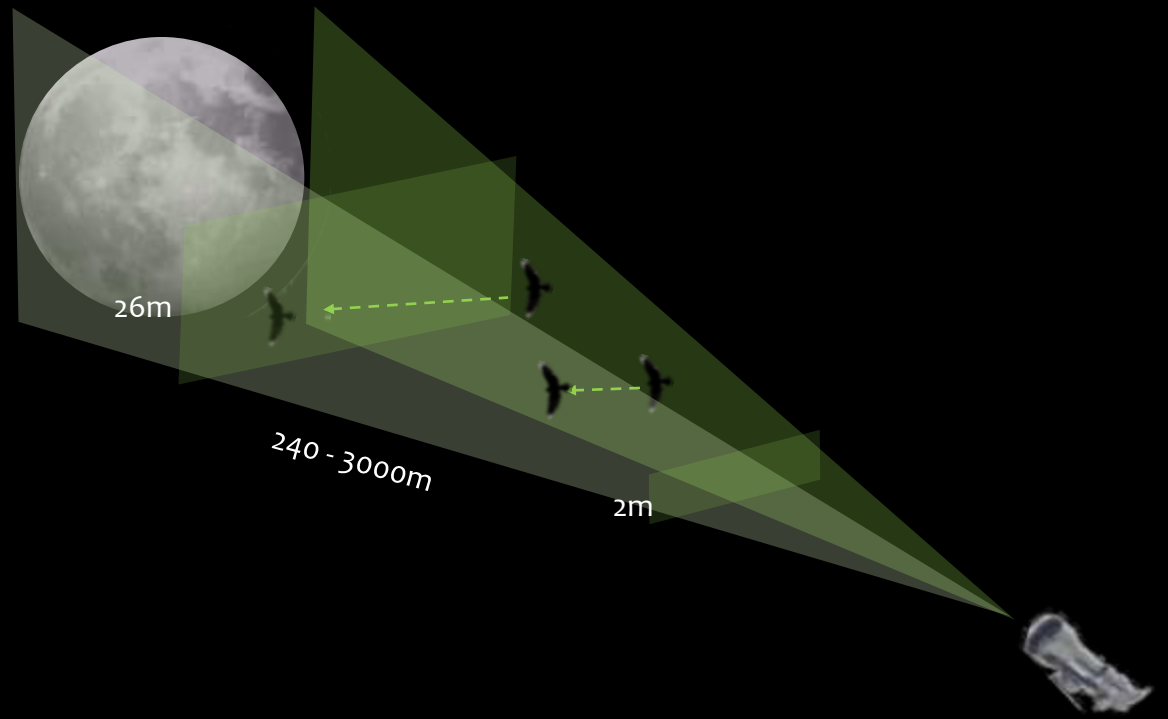
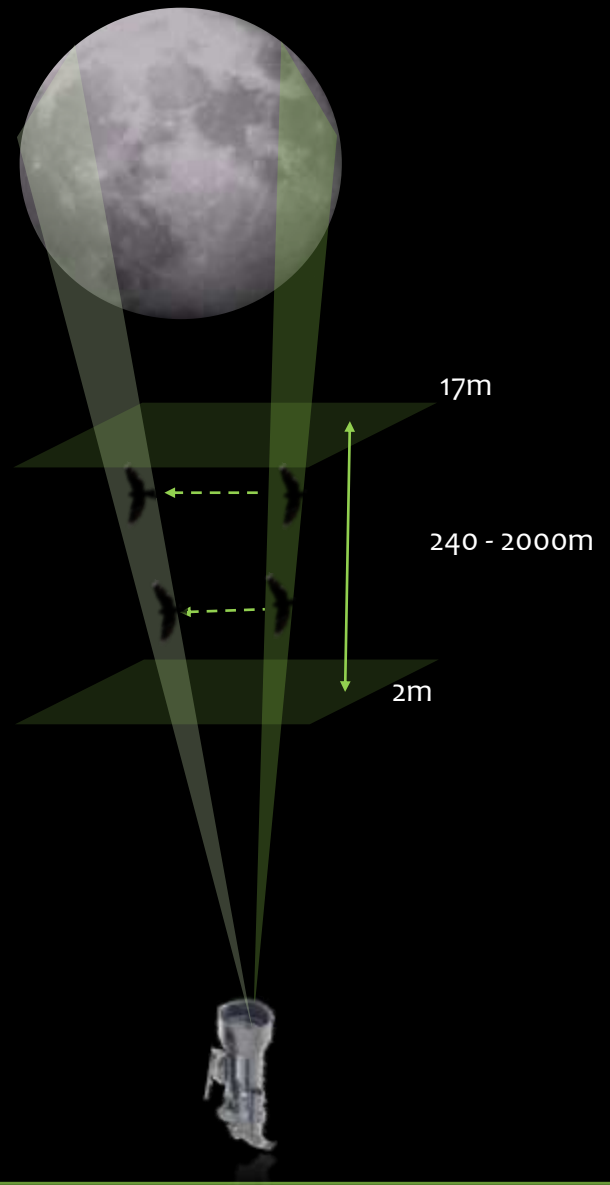
lunaves - revisiting moon watching

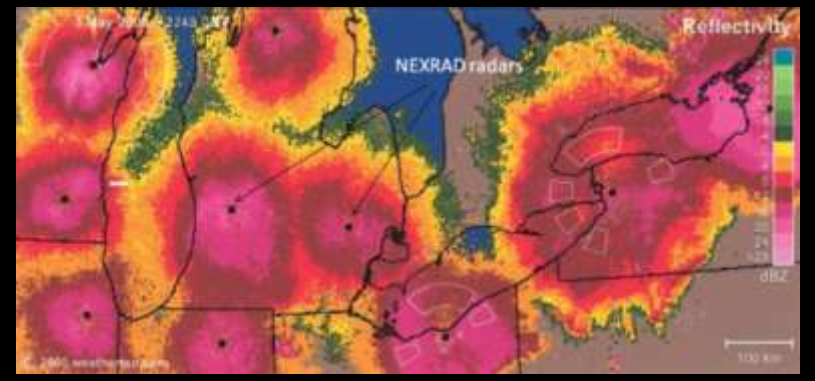
Can moon watching be an effective technique for bird migration studies?

- Effectiveness of moon watching is limited by two factors:
  1. Initiatives require large number of (very) dedicated volunteers
  2. Scope covers narrow field of view, even more during high moon altitude





Yet, we still lack suitable alternatives



- There are other techniques to observe nocturnal migration:
  - Ringing is relevant mainly for stopover points
  - Data from weather radars data not available in Europe as in US
  - Mobile radar units are expensive, impractical except for specialised research

- Through the lunaves initiative we aim to answer :

Despite known limitations, what insights could we get from moon watching if we can address the human factor?

The lunaves project

Astro telescope

- 70mm lens
- 40x magnification

Motorized scope mount

- Azm / Alt axis
- RS-232 interface

Webcam (x2)

