Do passerine birds utilise artificial light to prolong their diurnal activity during winter at northern latitudes?

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Abstract. Boreal regions with a mild winter climate, such as the western coastal area of Norway, may hold a number of wintering passerine birds, in spite of the short day length in mid winter. To determine whether birds wintering under such conditions were able to use artificial light to increase their activity periods, day-time and night-time bird censuses were done from October to March in a residential area in Bergen, western Norway, along roads lit by street lights. Situated at latitude 60°N, the area has 18 hours of darkness in mid winter. Twenty-four passerine species were recorded. Of these European Robin *Erithacus rubecula*, Common Blackbird *Turdus merula*, and Eurasian Wren *Troglodytes troglodytes* regularly started their activity several hours before sunrise, whereas Great Tits *Parus major* and Blue Tits *Cyanistes caeruleus* did so to some extent. The other species did not start their activity until morning civil twilight. Measurements of distance from street lights for European Robins during night-time showed that the birds were closer than random to lights. The study shows that some passerine species are able to extend their activity period by 4–5 hours utilising artificial light during the darkest part of the winter.

Key words: Winter ecology; artificial light; nocturnal activity

INTRODUCTION

Characterized by low temperatures and short day lengths, northern winters pose difficulties for many bird species, causing them to migrate to more hospitable latitudes. Those that stay face higher demands for food intake to sustain them through long and cold nights, while the time for feeding is actually decreased. This could be particularly energetically severe for passerine birds, which due to their small size have a large surface to volume ratio.

One effect of increasing urbanization is an increased abundance of artificial light from buildings and other constructions, and not least from street lights along roads. Artificial light occurs in human-inhabited areas (e.g. Elvidge et al. 2001) to such an extent as to become an ecological factor affecting migration, predation, reproduction, and communication of birds and other animals, often in a negative way (Mizon 2002, Jones & Francis 2003, Longcore & Rich 2004, Longcore et al 2008). Nevertheless, birds have been observed to be actively feeding under artificial light at night (Bakken & Bakken 1977, Miller 2006, Lebbin et al. 2007) and in these instances artificial light apparently was used favourably by the birds.

Influenced by mild ocean currents, the south-western coast of Norway offers relatively mild winter conditions with mean temperatures above 0°C in January (Ouren et al. 1987–93), and this area holds a larger number of wintering birds than other parts of the Scandinavian Peninsula (Svorkmo-Lundberg et al. 2006). However, in mid winter the region has no more than 5–6 hours of daylight. Casual observations from this region have shown birds (several species) sometimes to be active under artificial light in winter (pers. obs.), indicating that this might be a way they could extend their time of feeding. We therefore examined the nocturnal activity of passerine birds in a suburban area in south-west Norway through one winter to see (a) what type of birds if any were active during night-time, and (b) whether such activity could be associated with the distribution of artificial light.

MATERIAL AND METHODS

The study was conducted in the winter 2009–2010 in a suburban area near the city of Bergen, Norway. Bergen is situated at 60° northern latitude and has daylight for only six hours in mid winter. The study site is mainly a residential area with houses and gardens, but also contains a small lake surrounded by riparian vegetation

