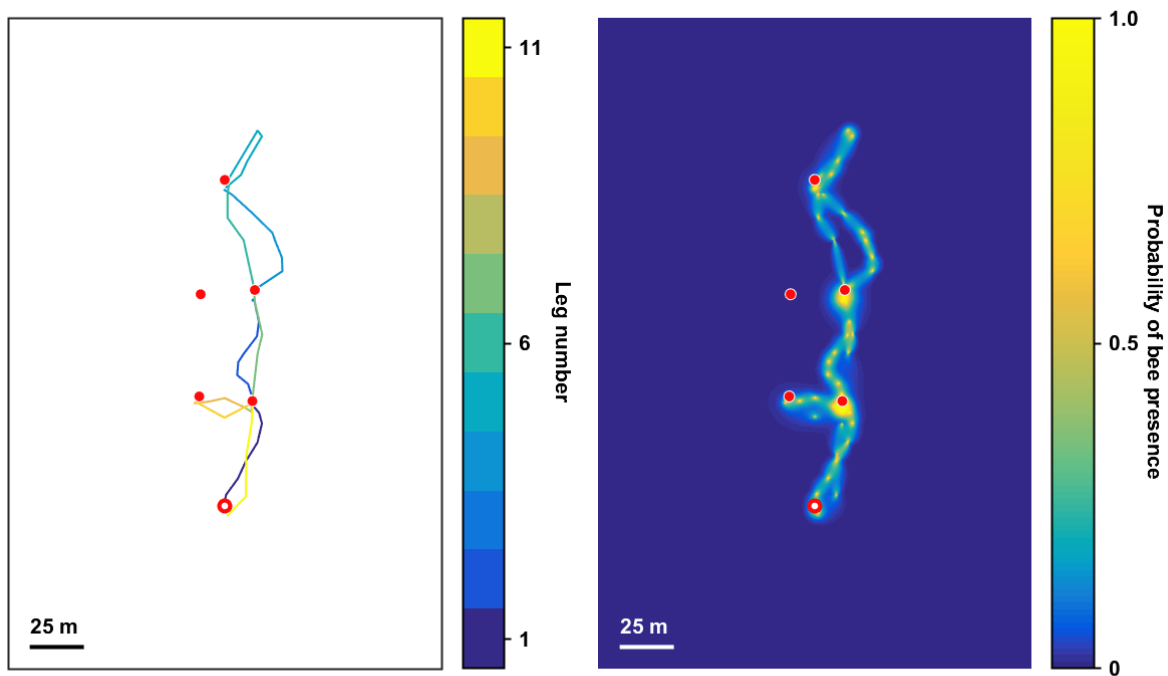


Fig S180

Bee 5, Bout 14, 03/10/2014  
Duration: 00:04:35

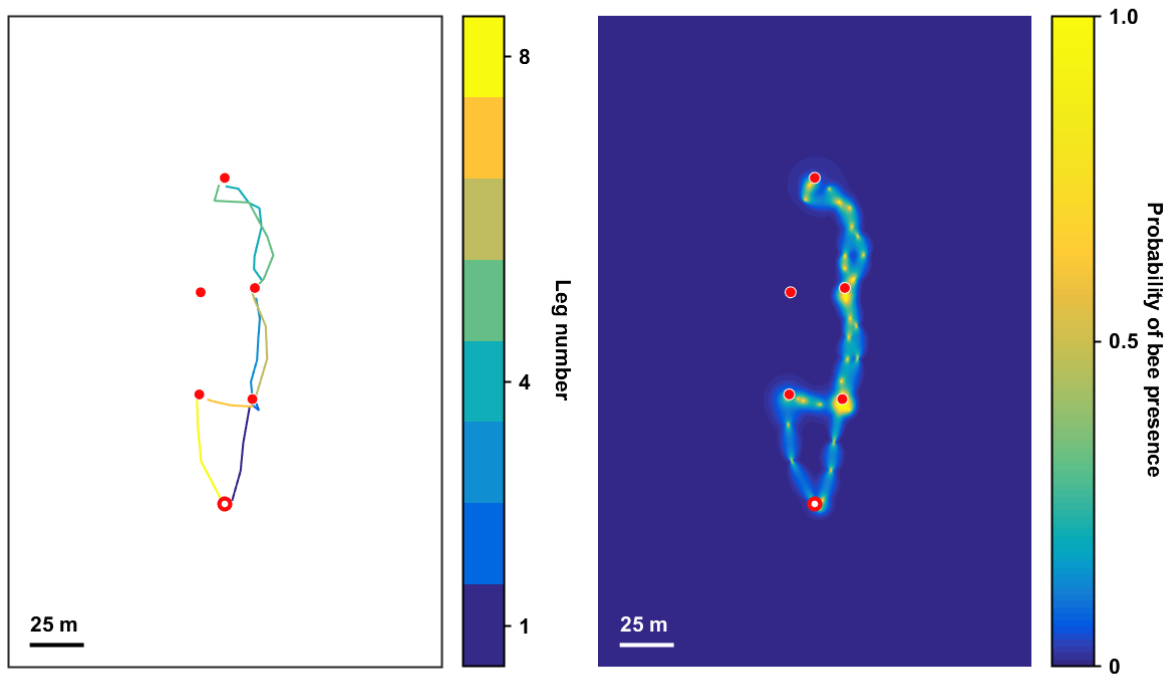


Fig S181

Bee 5, Bout 15, 03/10/2014  
Duration: 00:04:26

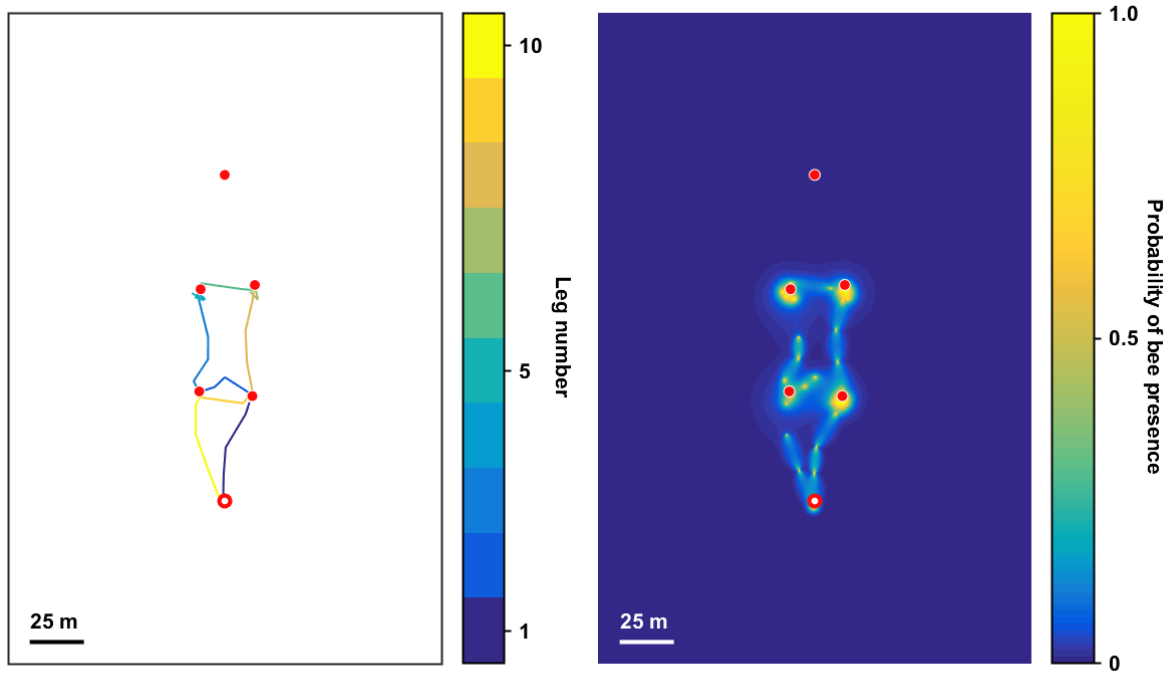


Fig S182

Bee 5, Bout 16, 03/10/2014  
Duration: 00:04:55