- 30 fps
- 1080p resolution

Software & Hardware

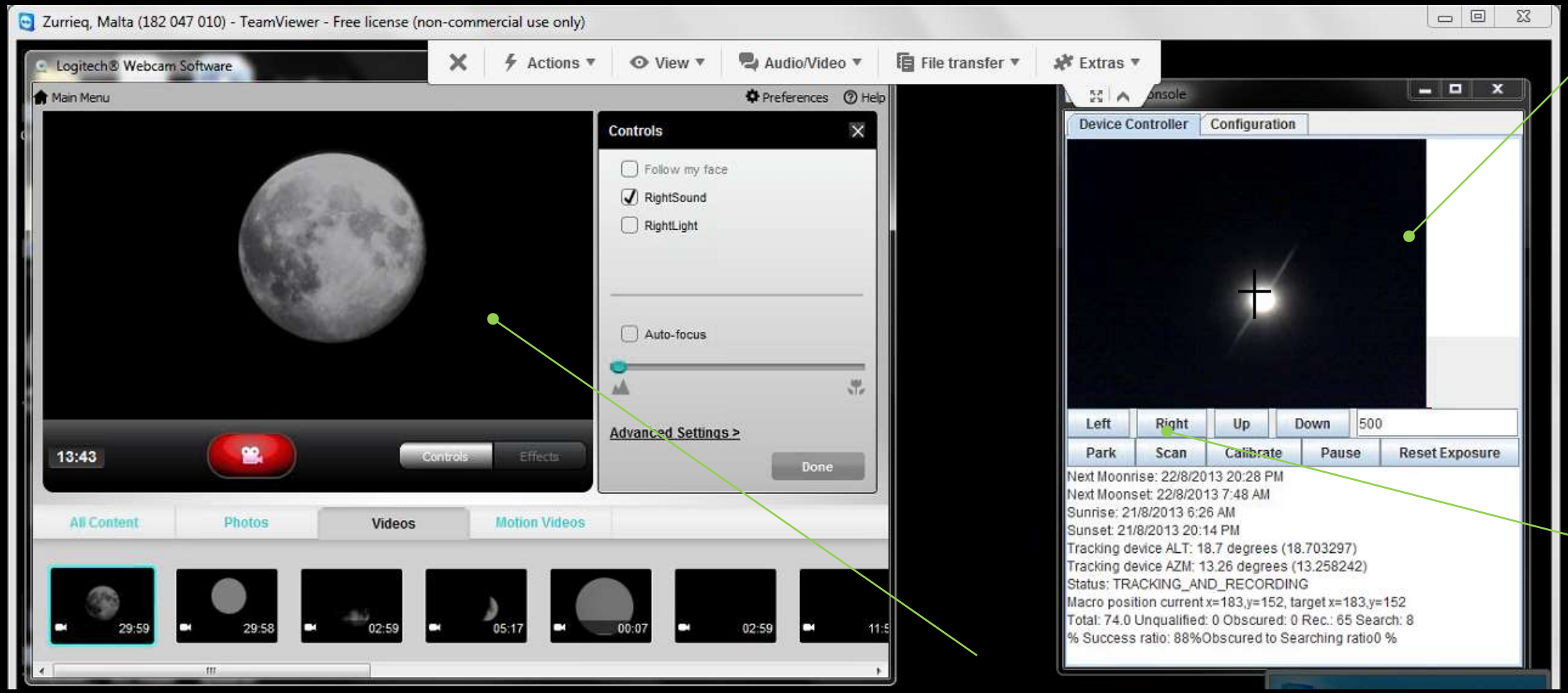
- Core i5 processor
- lunaves Tracker
- lunaves Scanner

Part 1: lunaves Tracker software

1. Scope is set horizontally pointing to East
2. At moonrise the scope will use the wide-angle view webcam to align the moon across the scope
3. Mount is moved along Altitude and Azimuth to keep moon centred
4. Continuous video is recorded on file
5. Upon moonset or sunrise, scope is parked to standby position pointing to east, ready for next day
6. In case of clouds, setup calculates approximate position using lunar orbit calculations, until clouds clear

lunaves Tracker user interface

Webcam1:
Wide-angle view



Console :
Manual control operations

Webcam2:
Digiscoped view

List of files recorded over a single night session

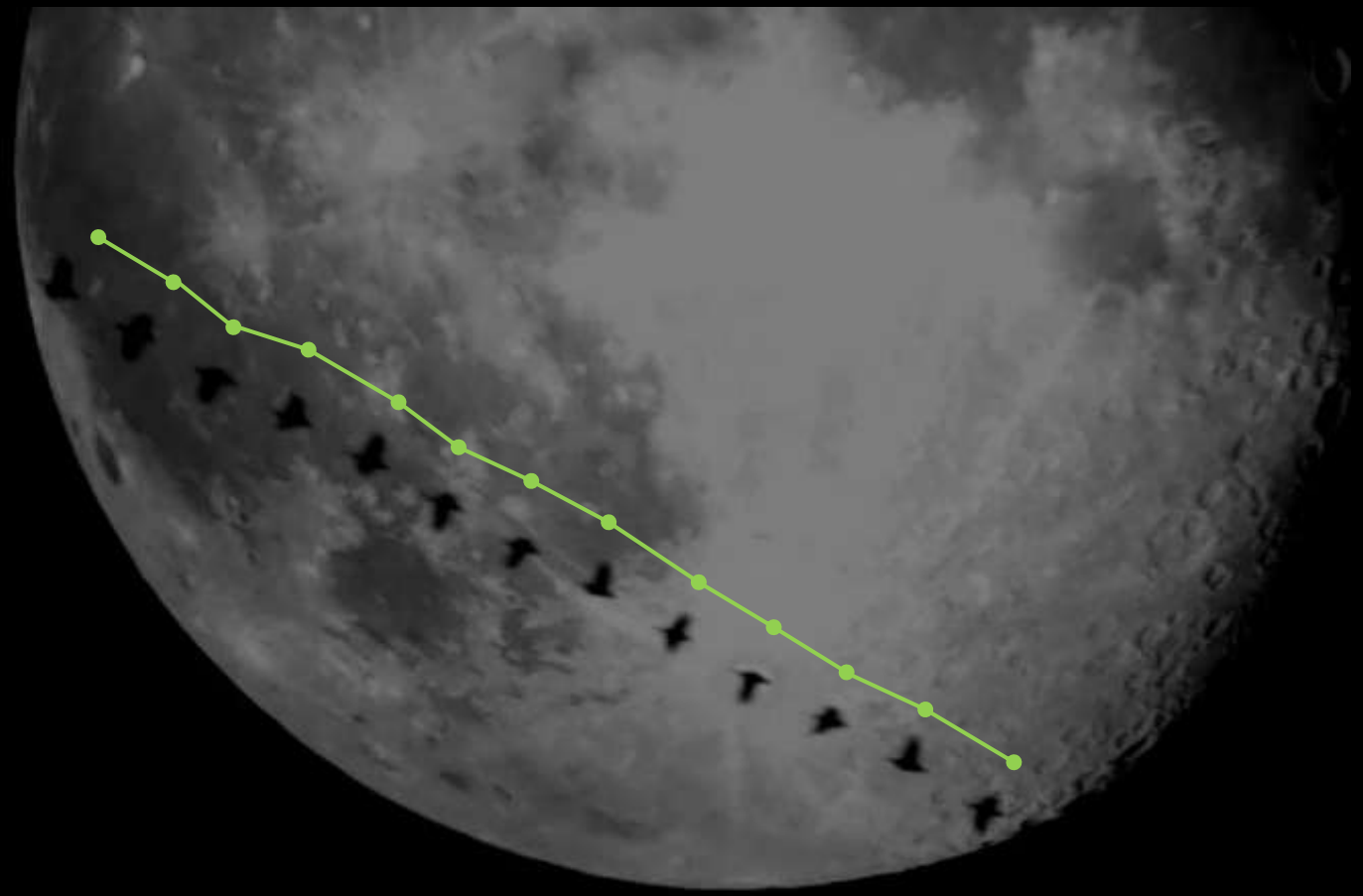
Name	Date	Type	Size	Length
parked	12/10/2013 04:51	File folder		
Video 1778	14/11/2013 20:58	MP4 File	1,233,770 KB	00:29:59
Video 1779	14/11/2013 21:29	MP4 File	1,235,169 KB	00:29:58
Video 1780	14/11/2013 21:59	MP4 File	1,247,154 KB	00:29:59
Video 1781	14/11/2013 22:29	MP4 File	1,290,926 KB	00:29:59
Video 1782	14/11/2013 22:59	MP4 File	1,293,953 KB	00:29:59
Video 1783	14/11/2013 23:30	MP4 File	1,290,088 KB	00:29:59
Video 1784	15/11/2013 00:00	MP4 File	1,280,248 KB	00:29:59
Video 1785	15/11/2013 00:30	MP4 File	1,271,182 KB	00:29:59
Video 1786	15/11/2013 01:00	MP4 File	1,264,351 KB	00:29:59
Video 1787	15/11/2013 01:31	MP4 File	1,279,840 KB	00:29:59
Video 1788	15/11/2013 01:45	MP4 File	521,919 KB	00:13:59
Video 1789	15/11/2013 01:55	MP4 File	333,146 KB	00:09:59
Video 1790	15/11/2013 01:57	MP4 File	36,535 KB	00:01:59
Video 1791	15/11/2013 02:10	MP4 File	59,637 KB	00:02:59