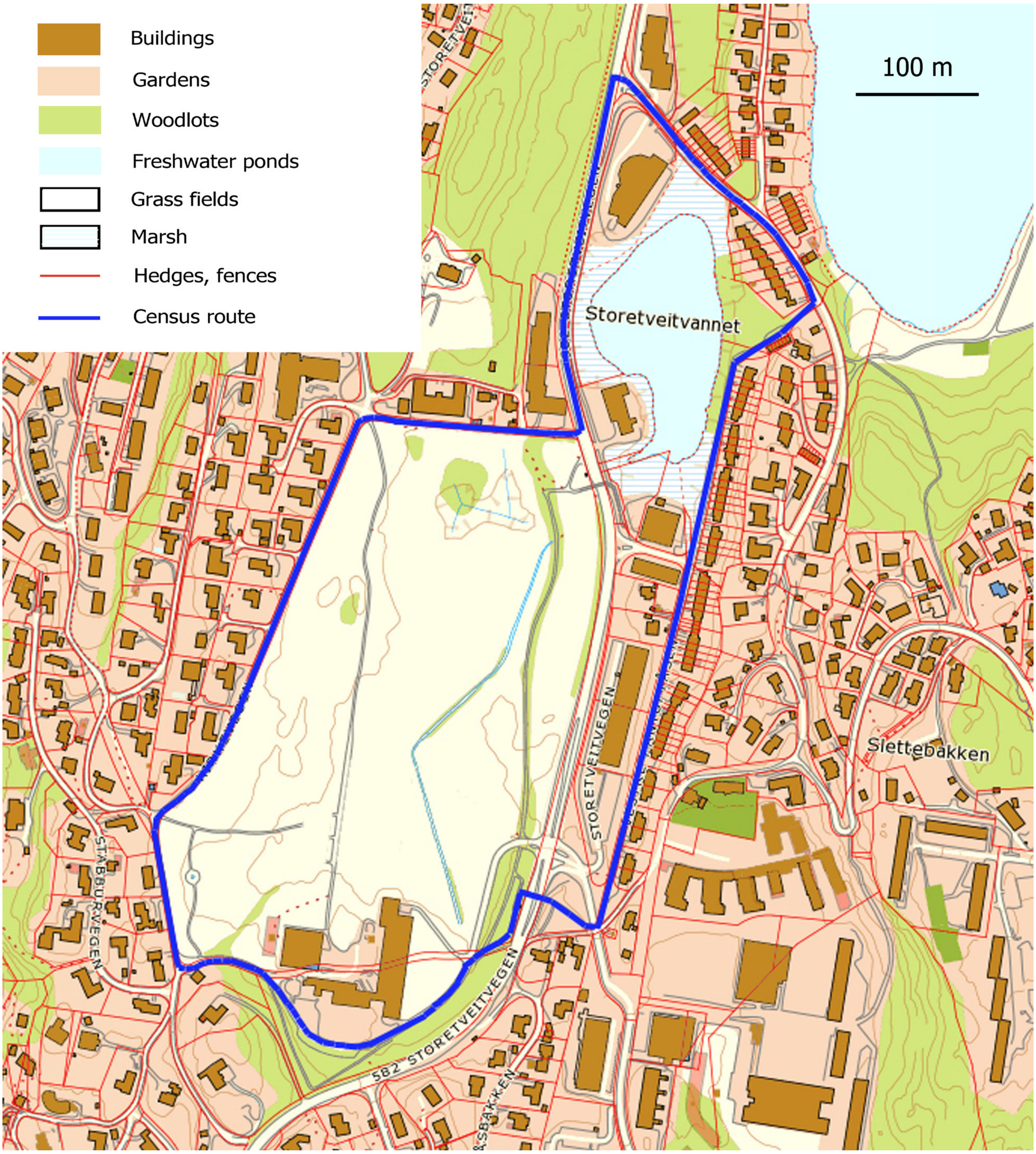

Figure 1. Study area, with the census route indicated by blue line.

and tree clusters, and an open grass field. Roads in the area are partly bordered by tree alleys (Figure 1). The main source of artificial light is the street lighting along the roads, as lights from houses are mostly switched off at night.