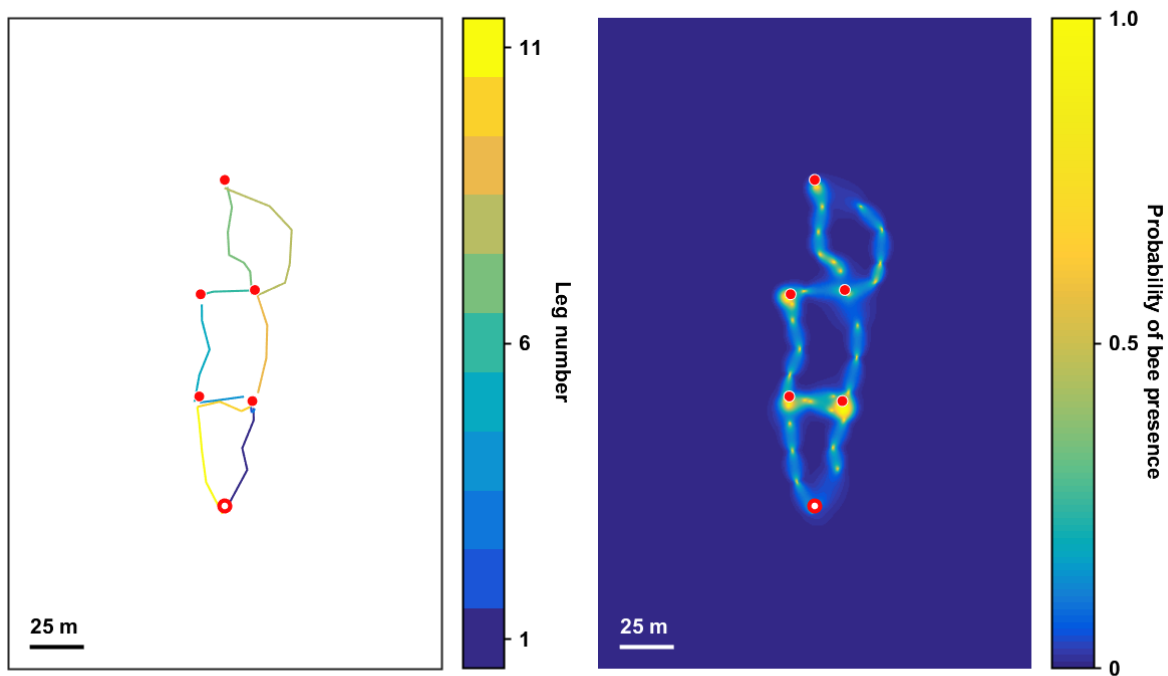


Fig S183

Bee 5, Bout 17, 03/10/2014  
Duration: 00:06:39

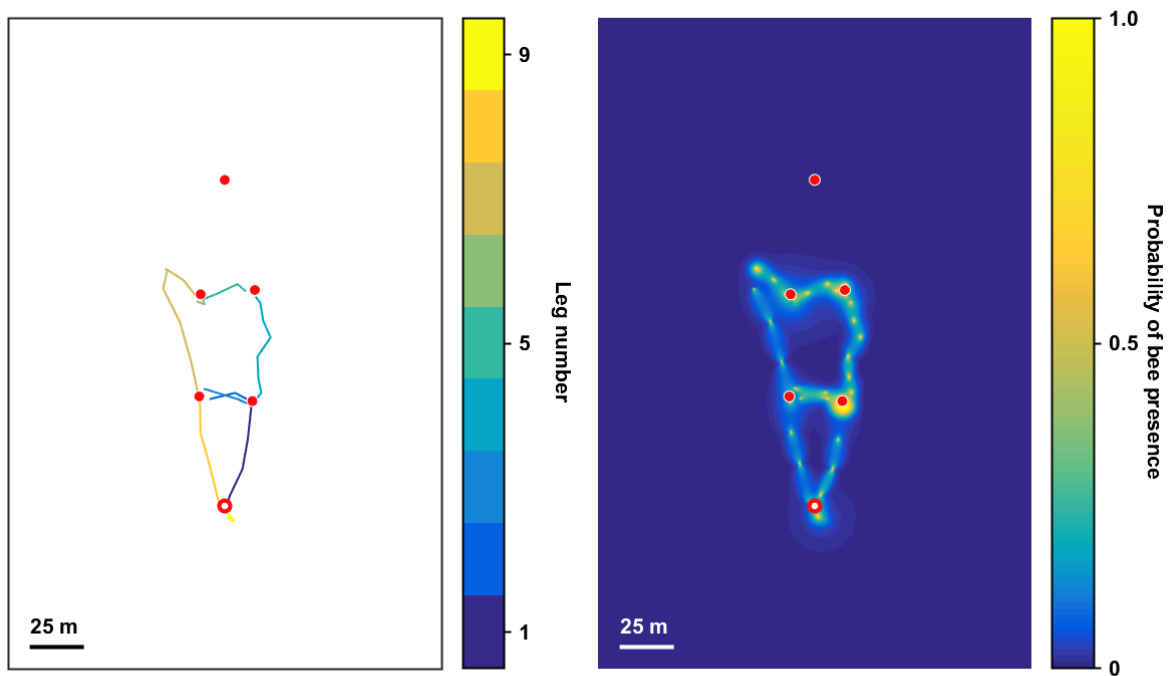


Fig S184

Bee 5, Bout 18, 03/10/2014  
Duration: 00:04:32

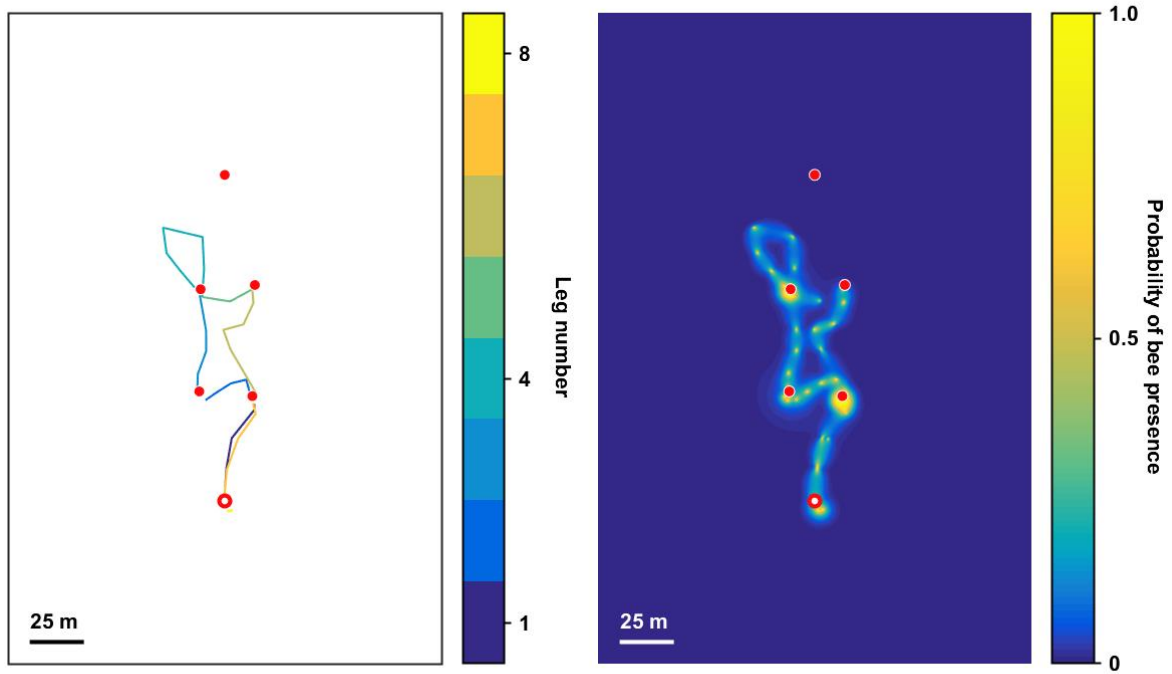
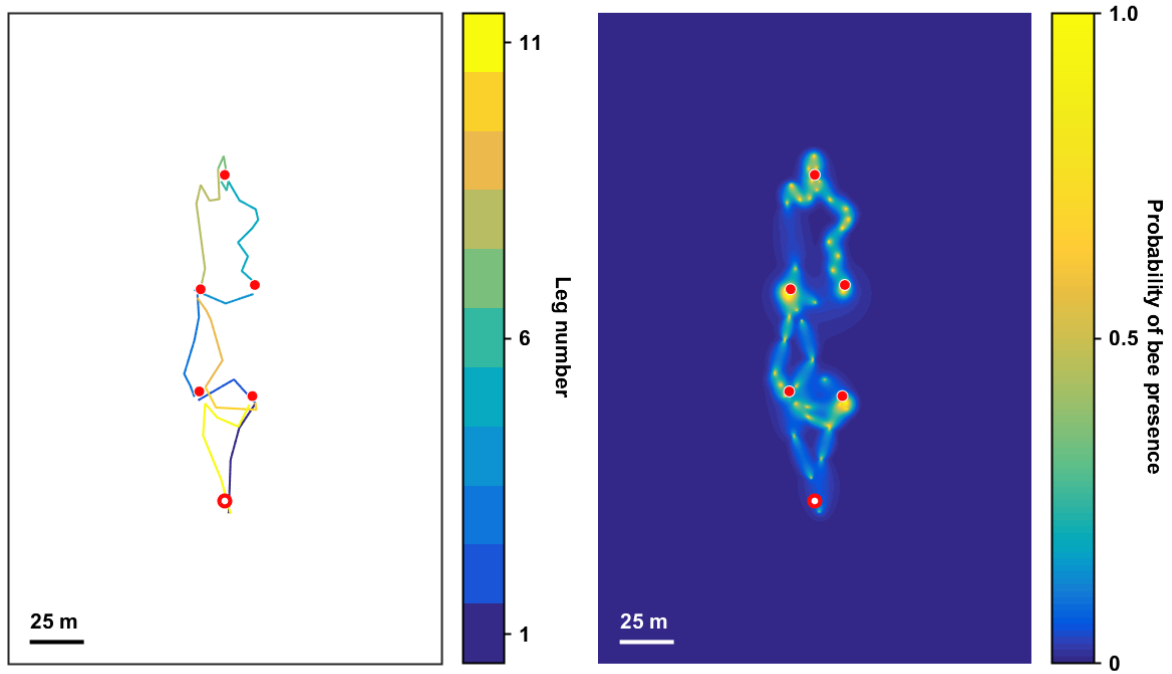