At 1080p, size of file is about 1.25GB for every 30 minutes

Part 2: Using the lunaves Scanner software

1. The lunaves Scanner software takes each frame from video recorded by lunaves Tracker and using custom motion detection algorithms it distinguishes between bird silhouettes and general pixel noise

2. A trajectory between all the relevant of flight trajectory are mapped out



14-09-2013, Hamrun

Hamrun,
14-09-2013
21.45-21.51
(6 mins)

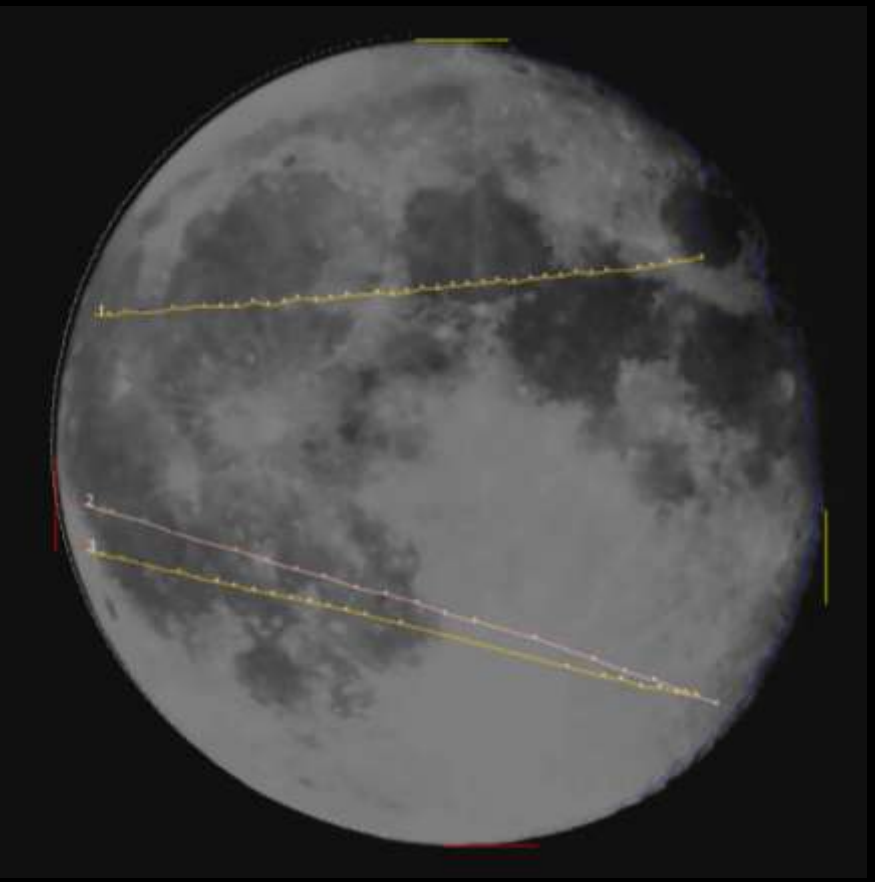
0mins

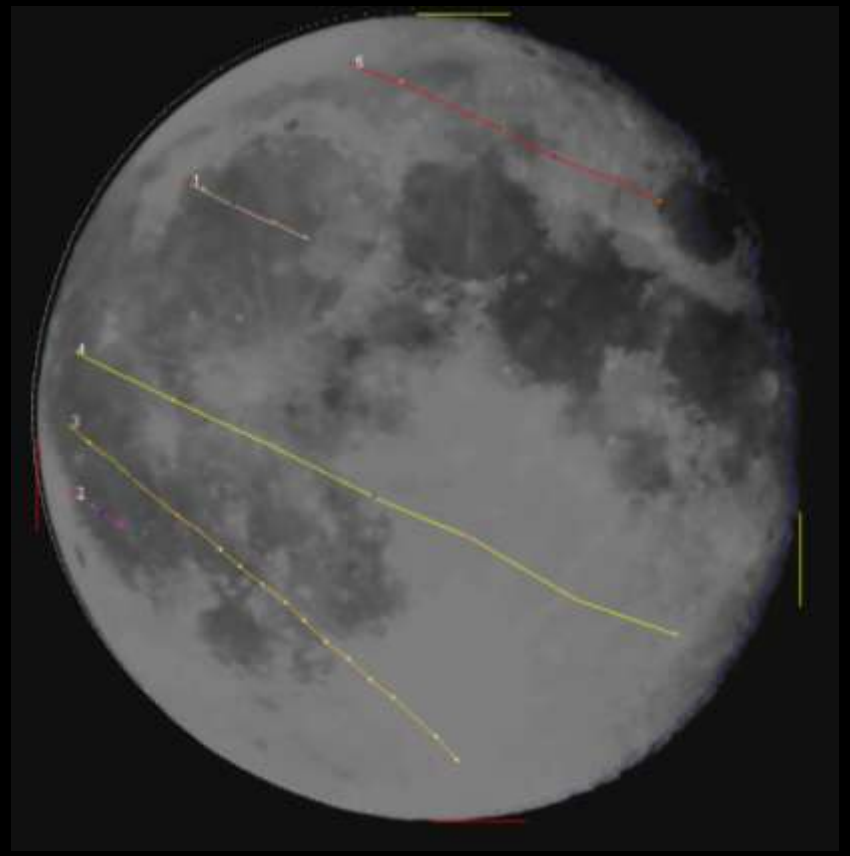
3mins

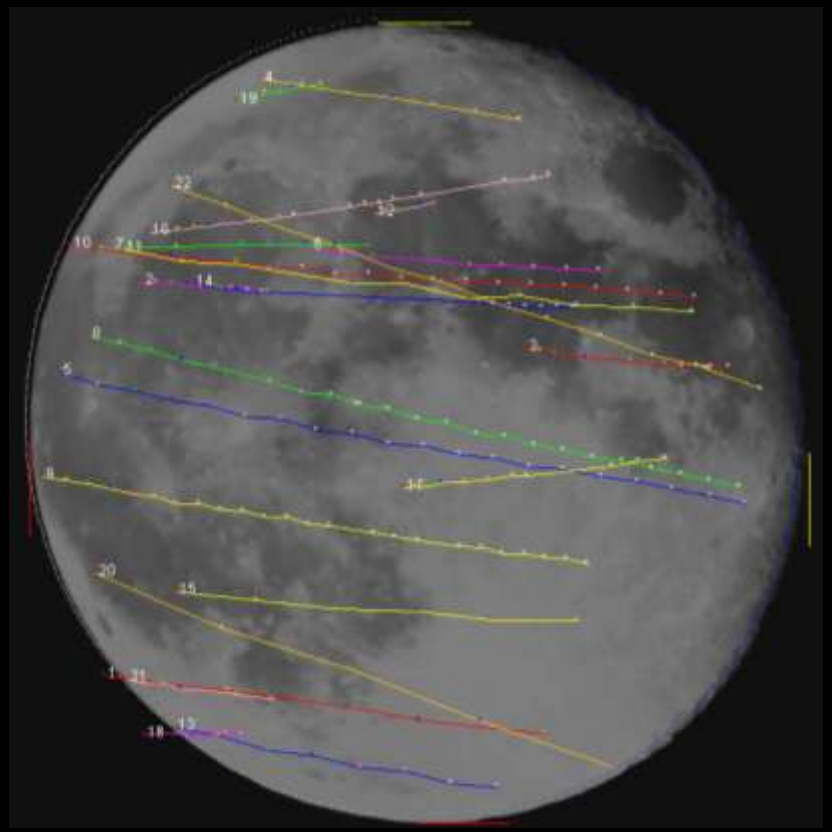
6mins

Outputs 1 – Trajectories summary snapshot for a video clip

Output 1: Each video has a summary image with all trajectories of the identified birds







Outputs 2 : Sighting data in CSV format for analysis

Output 2 : CSV (excel) file with all the details about the sighting, useful for further analysis