We recorded birds while walking along a fixed route of roads encircling the area. The route, which measured 2360 m, was illuminated by street lights in its entire length. Walking the route (one census walk) took about 45 minutes, during which all birds seen and heard were recorded and plotted on maps as accurately as possible, and the time noted. Efforts were made to avoid repeatedly recording the same birds during the same census walk. Overall, 214 registrations were made at night, 264 during twilight and 824 during day, and 79% of the registrations at night and 74% during twilight were of birds first heard. During day, 58% of the birds were heard before they were seen, and for 10 of 24 species more than 80% of the day-time registrations were of calling birds. Censuses were carried out on the following nine dates: 27 October, 12 November, 28 November, 8 December, 30 December, 13 January, 12 February, 10 March, and 25 March. On each date census walks started at the following hours: 0000, 0130 0300, 0430, 0600, 0730, 0900, 1500, 1630, 1800, 1930, 2100, and 2230. This schedule sampled the dark part of the night, the civil twilight dawn and dusk, and some time after sunrise and before sunset. The local times of sunrise, sunset, and the beginning and end of civil twilight were obtained from U.S. Naval Observatory (2009). Civil twilight in the morning is defined to begin when the centre of the sun is 6° below the horizon (beginning of dawn) until sunrise, and in the evening from sunset until the centre of the sun is 6° below the horizon (end of dusk).

The sampling depended on calm weather, and rainy days or days with snowfall were avoided. An exceptionally cold spell with heavy snow cover prevailed from 20 December until mid March. The period was characterized by subzero temperatures, at night regularly reaching between –10 and –15°C, and snow (20–50 cm depth) entirely covering the ground. The severe weather caused a strong decline in number of birds seen in mid winter, either from increased winter mortality or birds moving to bird feeders or out of the region. Thus, the mid winter situation caused an anomaly in bird distribution. In spite of this we consider our data adequate for the present purpose.

Nocturnal light conditions in the study area varied from well-lit areas below lamp posts to almost complete darkness in areas where no artificial light was available. To test if birds were distributed non-randomly in relation to artificial light, distances of birds to lamps were compared to those of random points. In this we utilised the variation in illumination within the census route caused by the light gradients from lamp posts, instead of choosing, for comparison, a non-illuminated route, which would have to be sought tens of kilometres away and thus unavoidably would have differed in habitat. Birds and random points were recorded within a belt 50 m to each side of the census route. Within this distance birds could be reasonably accurately located, and their distance to nearest artificial light source estimated. Data for this purpose were obtained 8 December (i.e. before the exceptional cold weather had set in), and the census walk that night that gave highest number of recorded birds was used. Random points were generated from intersections by linear and lateral bearings along the route, using Microsoft Office Excel 2007. Random points falling on buildings or lakes were discarded and new points generated. Only birds heard calling or singing were used in this analysis; visual records of silent birds were excluded, as their detection depended on distance from light.

RESULTS

Twenty-four species of passerine birds were recorded during the censuses. Of these, only European Robin *Erithacus rubecula* (Figure 2), Common Blackbird *Turdus merula* (Figure 3) and Eurasian Wren *Troglodytes troglodytes* (Figure 4) were regularly active at night. While European Robins and Eurasian Wrens started their activity around 0330–0400, individual European Robins sometimes earlier (e.g. 0030 on 25 March), Common Blackbirds began their activity between 0400 and 0500. These three species occurred solitarily. Some individual Great Tits *Parus major* (Figure 5) and Blue Tits *Cyanistes caeruleus* (Figure 6) showed activity about the same time as the European Robins, but most of their activity clearly took place during the day-time. Night-time fraction of all census data points for European Robin, Eurasian Wren and Common

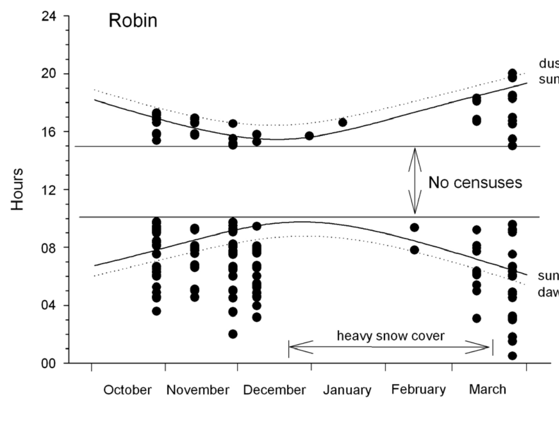

Figure 2. Activity patterns of European Robin. Each dot represents one individual censused (n = 233).