Fig S185

Bee 5, Bout 19, 03/10/2014  
Duration: 00:05:17



**Bee 5, Bout 20, 03/10/2014**  
**Duration: 00:05:31**

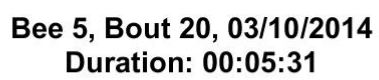




Fig S187

Bee 5, Bout 21, 03/10/2014  
Duration: 00:09:26

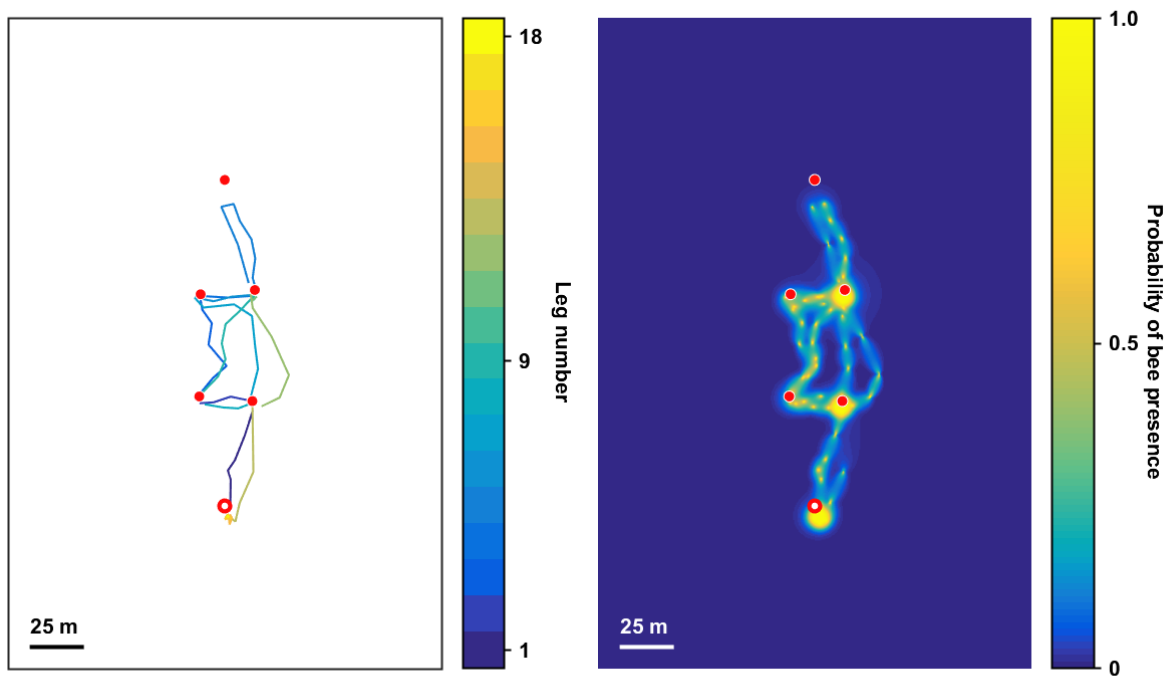


Fig S188

Bee 5, Bout 22, 03/10/2014  
Duration: 00:08:00

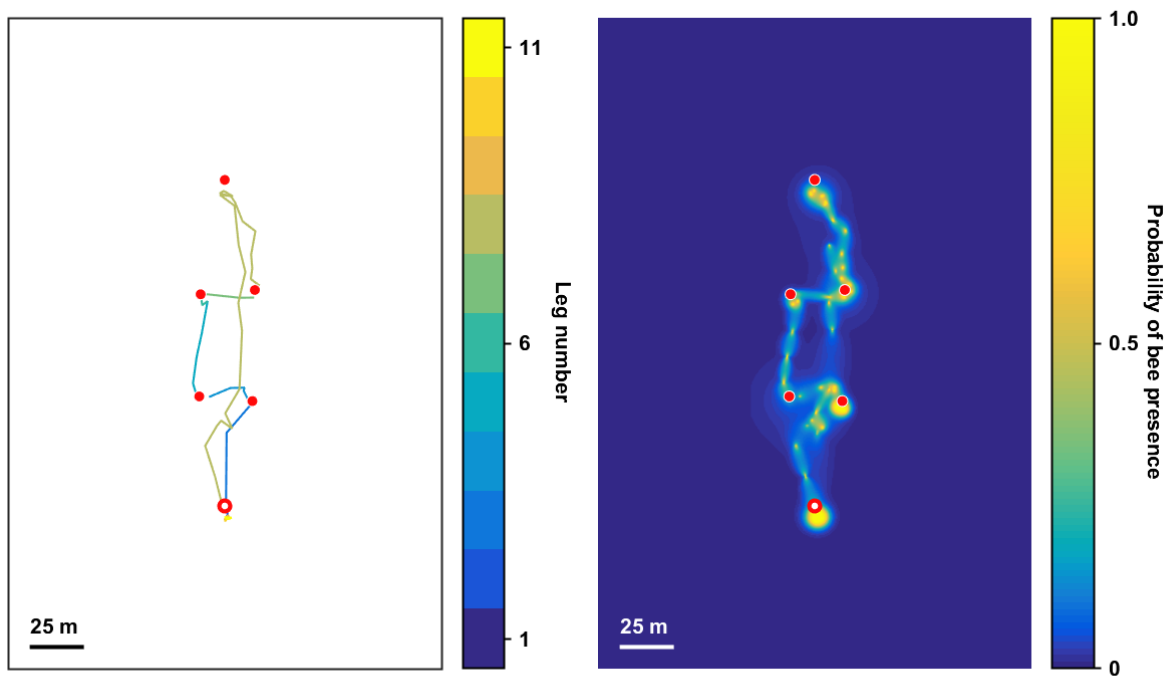


Fig S189

Bee 5, Bout 23, 03/10/2014  
Duration: 00:10:09

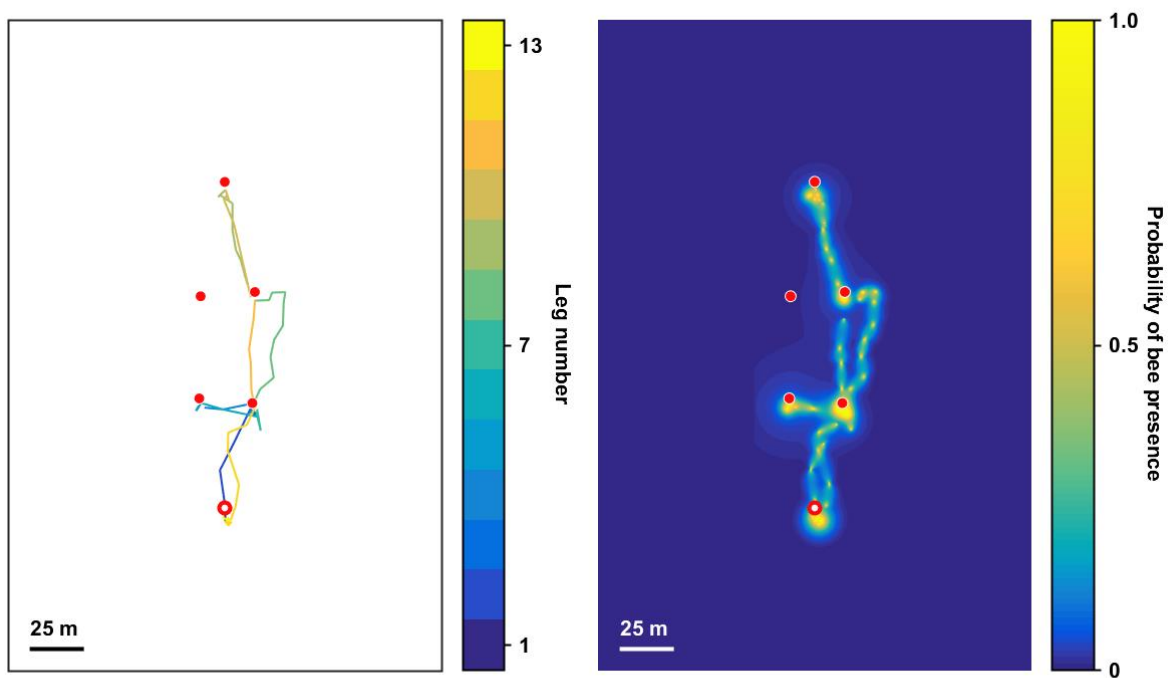


Fig S190

Bee 5, Bout 24, 03/10/2014  
Duration: 00:08:42

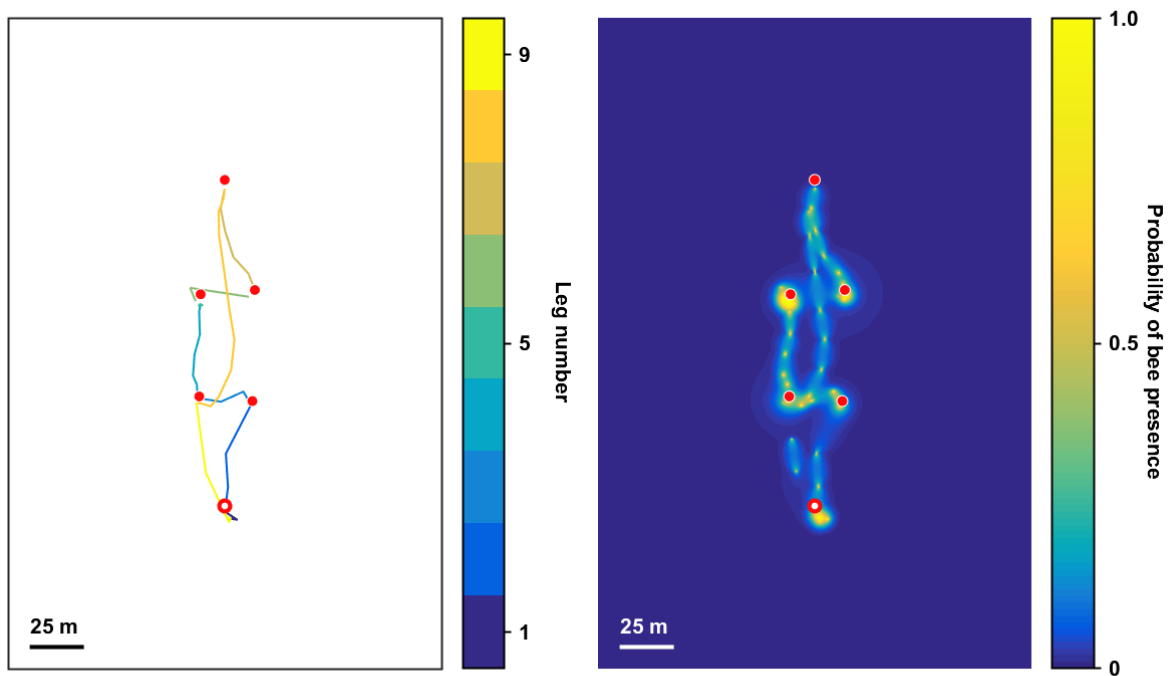


Fig S191

Bee 5, Bout 25, 03/10/2014  
Duration: 00:08:02

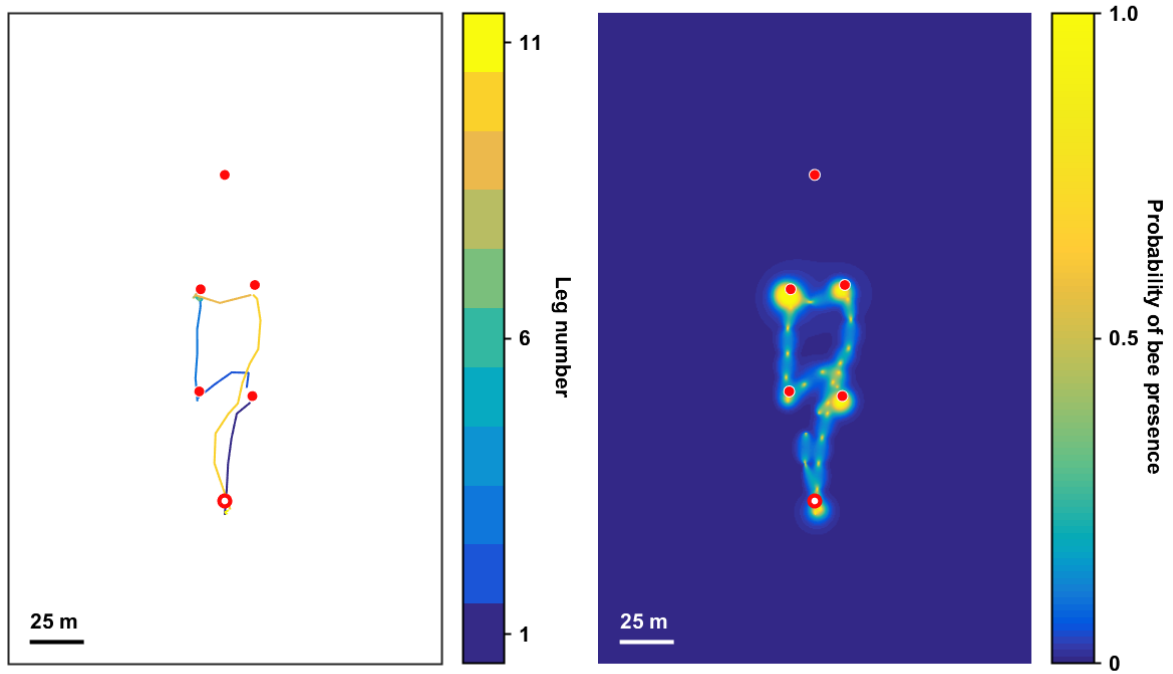


Fig S192

Bee 5, Bout 26, 03/10/2014  
Duration: 00:07:55

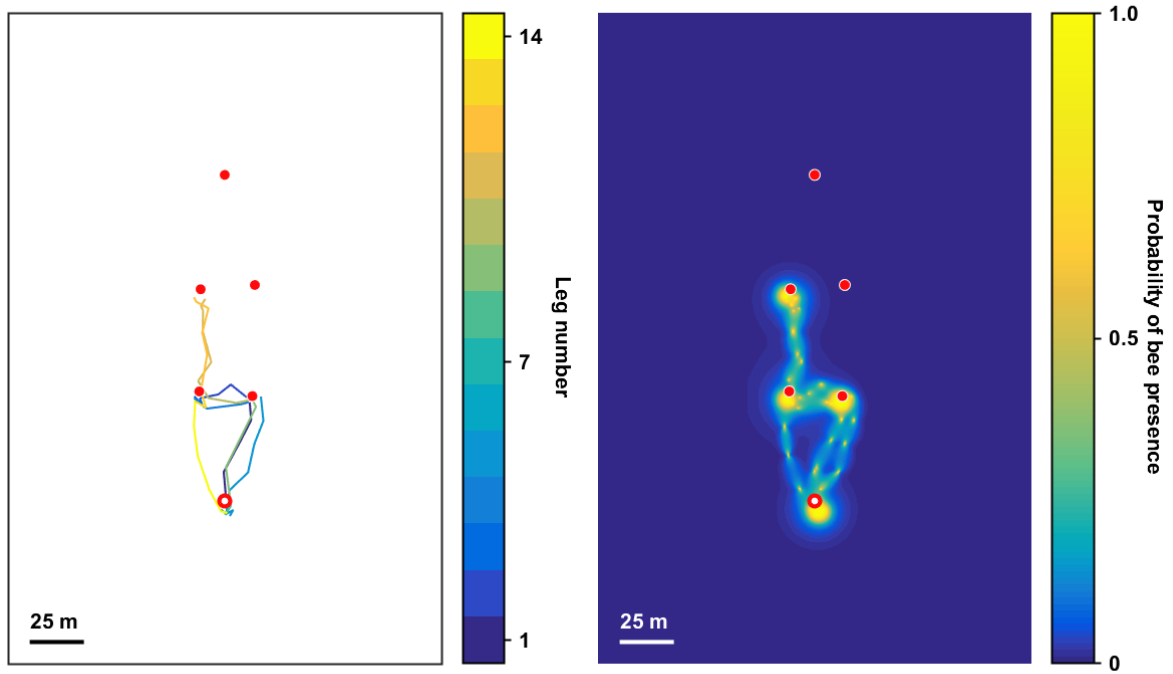


Fig S193

Bee 5, Bout 27, 03/10/2014  
Duration: 00:03:50

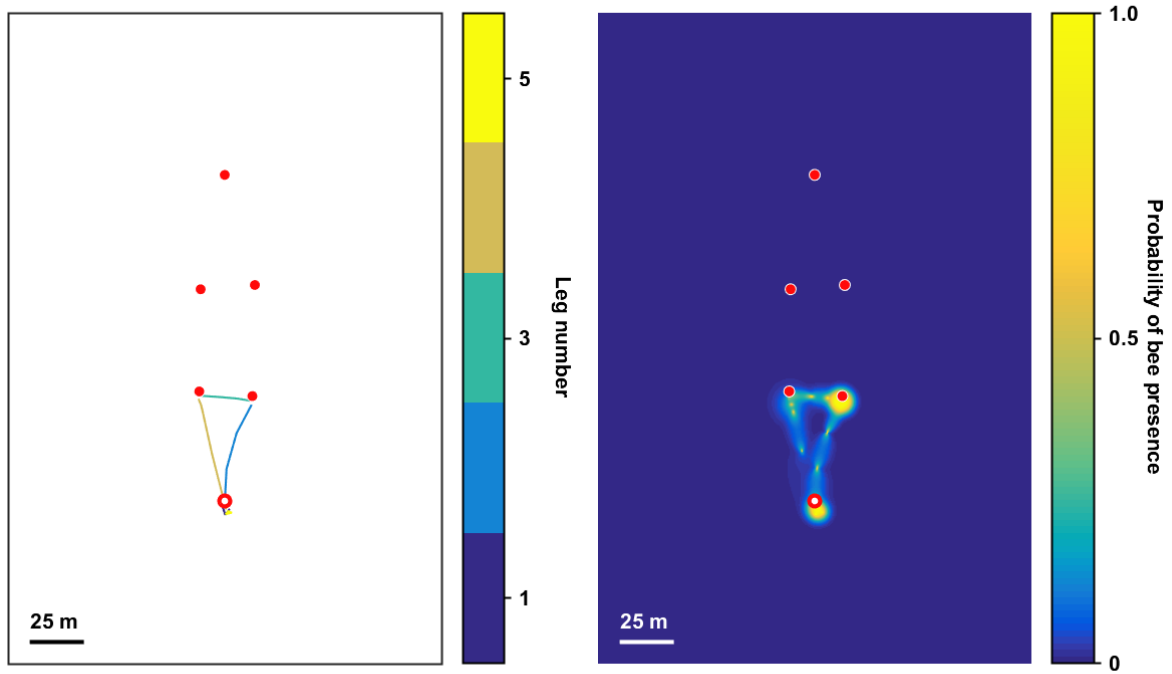


Fig S194

Bee 6, Bout 1, 28/09/2015  
Duration: 00:10:19

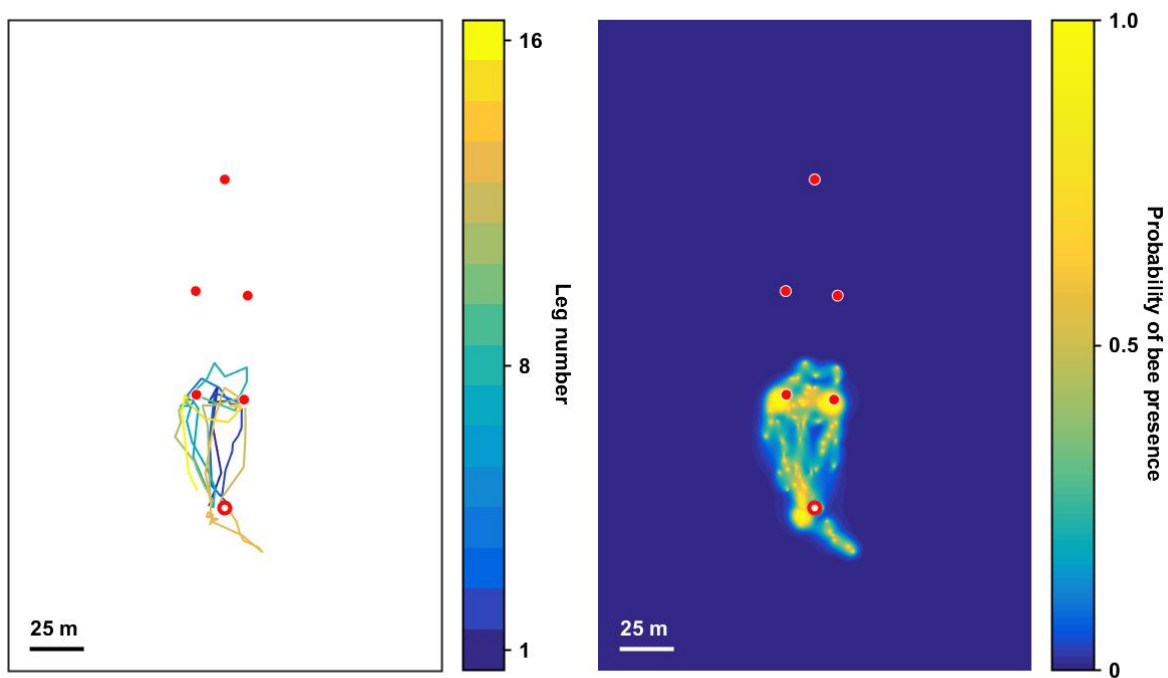