1	Trajectory index	Video File name	Session start	Session end	Trajectory time	Record generation date	Num minutes from video start	Num seconds from video start	Num detected clumps	Confidence level	First clump co-ordinates	Last clump co-ordinates	Direction (rel. to moon)	Num pix largest sighting	Speed (pix/frame)	Moon AZM	Moon ALT	Moon phase
2	1	Video 756	14/09/2013 21:45	14/09/2013 21:45	14/09/2013 21:45	14/10/2013 19:18	0	0	21	10	X: 1245, Y	X: 1083, Y	SOUTHWE	5	12	196.164	34.6205	0.33099
3	2	Video 756	14/09/2013 21:45	14/09/2013 21:45	14/09/2013 21:45	14/10/2013 19:18	0	3	18	10	X: 1188, Y	X: 913, Y:	SOUTHWE	29	17	196.177	34.6179	0.33099
4	3	Video 756	14/09/2013 21:45	14/09/2013 21:45	14/09/2013 21:47	14/10/2013 19:21	1	43	5	10	X: 1117, Y	X: 1069, Y	SOUTHWE	3	14	196.634	34.5281	0.33104
5	4	Video 756	14/09/2013 21:45	14/09/2013 21:45	14/09/2013 21:48	14/10/2013 19:23	2	43	17	10	X: 1223, Y	X: 936, Y:	SOUTHWE	15	16	196.908	34.473	0.33106
6	5	Video 756	14/09/2013 21:45	14/09/2013 21:45	14/09/2013 21:49	14/10/2013 19:24	3	36	19	10	X: 1110, Y	X: 960, Y:	SOUTHWE	77	23	197.149	34.4236	0.33108
7	6	Video 756	14/09/2013 21:45	14/09/2013 21:45	14/09/2013 21:49	14/10/2013 19:25	4	7	8	10	X: 1175, Y	X: 1122, Y	SOUTHWE	8	7	197.29	34.3944	0.3311
8	7	Video 756	14/09/2013 21:45	14/09/2013 21:45	14/09/2013 21:49	14/10/2013 19:25	4	8	18	10	X: 963, Y:	X: 769, Y:	SOUTHWE	10	6	197.295	34.3934	0.3311
9	8	Video 756	14/09/2013 21:45	14/09/2013 21:45	14/09/2013 21:50	14/10/2013 19:26	4	37	13	10	X: 933, Y:	X: 773, Y:	SOUTHWE	7	16	197.427	34.3659	0.33111
10	9	Video 756	14/09/2013 21:45	14/09/2013 21:45	14/09/2013 21:50	14/10/2013 19:27	5	14	5	10	X: 1038, Y	X: 1001, Y	SOUTHWE	8	11	197.594	34.3304	0.33113
11	10	Video 756	14/09/2013 21:45	14/09/2013 21:45	14/09/2013 21:51	14/10/2013 19:28	5	35	23	10	X: 1225, Y	X: 818, Y:	SOUTHWE	91	27	197.69	34.3101	0.33114
12	11	Video 756	14/09/2013 21:45	14/09/2013 21:45	14/09/2013 21:51	14/10/2013 19:29	6	15	25	10	X: 1229, Y	X: 840, Y:	SOUTHWE	27	16	197.871	34.2712	0.33115
13	12	Video 756	14/09/2013 21:45	14/09/2013 21:45	14/09/2013 21:52	14/10/2013 19:30	6	37	14	10	X: 1137, Y	X: 777, Y:	SOUTHWE	4	24	197.971	34.2496	0.33116

Output 3 – slow-motion video clip for every identified bird

Line indicating trajectory across clip – useful when the target is particularly faint

Information about sighting (time & place)

Output 3 – mp4 video clip for every trajectory

Video output (with slow motion)
from scanner showing identified target

Stations in action

- Development of system started around August 2012
- Two stations active during the past 6 months in Malta – units kept outside
- Main requirement is cover from wind, power supply and WiFi for remote management (mainly from UK)
- So far:
  - Reliable data collected for September 2013
  - 2 Terabytes+ of video data collected
  - +500 sightings from processed videos
  - Survived burnout of scope lenses and flooding!

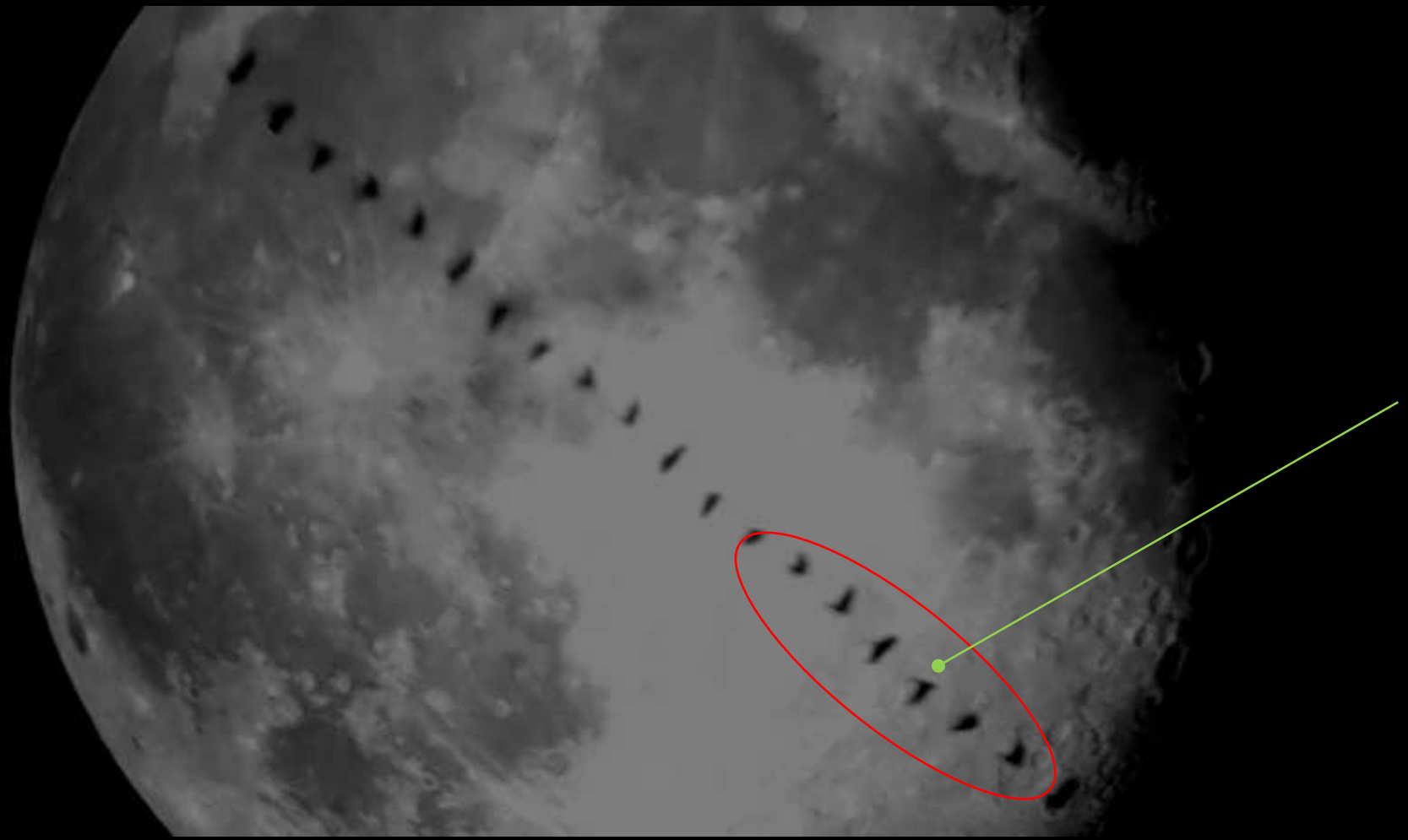
Hamrun, Malta

Zurrieq, Malta

Observation 1 : Eye versus Camera : 0 - 1

1. Capturing 30 frames per second on film and algorithm are much sharper than human eye – can collect records which previously would have been missed
2. Level of detail makes possible attempts at identification
3. Consistent and uniform readings – not dependent on experience of watcher
4. Detection can be achieved also for the smaller phases of moon, this extending the period of observation (clouds permitting)