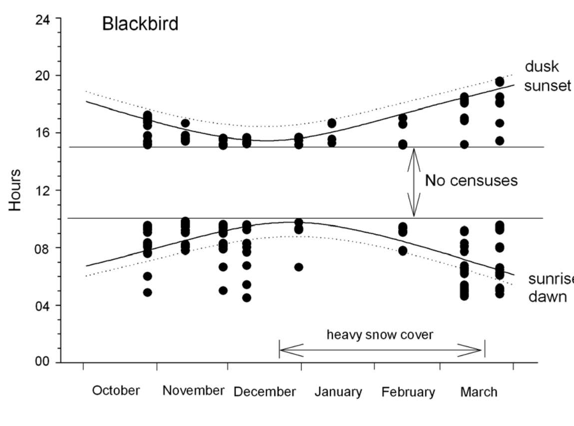

Figure 3. Activity patterns of Common Blackbird. Solitary individuals as well as flocks are represented by one dot (n = 209 census data points, 264 birds).

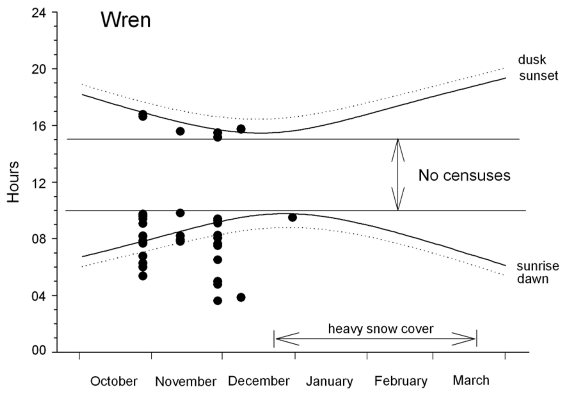

Figure 4. Activity patterns of Eurasian Wren. Legends as in Figure 2; n = 41.

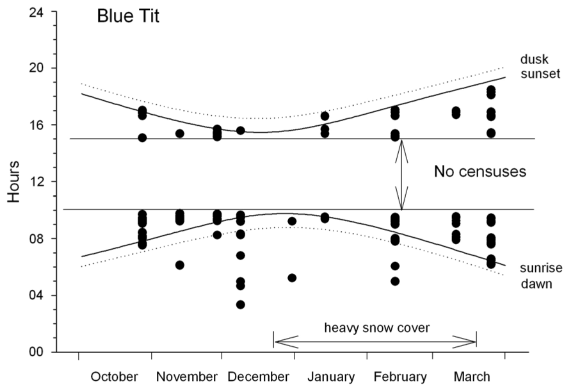

Figure 6. Activity patterns of Blue Tit. Legends as in Figure 3; n = 139 census data points, 195 birds.

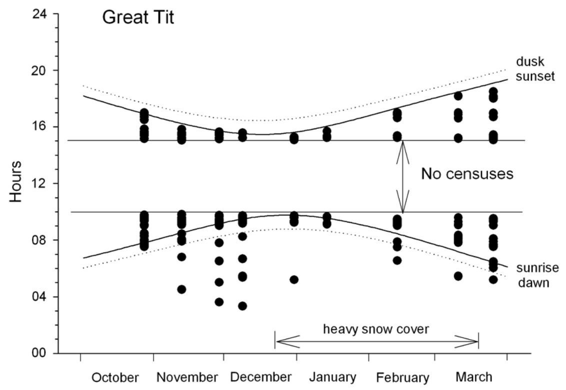

Figure 5. Activity patterns of Great Tit. Legends as in Figure 3; n = 209 census data points, 264 birds.