Fig S195

Bee 6, Bout 2, 28/09/2015  
Duration: 00:13:14

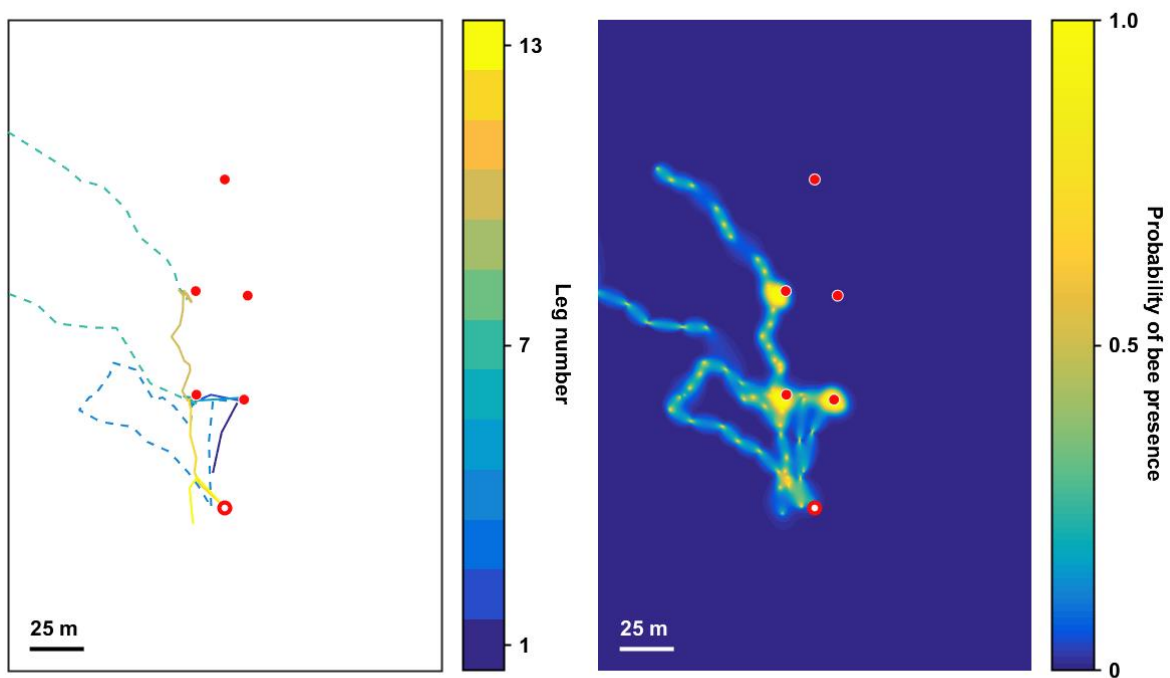


Fig S196

Bee 6, Bout 3, 28/09/2015  
Duration: 00:07:09

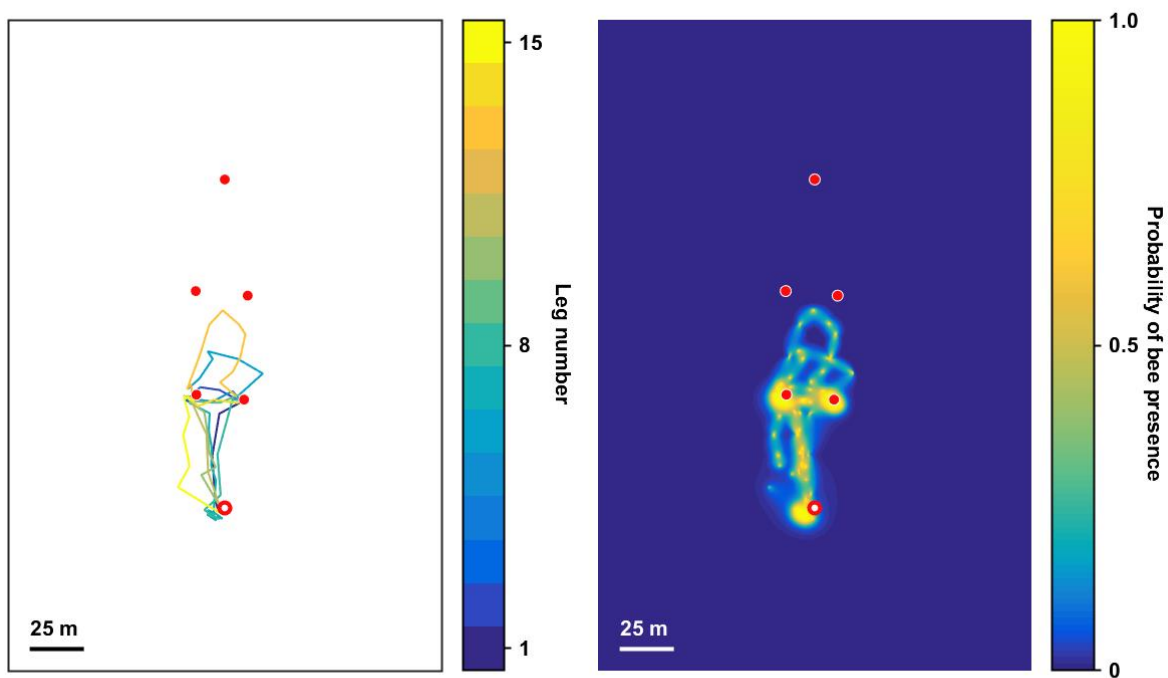


Fig S197

Bee 6, Bout 4, 28/09/2015  
Duration: 00:05:56

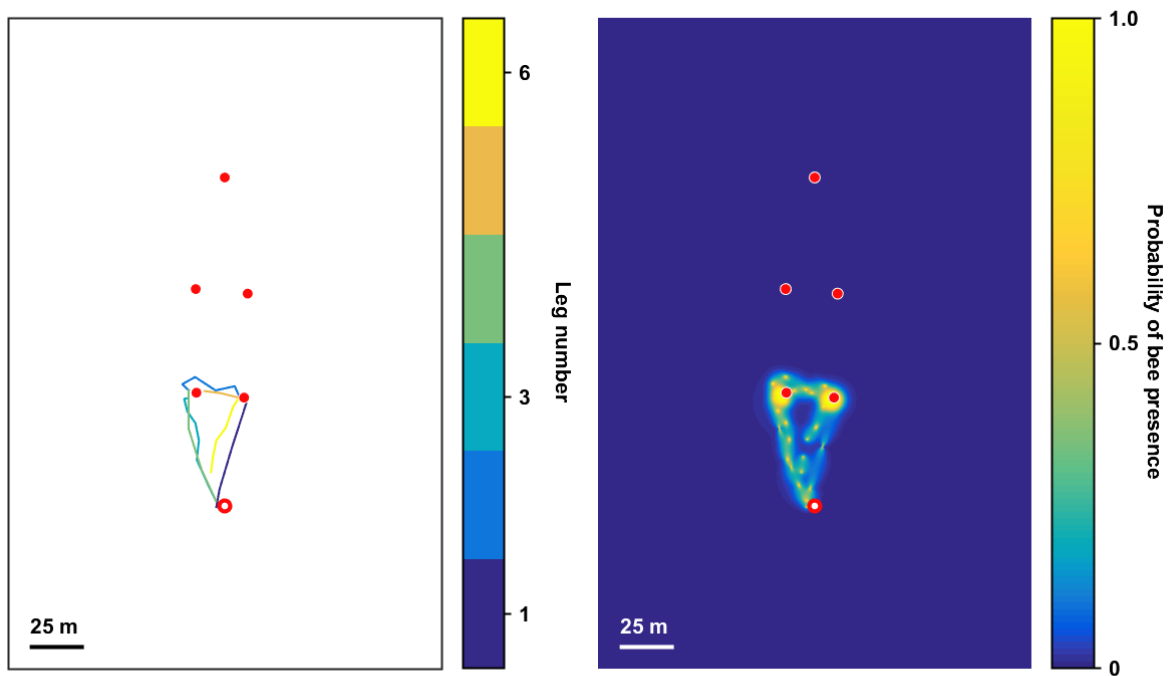


Fig S198

Bee 6, Bout 5, 28/09/2015  
Duration: 00:09:55

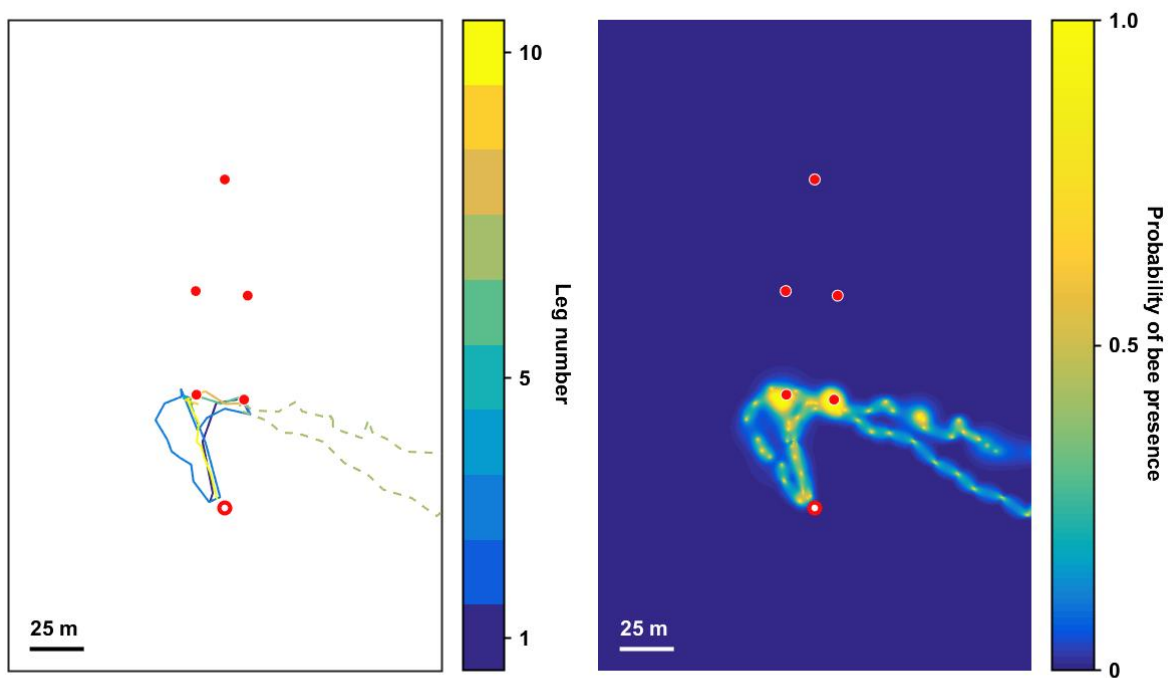


Fig S199

Bee 6, Bout 6, 28/09/2015  
Duration: 00:03:39

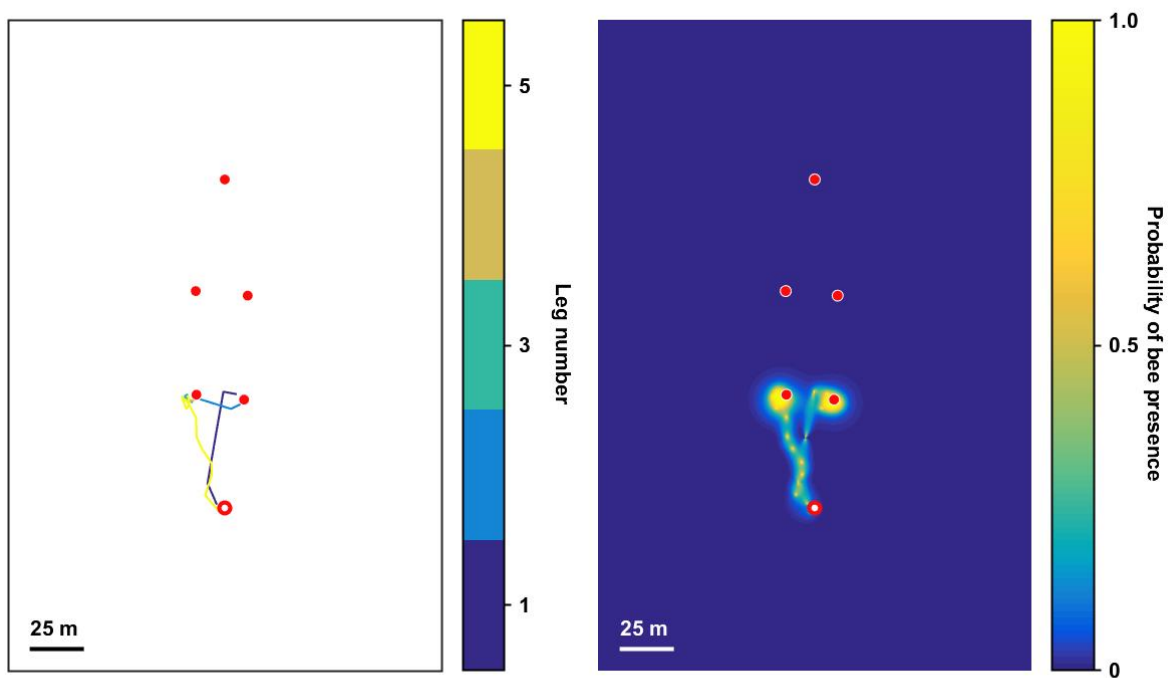


Fig S200

Bee 6, Bout 8, 28/09/2015  
Duration: 00:05:48

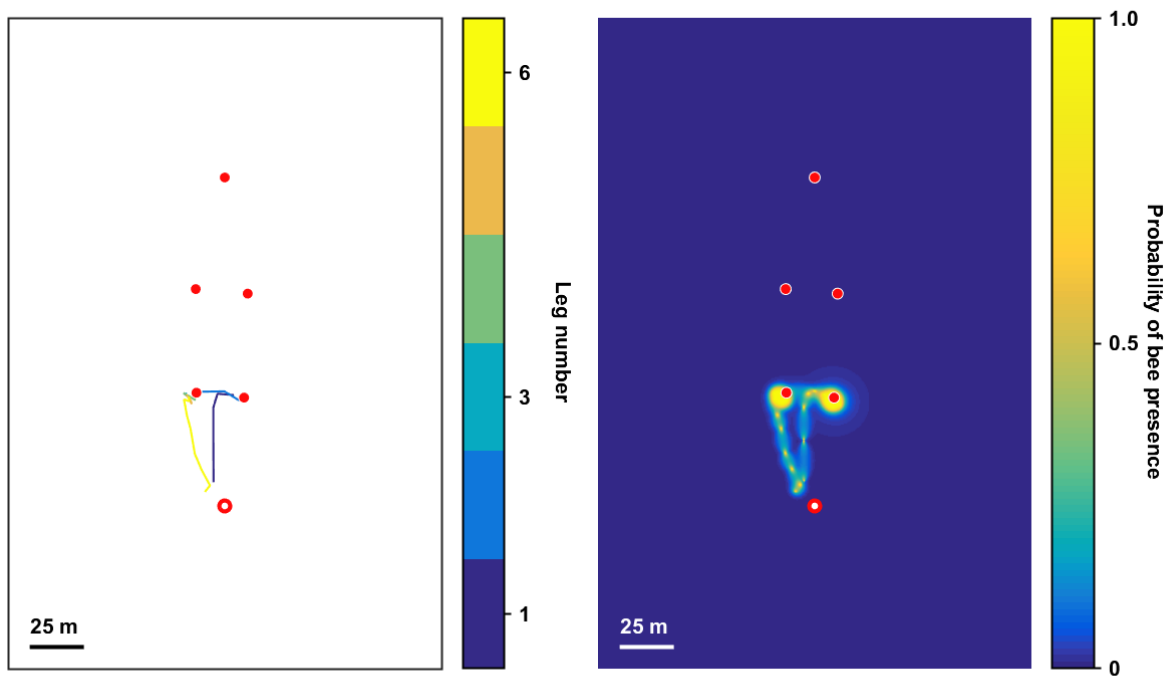
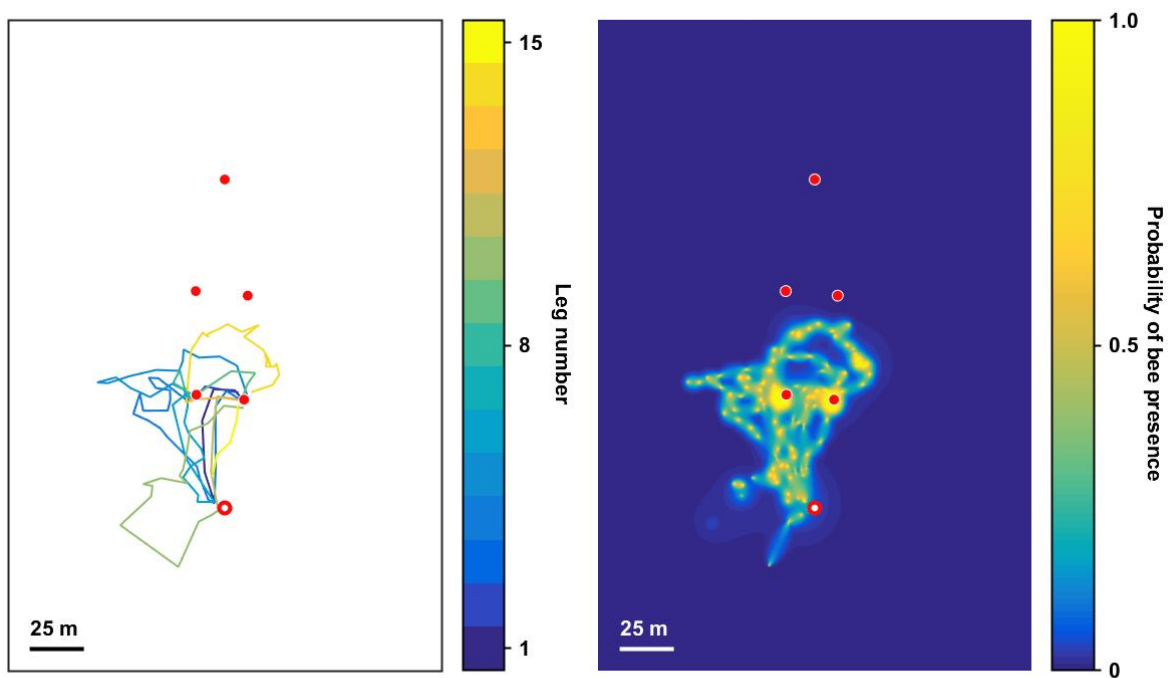
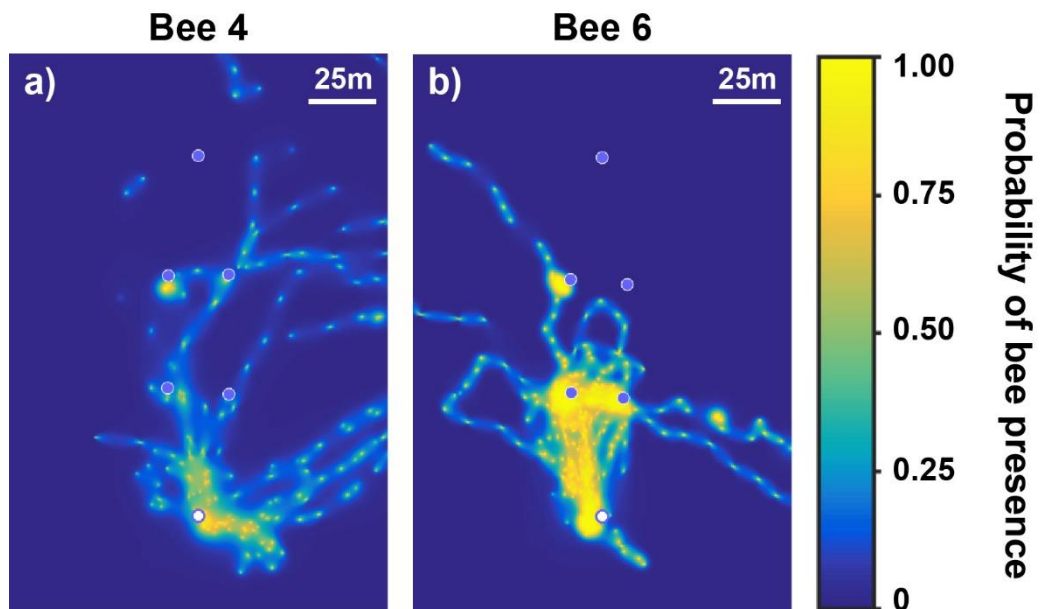


Fig S201

Bee 6, Bout 9, 28/09/2015  
Duration: 00:26:07

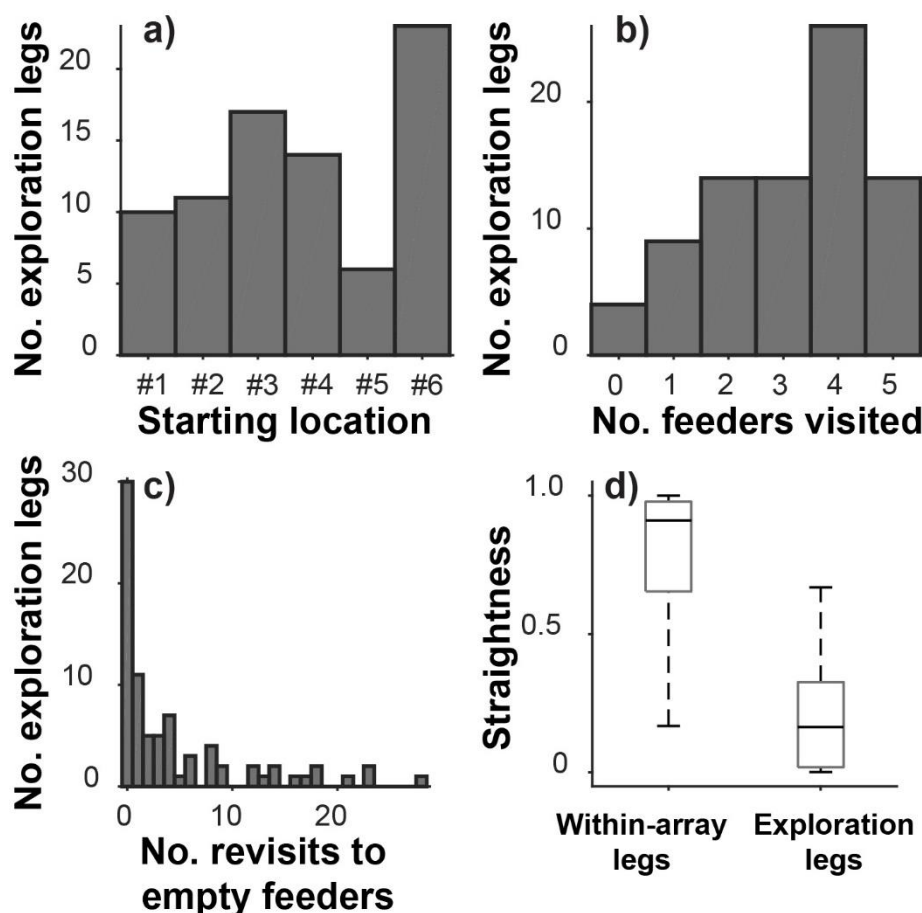


**Supplementary Fig S202: Heat maps showing the early foraging bouts of two bees.