…analysis of silhouettes



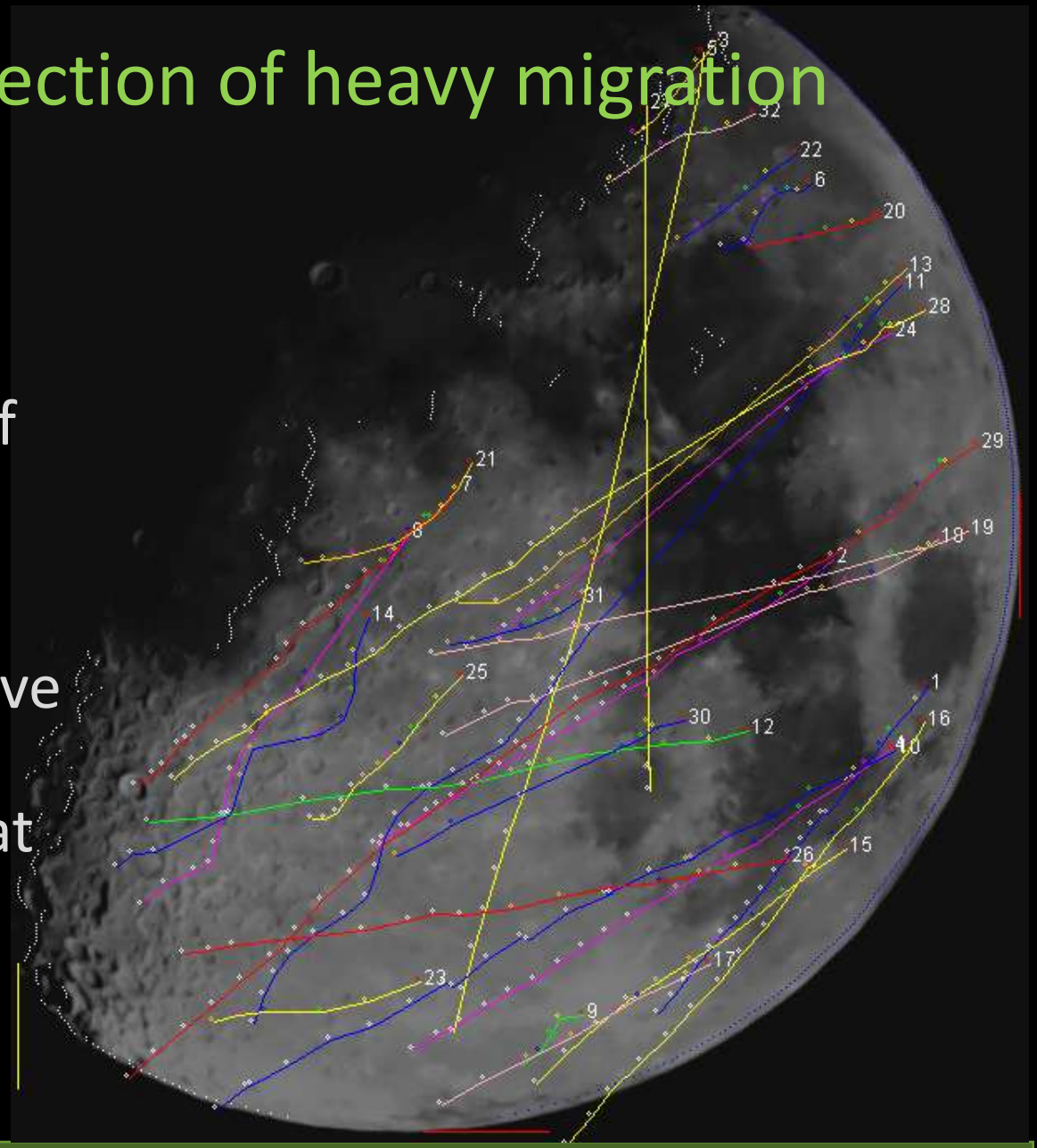
Detailed silhouette analysis is possible – something that cannot be done in the field.

With improved equipment images could be made sharper

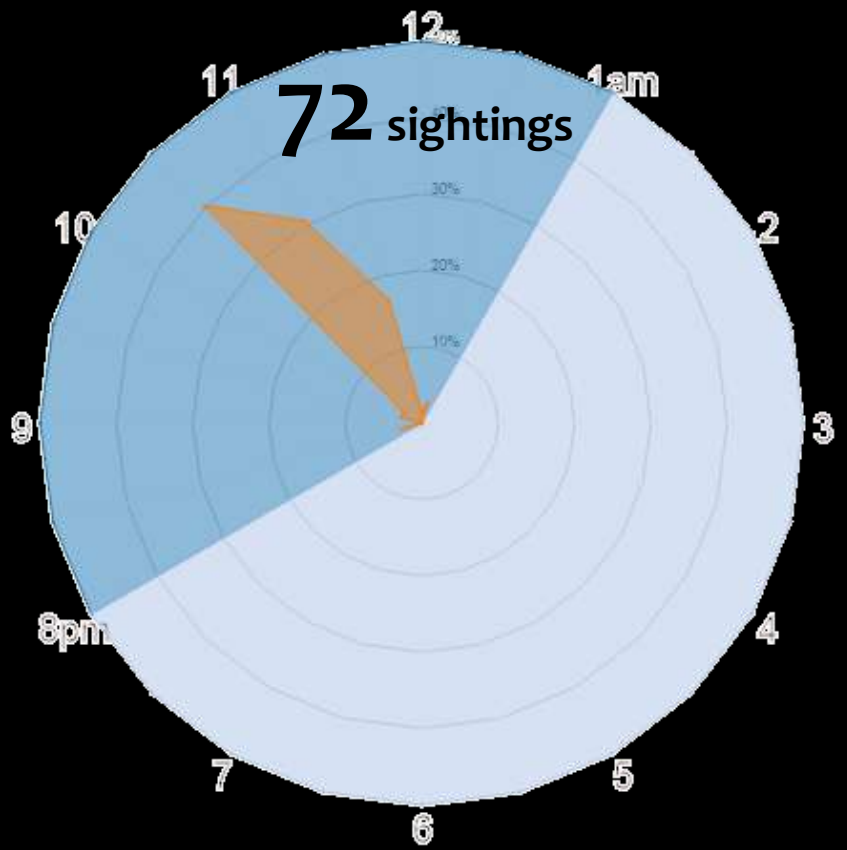
…spotting of birds with 25% moon

Observation 2– Effective detection of heavy migration

- 14th September, 76 sightings in 1.5 hours
- 20 sightings in 15 minutes with just 65% of moon visible
- If there were 20 sightings within an effective area of just 17m x 17m, what was the migration across 27km of Malta during that hour?