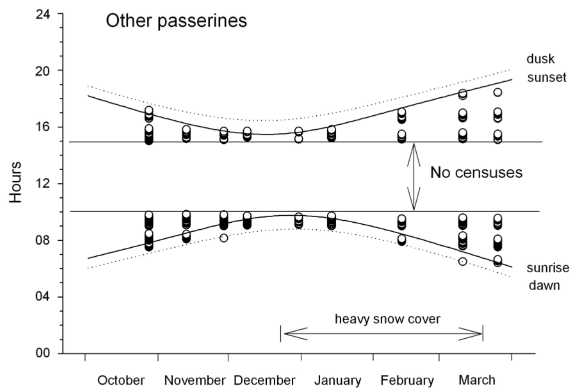

Figure 7. Activity patterns of passerines other than those shown in Figures 2–6. Circles represent flocks and solitary individuals censused. Sample sizes are given in parentheses, where c = number of census data points and b = total number of birds involved. The species were Fieldfare *Turdus pilaris* (c = 32, b = 71), Redwing *Turdus iliacus* (c = 20, b = 40), Goldcrests *Regulus regulus* (c = 1, b = 1), Marsh Tits *Poecile palustris* (c = 2, b = 3), Long-tailed Tits *Aegithalos caudatus* (c = 1, b = 6), Eurasian Nuthatch *Sitta europaea* (c = 9, b = 9), Eurasian Treecreeper *Certhia familiaris* (c = 1,b = 1), Eurasian Magpie *Pica pica* (c = 106, b = 146), Western Jackdaw *Corvus monedula* (c = 13, b = 68), Hooded Crow *Corvus cornix* (c = 165, b = 693), Northern Raven *Corvus corax* (c = 1, b = 2), Common Starling *Sturnus vulgaris* (c = 14, b = 47), House Sparrow *Passer domesticus* (c = 88, b = 165), Chaffinch *Fringilla coelebs* (c = 6, b = 7), Brambling *Fringilla montifringilla* (c = 12, b = 71), European Greenfinch *Chloris chloris* (c = 47, b = 88), Eurasian Siskin *Spinus spinus* (c = 47, b = 113), Common Crossbills *Loxia curvirostra* (c = 13, b = 79), and Yellowhammer *Emberiza citrinella* (c = 3, b = 3).

Blackbird (n data points given in Figures 2–4) were 53.6%, 39.1% and 19.4%, respectively, whereas for Great and Blue Tits corresponding figures were only 9.6% and 8.6% (n data points given in Figures 5 and 6). Nightly census effort constituted 72.8% of totally 5265 census minutes.

None of the other 19 species were active during night, but most of them started their activity during the morning twilight (Figure 7). Only European Robins, Eurasian Wrens, Common Blackbirds and Blue Tits were recorded after sunset, but no species showed any activity after the evening civil twilight. Thus, night-time activity represented an early start of the morning, but did not extend to the dark part of the evening.

Distances from street lights of night-active birds in relation to random points were recorded 8 December. The census walk from 0430 to 0530 gave highest number of birds and was selected for analysis. Data sufficient for analysis were obtained only for European Robins (n = 8). These birds positioned themselves closer to street lights than expected from a random distribution (Mann-Whitney U = 46, P = 0.001, two-tailed; Figure 8).

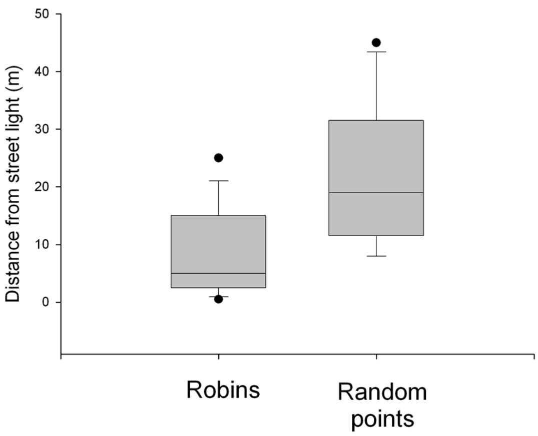

Figure 8. Distance from street lights by European Robins (n = 8) and random points (n = 8) in a 100 m corridor along the census route, 8 December, 0430–0530 h.