** Bees 4 and 6 completed only 6 and 9 bouts respectively, too few to assess how their routes changed over time as in Fig 2. Their initial 5 bouts on the array are shown here for comparison with Fig 2 a-d. Nest position: open circle; positions of feeders: closed circles. The colour of each pixel represents the probability that the bee passed over that point in the landscape as estimated from the radar tracks using a Brownian bridges technique (described in Methods). Each pixel represents an area 5 x 5m. Scale bars represent a distance of 25m. Each panel represents the cumulative probability map of one bee's location over its first 5 bouts of foraging on the feeder array: a) Bee 4. b) Bee 6.

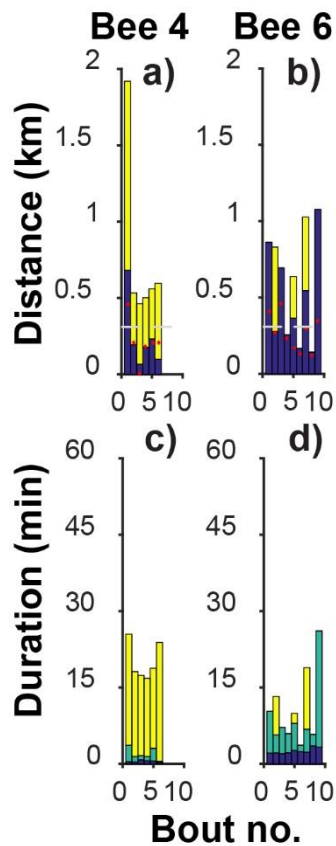




**Supplementary Fig S203: Conditions under which exploration legs take place.** Individual legs of each foraging bout were categorised as ‘explorations’ if the bee travelled further than 50m from the nest and all feeders it had previously visited (i.e. the bee was further from all known feeders than the feeders were from one another). All panels show the combined data from all bees 1-6. a) Histogram showing how many exploration legs started at each feeder (1-5 indicate feeders #1-#5, 6 indicates the nest). Explorations started from all feeders but most commonly originated at the nest. b) Histogram showing how many feeders had been discovered and fed from at the point each exploration leg began. Explorations rarely occurred before the bee had fed at all and were most common when the bee had visited four out of five feeders. c) Histogram showing how many times a bee had revisited empty feeders before beginning an exploration leg. Explorations commonly occurred without any revisits to empty feeders. d) Comparison of the straightness of the flight paths during legs in which the bee remained within the array to exploration legs. Exploration legs are significantly less straight than those that remained within the array.