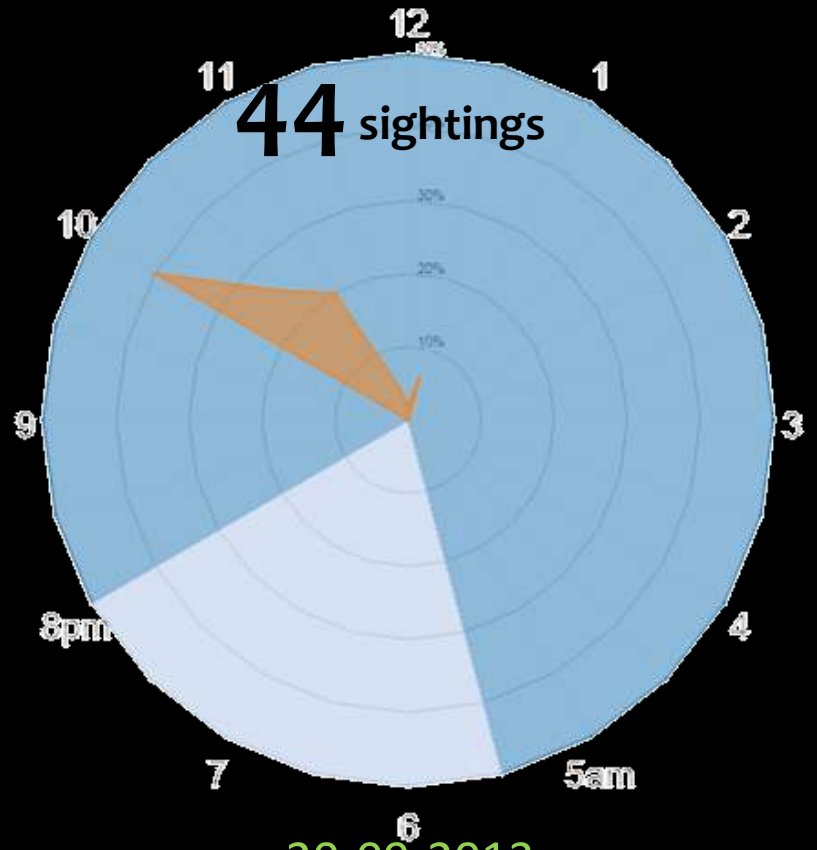
Observation 3– Punctual arrival of autumn migrants