DISCUSSION

The study confirms that nocturnal activity is found in some of the passerines wintering in boreal latitudes; regularly in European Robins, Eurasian Wrens and Common Blackbirds, occasionally in Great and Blue Tits. While all of the observed species ceased their activity at latest during the evening civil twilight, the species showing nocturnal activity apparently could add 4–5 hours to their daily activity period by becoming active long before the morning civil twilight, and these extra hours could potentially increase their feeding time.

The three regularly nocturnal species, European Robin, Eurasian Wren and Common Blackbird, feed chiefly on invertebrates living on or near the ground, and to a varying degree they hold non-breeding territories (Cramp 1988 and references therein). Crepuscular activity is common in these three species, and presumably they are pre-adapted to activity under poor light conditions (Thomas et al. 2002). Species active only during daylight were granivorous (seven finches, the three tits mainly granivorous, and Eurasian Nuthatch *Sitta europaea*), omnivorous (Common Starling *Sturnus vulgaris*, four corvids), or living on arboreal insects (Long-tailed Tit *Aegithalos caudatus*, Eurasian Treecreeper *Certhia familiaris*, Goldcrest *Regulus regulus*). Omnivorous and granivorous birds may be less restricted by short day-length in northern latitudes due to a usually more abundant and localized food (such as garbage, beech mast, cone seed, grass seed, human bird feeders, etc.). Although territorial in the non-breeding season, two of the species (Eurasian Nuthatch, Marsh Tit *Poecile palustris*) increase their resource predictability by caching food (Cramp & Perrins 1993). Tits may also reduce energy demands by being hypothermic during cold spells (Reinertsen & Haftorn 1983). Thus these species can presumably restrict their activity to the daylight period without compromising their energy balance. Arboreal insectivorous birds presumably have to search food while straying in wooded tracts outside the urban and suburban areas, usually well beyond areas with a high density of artificial lights. It is less obvious why Fieldfare *Turdus pilaris* and Redwing *Turdus iliacus* should not be nocturnal, as their food is fairly similar to that of Common Blackbirds. However, these two species are more or less gregarious in the non-breeding season, straying about in search of berries or open fields with a good supply of ground-living invertebrates. There is no evidence suggesting that the species recorded only during day-time, most of them highly vocal, should turn silent at night and still be active and thus pass undetected by us.

Data for European Robins demonstrated that night-active birds occur closer to street lights than random, indicating that the birds preferred illuminated areas. For obvious reasons our data for this aspect were based on vocalizations, which usually were song. According to Fuller et al. (2007) European Robins may sing during the night to avoid urban noise. This may have been the case in our study as well, as traffic noise was more evident during day-time than during part of the night, when there was practically no motor traffic. This, however, would not explain why birds laid their activity to the illuminated areas. We hypothesize that the illuminated territories attracted food-seeking intruders from the darker periphery, and that this would induce territory owners to sing. Night-time singing by usually day-active birds is thought to occur if territories are challenged by night-migrating individuals or floaters (La 2012). Although we at most only got short glimpses of the birds during night, we observed instances of actual feeding as well as European Robins chasing each other. Singing during the dark hours may also be a way for birds to spend time on territorial defence while food-searching is less efficient (Kacelnik 1979), which could benefit the birds energetically if allowing them to spend less time defending territories when daylight facilitates efficient foraging.

This study demonstrates that artificial light can increase the diurnal activity period of territorial, ground-feeding passerine birds, potentially increasing their food intake during the short boreal winter days. To gain further insight, a study of feeding and other activities, e.g., by means of radio telemetry, of night-active birds would be needed.

Acknowledgements. The study was done in association with the Polar & Bird Ecology Group, Institute of Ecology, Friedrich-Schiller-University Jena. We are grateful for valuable comments by two anonymous reviewers.

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Received 15 March 2012. Accepted 6 September 2012