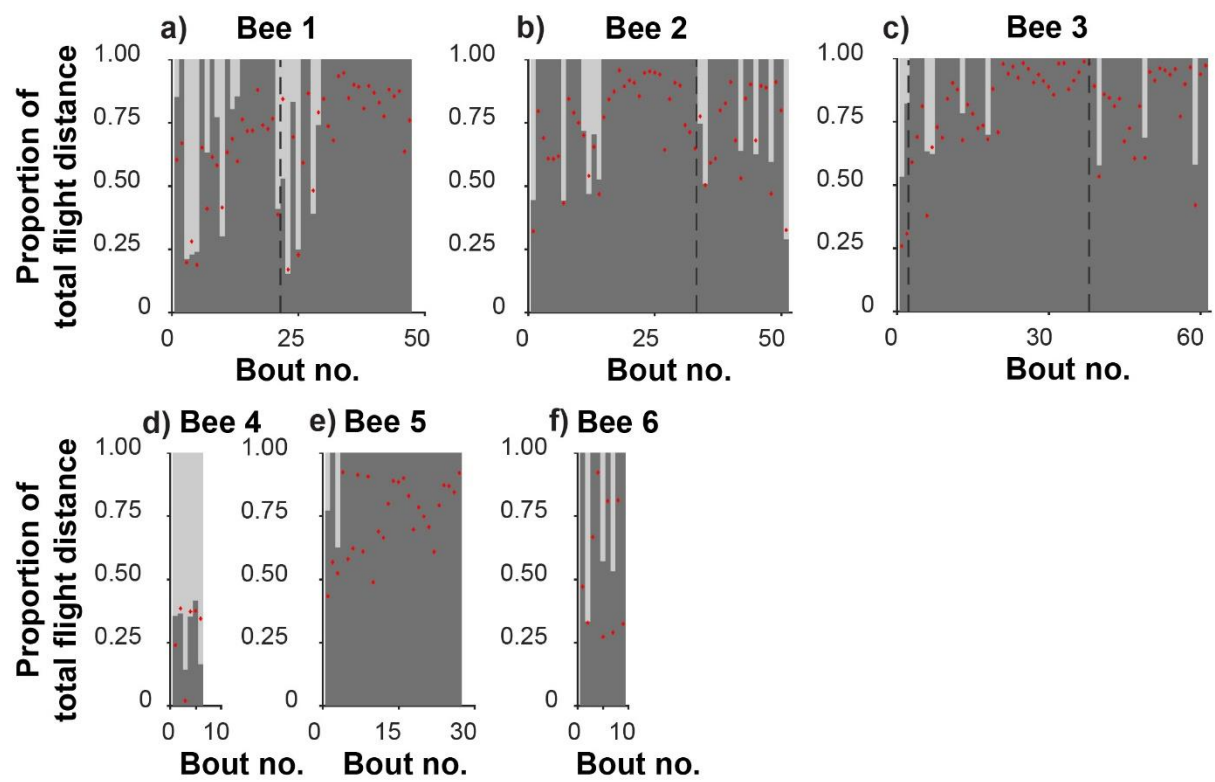


**Supplementary Fig S204: Path length and duration of foraging bouts of two bees.** Bees 4 and 6 completed only 6 and 9 bouts respectively, too few to assess how path lengths and duration of their flights changed over time as in Fig 3; data are shown here for comparison. X-axis of each plot shows the cumulative number of foraging bouts by each bee. a-b) Path length of each bout by bees 4 and 6 respectively. Distances were estimated as the cumulative length of a series of straight lines joining every pair of consecutive radar observations of the bees' positions. Total distance flown is broken down into two categories: blue bars = distance flown in legs that remained within 50m of a feeder; yellow bars = distance flown during 'exploration' legs (those in which the bee travels further than 50m from all feeders it has previously visited). Horizontal dashed grey line indicates minimum possible length of an optimal route visiting all feeders. Red dots indicate straight-line path length, the theoretical distance of a route composed of straight lines that visits the feeders in the order observed in each bout. c-d) Duration of each bout flown by bees 4 and 6 respectively. Total duration is broken down into three categories: blue bars = time spent within 5m of a feeder; green bars = total duration of legs that remained within 50m of a feeder; yellow bars = total duration of 'exploration' legs.

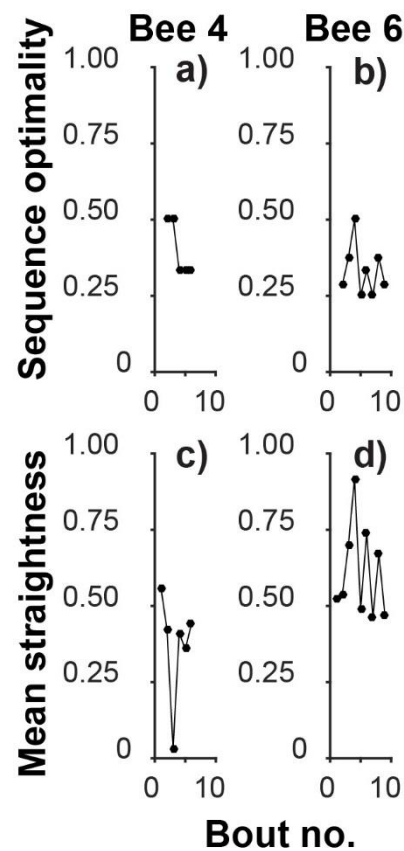


**Supplementary Fig S205: Proportion of total flight distance attributable to visit sequence.**

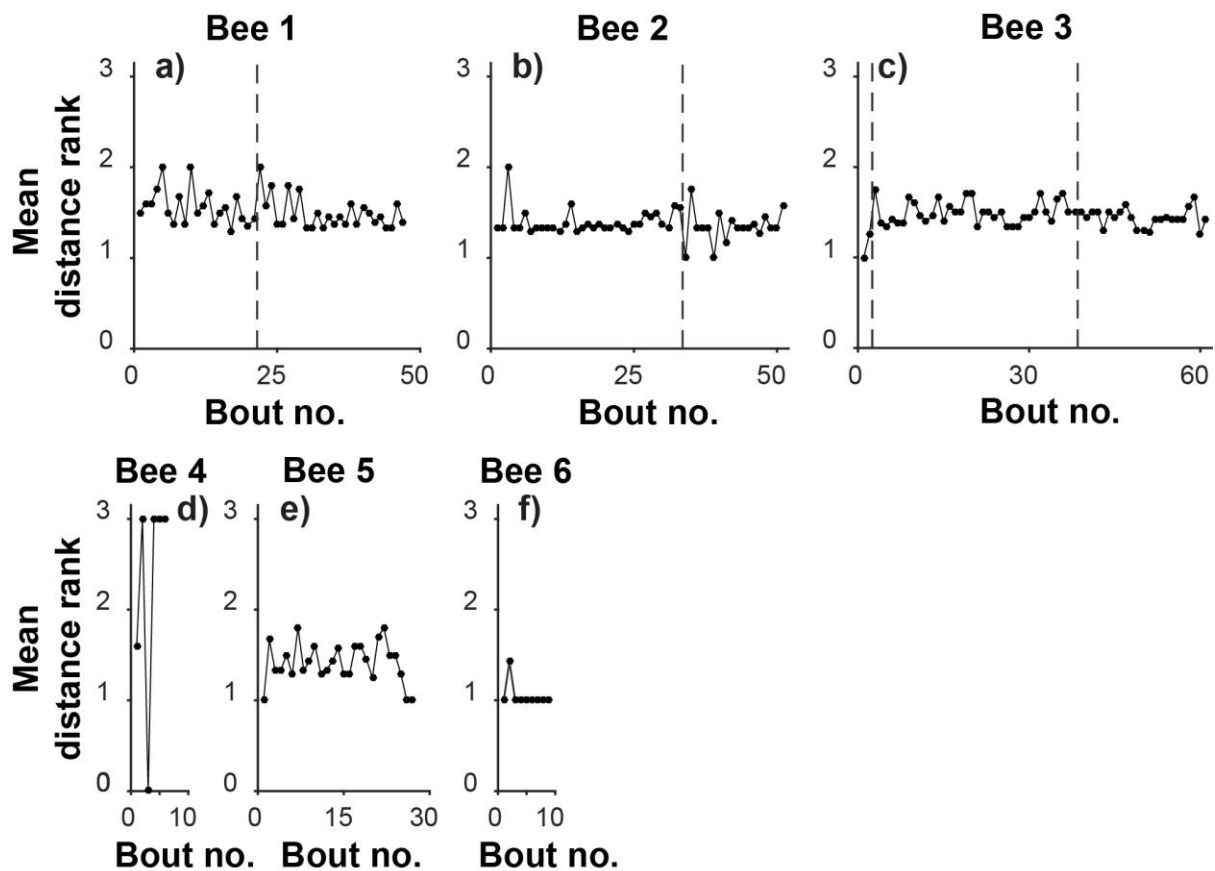
The red diamonds represent straight-line path length, the theoretical minimal distance required to visit the feeders in the order observed during each bout. This distance is expressed as a proportion of the total distance actually travelled by the bee in each bout. The background to each plot shows the proportion of the total distance flown by the bee which can be attributed to legs within the array (darker grey bars) and to 'exploration' legs (those in which the bee travels further than 50 m from all feeders it has previously visited; pale grey bars). Each panel represents every foraging bout flown by one bee. The x-axis of each plot shows the cumulative number of foraging bouts experienced by each bee. a-f) Bees 1-6 respectively. As bees gained experience on the feeder array an increasing proportion of the distance they flew could be attributed to the chosen visit sequence rather than inefficiency in the flight paths.



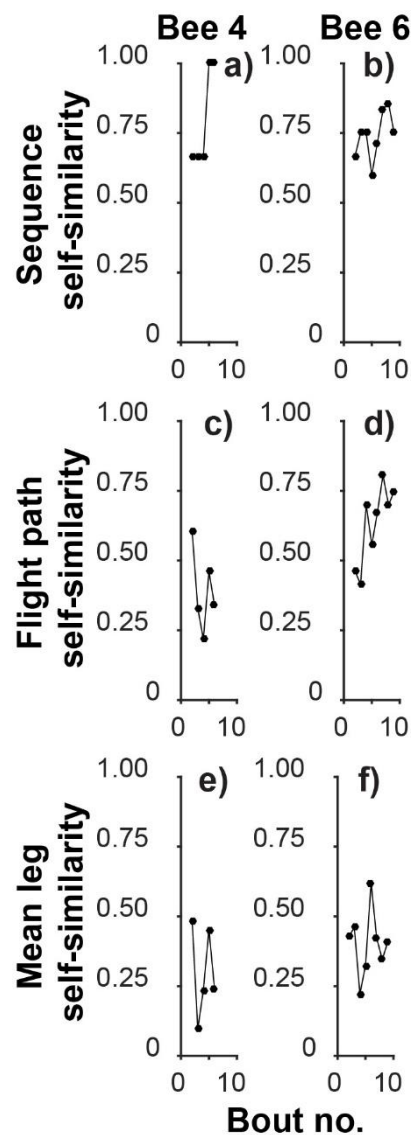
**Supplementary Fig S206: Optimality of visit sequence and straightness of flights for two bees.** Bees 4 and 6 completed only 6 and 9 bouts respectively, too few to assess how the efficiency of their flights changed over time as in Fig 4; data are shown here for comparison. Each panel represents every foraging bout flown by one bee. The x-axis of each plot shows the cumulative number of foraging bouts experienced by each bee. a-b) Optimality score for the feeder visit sequence in each bout by bees 4 and 6 respectively. c-d) Mean straightness of the flight paths of all legs in each bout by bees 4 and 6 respectively.



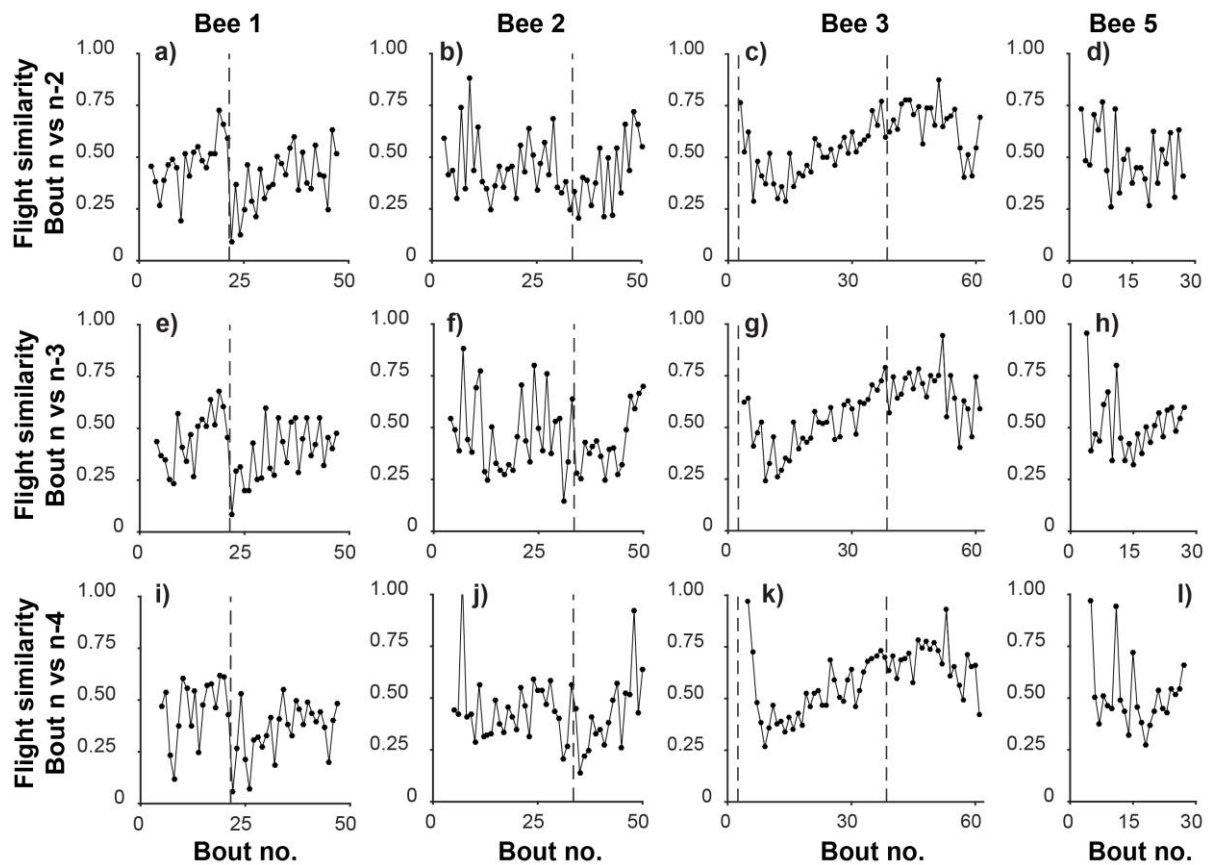
**Supplementary Fig S207: Mean distance ranks show legs largely involve transitions to nearby feeders.** Each panel represents every foraging bout flown by one bee. The x-axis of each plot shows the cumulative number of foraging bouts experienced by each bee. The vertical dashed lines indicate overnight breaks between foraging bouts. a-f) For bees 1-6 respectively, the mean distance rank of all legs in each bout. Each leg is assigned a rank reflecting how far the destination location is from the starting location. There was little change in these ranks with experience.