14-09-2013

20:52 - 00:56

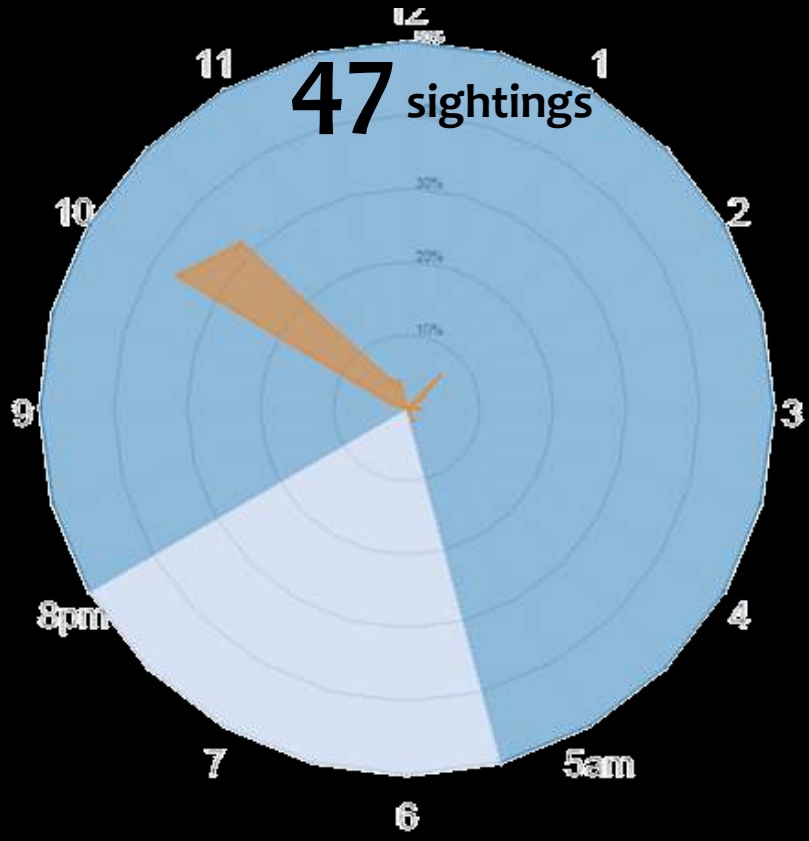
Hamrun



20-09-2013

22:08- 05:00

Hamrun

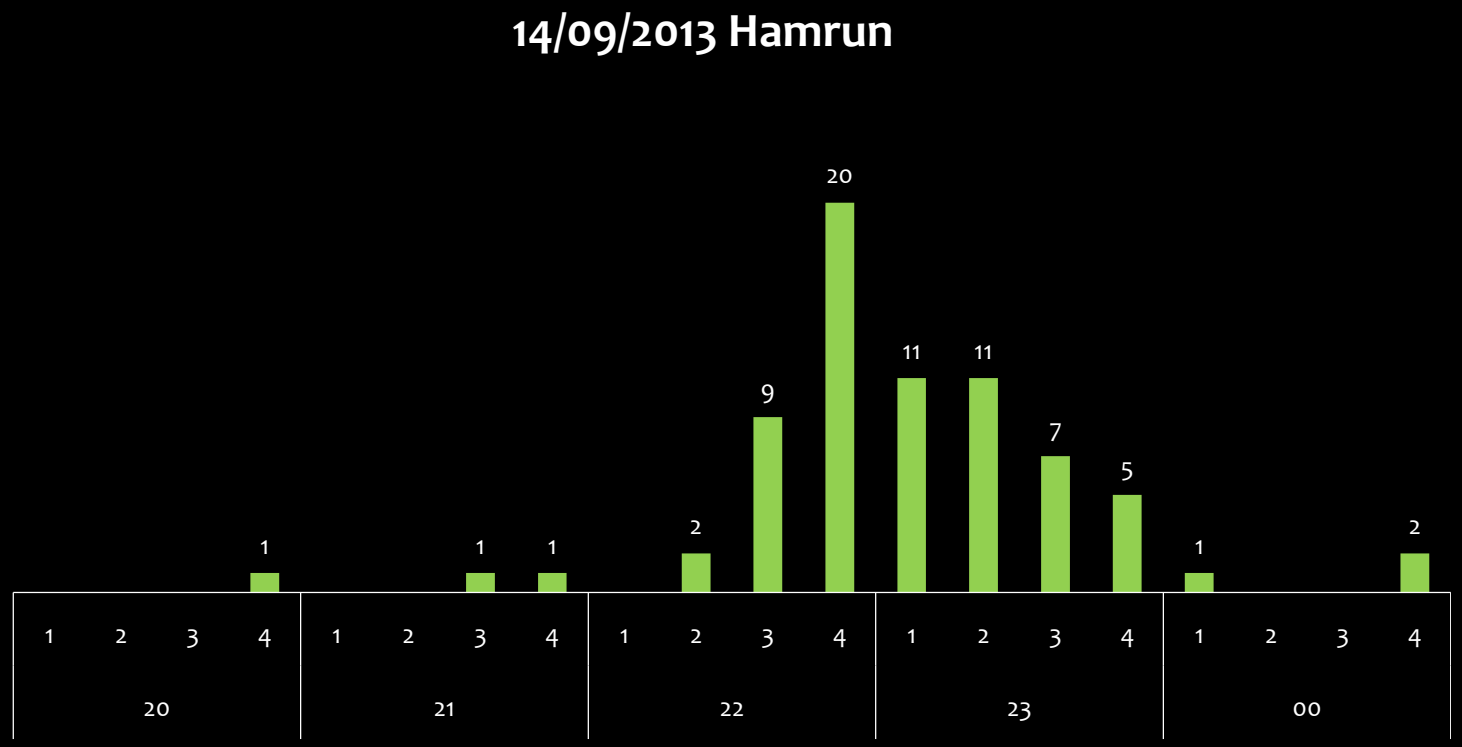


21-09-2013

21:59 - 05:10

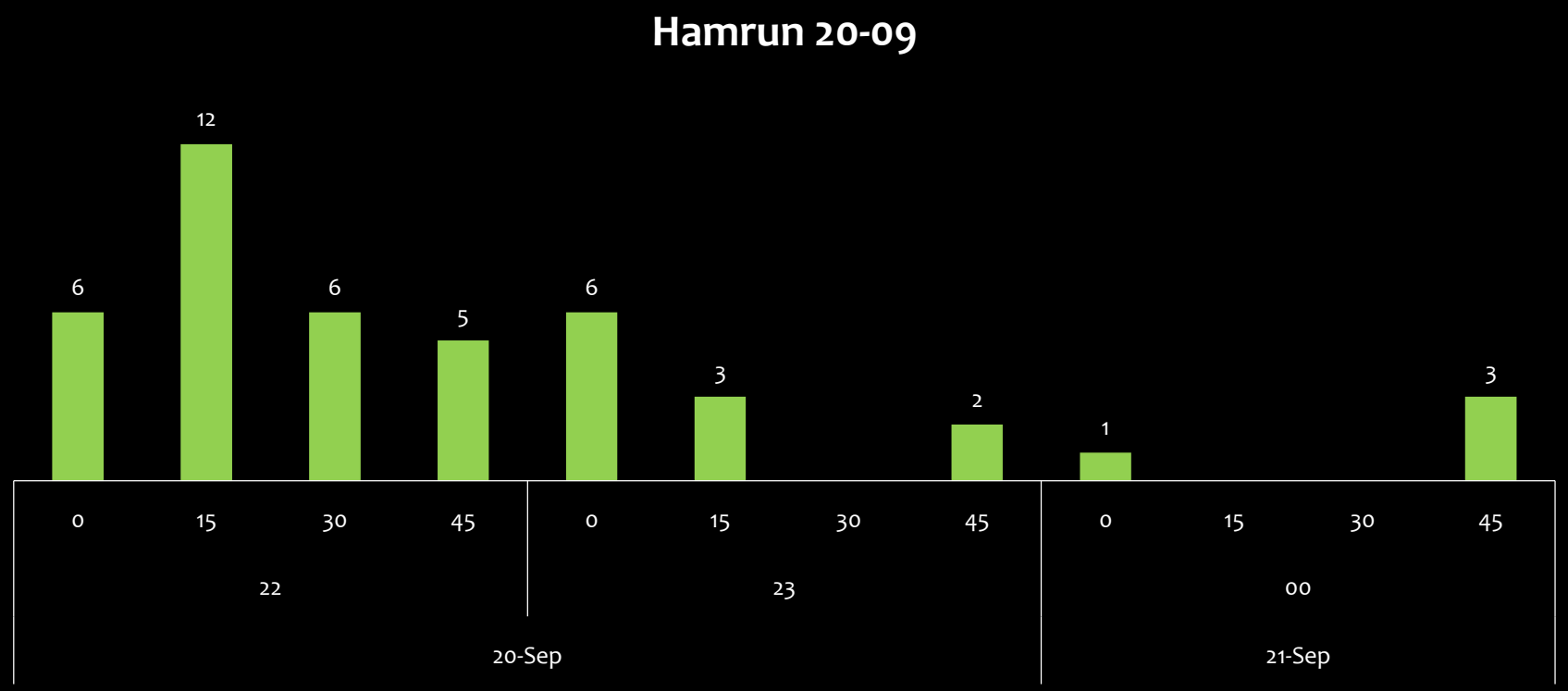
Hamrun

Observation 3 – Sightings grouped by 15mins intervals



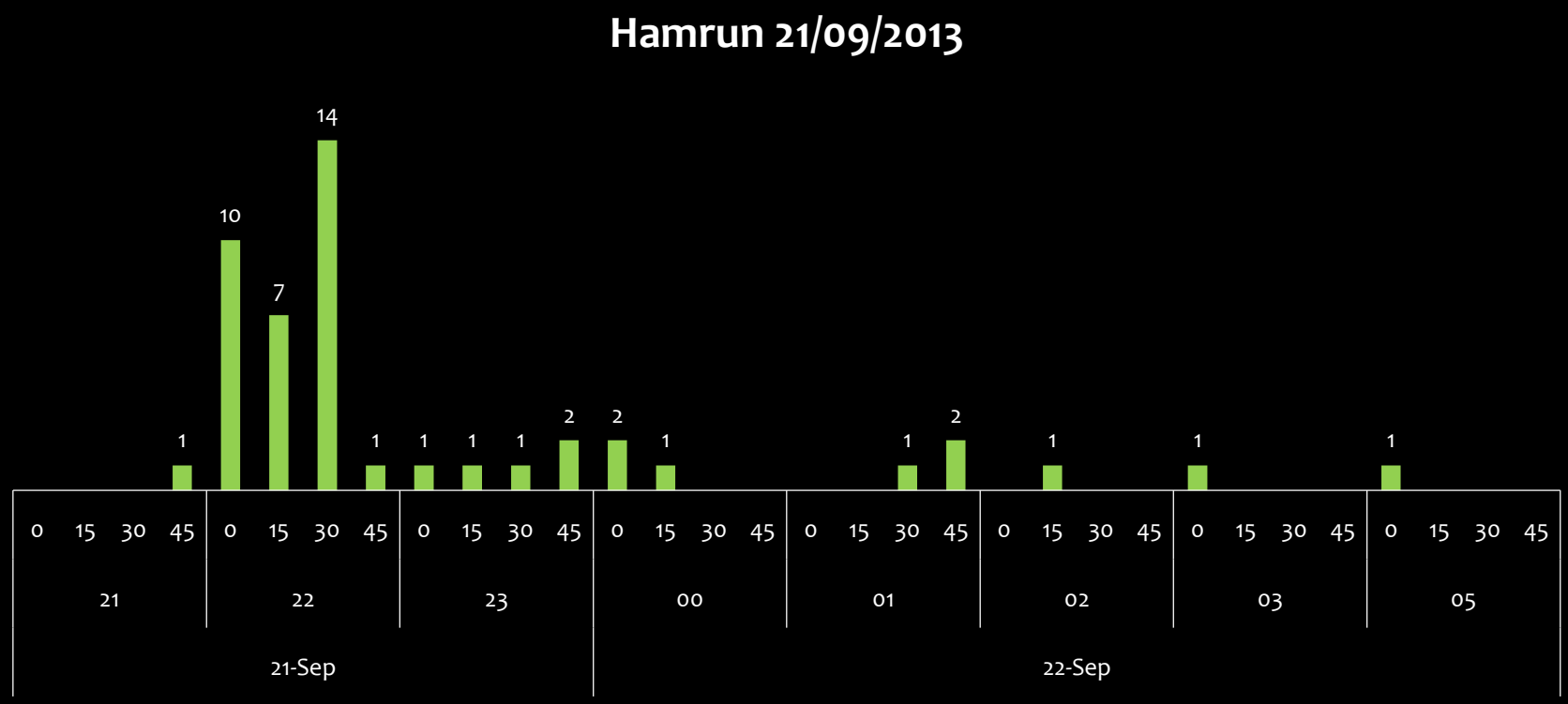
15 minute intervals

Observation 3 – Sightings grouped by 15mins intervals



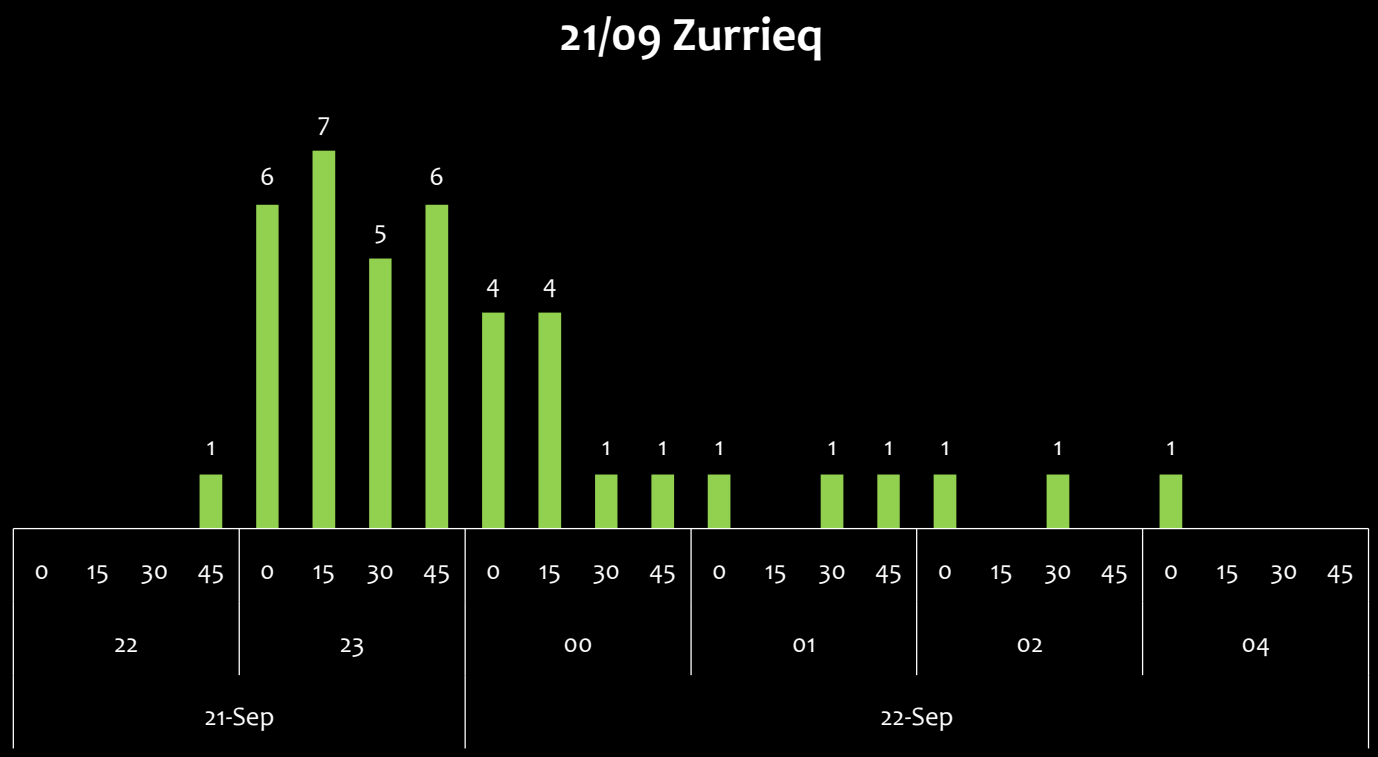
15 minute intervals

Observation 3 – Sightings grouped by 15mins intervals

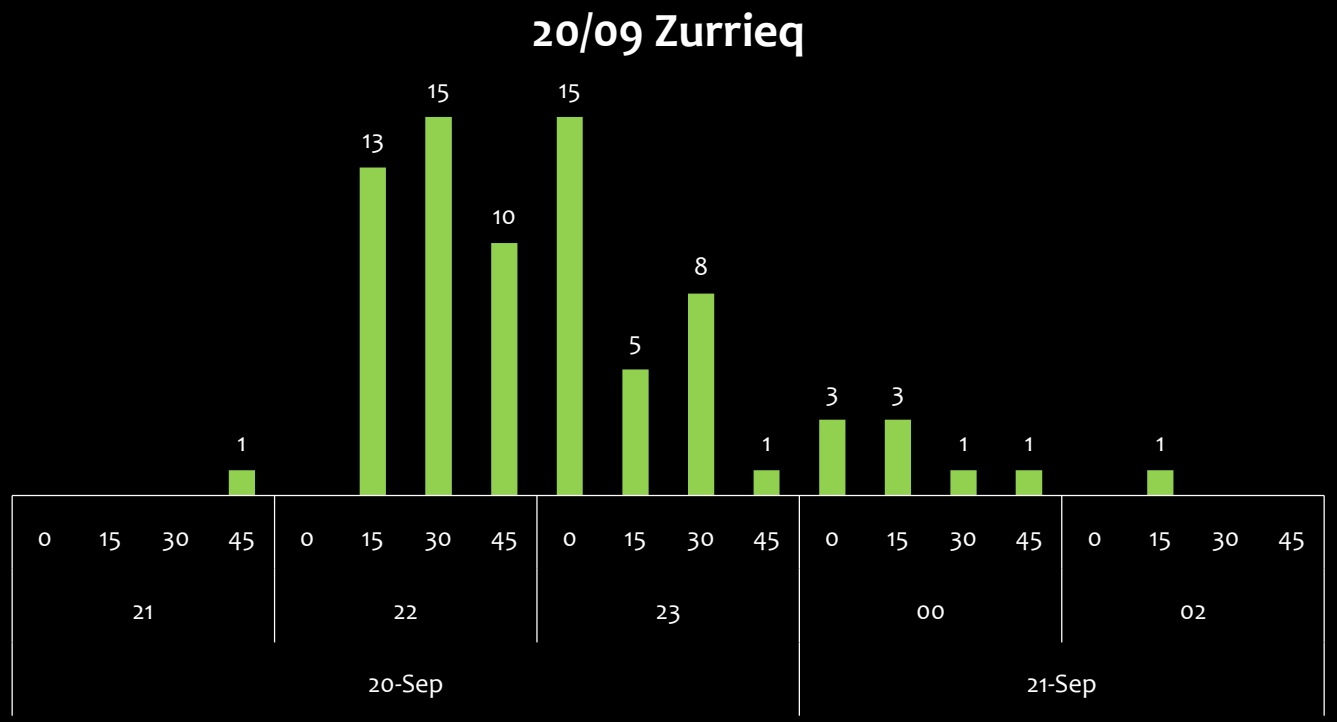


15 minute intervals

Observation 4 – Consistent with recordings from site 2



Observation 4 – Consistent with recordings from site 2

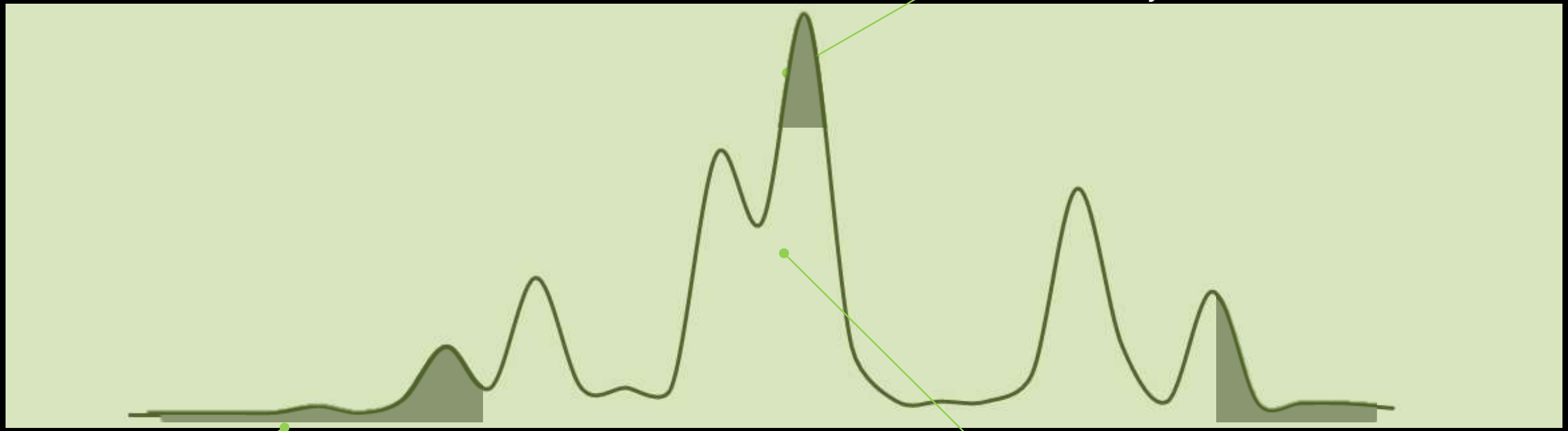


Observation 5 – Variety of readings (switch to video)

Check out the youtube videos on lunaves.org

Conclusion: Automated moon watching can still play an important role in conservation studies

Frequent readings during migration peaks increases confidence level and reduce confidence interval



Good indicator of first / last signs of migration – in 2013 recorded good migration in June

Unlike radar technology, it can be crowd sourced - deploying multiple units will increase the statistical relevance of readings

Roadmap

- Consolidating lunaves.org - an organisation that advances research on nocturnal migration
- Life+ initiative for conservation projects with European research institutes / interested parties such as BirdLife. Possibility of a Mediterrenean initiative?
- Deploy units on Europe's main migration routes - Eilat (Israel), Gibraltar and Falsterbo(Sweden)
- Improvement of optics and cameras (upgrade to 60 fps) and further software development
- Investigate use of low-cost hardware to allow scaling up and deployment of hundreds of cheap units

Get in touch…

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 : www.facebook.com/lunaves.org