**Supplementary Fig S208: Repeatability of visit sequence and flight path for two bees.** Bees 4 and 6 completed only 6 and 9 bouts respectively, too few to assess how the stability of their flights changed over time as in Fig 5; data are shown here for comparison. Each panel represents every foraging bout flown by one bee. The x-axis of each plot shows the cumulative number of foraging bouts experienced by each bee. a-b) Self-similarity score for the feeder visit sequence in each bout by bees 4 and 6 respectively (similarity of the sequence of feeder visits in each bout to that of the previous bout undertaken by the same bee). c-d) Self-similarity score comparing the probability map of the bee's location during each bout to that of the previous bout by bees 4 and respectively. e-f) For bees 4 and 6 respectively, the mean similarity of the individual legs of each bout to the most recent occasion on which the same bee made the same feeder-to-feeder transition.



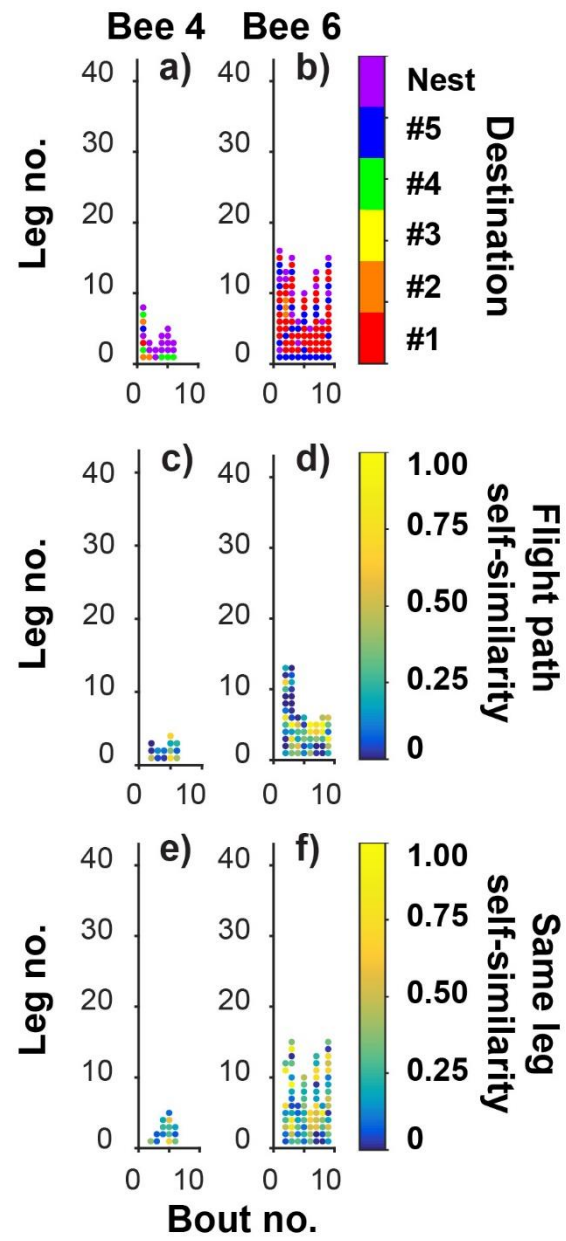
**Supplementary Fig S209: Flight paths become more repeatable with experience at multiple timescales.** Each panel represents every foraging bout flown by one bee. The x-axis of each plot shows the cumulative number of foraging bouts experienced by each bee. The vertical dashed lines indicate overnight breaks between foraging bouts. a-d) Self-similarity score for bees 1-3 and 5 respectively, comparing the probability map of the bees' location during each bout to that recorded two bouts previously. e-h) Self-similarity score comparing each bout's flight path to that recorded two bouts previously. i-l) Self-similarity score comparing each bout's flight path to that recorded three bouts previously. i-l) Self-similarity score comparing each bout's flight path to that recorded four bouts previously. Similar figures comparing each bout to that recorded one bout previously are shown in Fig 5e-h. At all timescales there is a tendency toward increasing similarity scores over time.



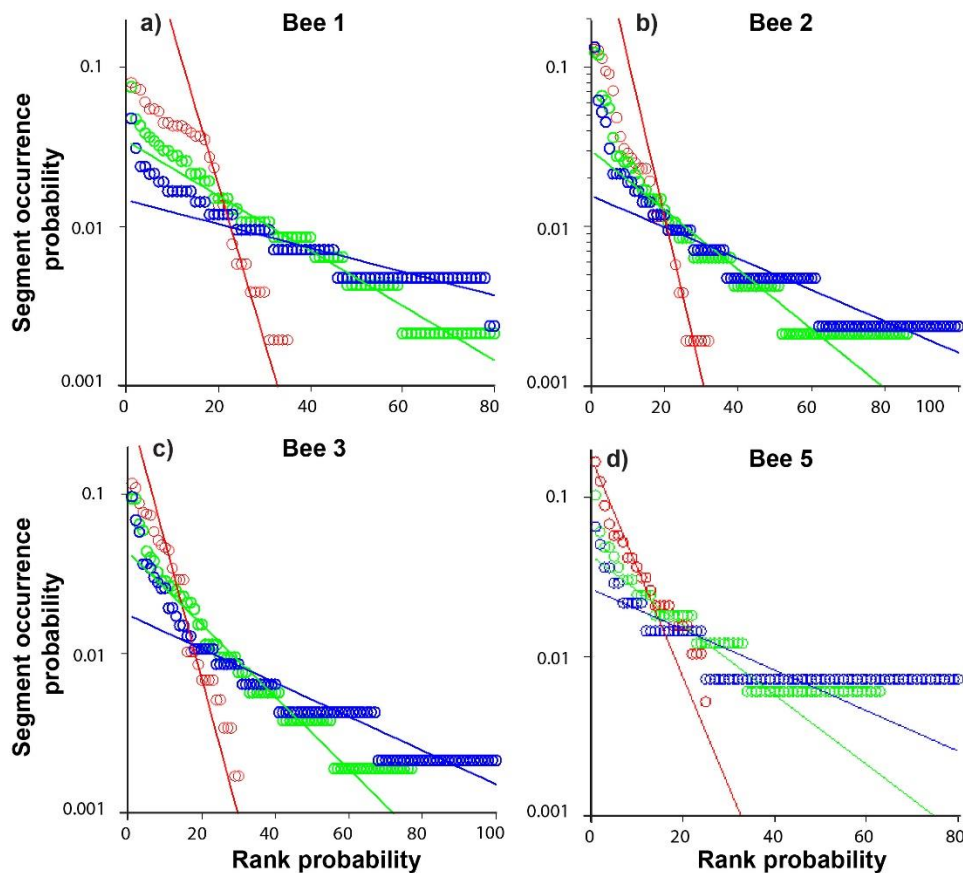


**Supplementary Fig S210: Repeatability of individual legs of a foraging route for two bees.**

Bees 4 and 6 completed only 6 and 9 bouts respectively, too few to assess how the stability of their flights changed over time as in Fig 6; the data are shown here for comparison. Each panel represents every individual leg (transitions from any feeder to another) of every foraging bout flown by one bee. The x-axis of each plot shows the cumulative number of foraging bouts experienced by each bee. The y-axis shows the cumulative number of legs within each bout. The vertical dashed lines indicate overnight breaks between foraging bouts. a-b) For bees 4 and 6 respectively, the colour of each dot represents the identity of the destination of each leg of the route (i.e. the feeders 1-5 or the nest). The presence of horizontal rows of the same colour demonstrates that the bee in question visited the same destination at the same stage during several consecutive foraging bouts. c-d) For bees 4 and 6, the colour of each dot represents the self-similarity score comparing the probability map of the bee's location during each leg of the bout to that of the same leg in the previous bout. i-l) For bees 4 and 6, the colour of each dot represents the similarity of each legs within each bout to the most recent occasion on which the same bee made the same feeder-to-feeder transition.



**Supplementary Fig S211: Probability of segments of flight of different lengths occurring within a foraging bout.** The feeder visitation sequence for each bout was broken into shorter segments of two, three or four destinations and the probability was calculated of each unique sequence occurring in any given bout of a particular bee. Each panel combines the occurrences of each segment across all bouts flown by one bee. a-d) For bees 1-3 and 5 respectively, the descending rank commonness of each flight segment is plotted against the occurrence probability of that segment on a log-linear scale. Segments of length two are shown in red, those of length three in green, and those of length four in blue. The lines show how well the distributions fit an exponential distribution. The most commonly occurring segments fit the line poorly and occurred more commonly than predicted by an exponential distribution, implying the use of memory and decision making. The less common segments fit an exponential distribution well, implying that their presence within a route was generated by purely stochastic processes.



## Legends for further supplementary material

**Supplementary Videos S1-S6: Animated heat maps showing the development of foraging routes on the experimental feeder array.** Each video graphically represents the flight path of a single bee over all of its foraging bouts on the experimental feeder array, using the same principles as Fig 2. The colour of each pixel represents the probability that the bee passed over that point in the landscape as estimated from the radar tracks using a technique derived from a Brownian Bridge movement model (described in the Methods). Each pixel represents an area 5 x 5m. Scale bars represent a distance of 20m. The colour of each pixel decays with time unless reinforced, in a manner analogous to an ant pheromone trail. Thus, abandoned segments of route gradually fade while those segments of the route used most frequently become reinforced. Videos play at 600x real speed and periods during which the bee's location did not change for more than 60s have been curtailed. Nest position: open circle; positions of feeders: closed circles.

**Supplementary Dataset S1: Variables describing flight path of each bout flown by each bee.**

All data used in the analyses presented in the manuscript.