

Journey through the bright night

A board game about light pollution

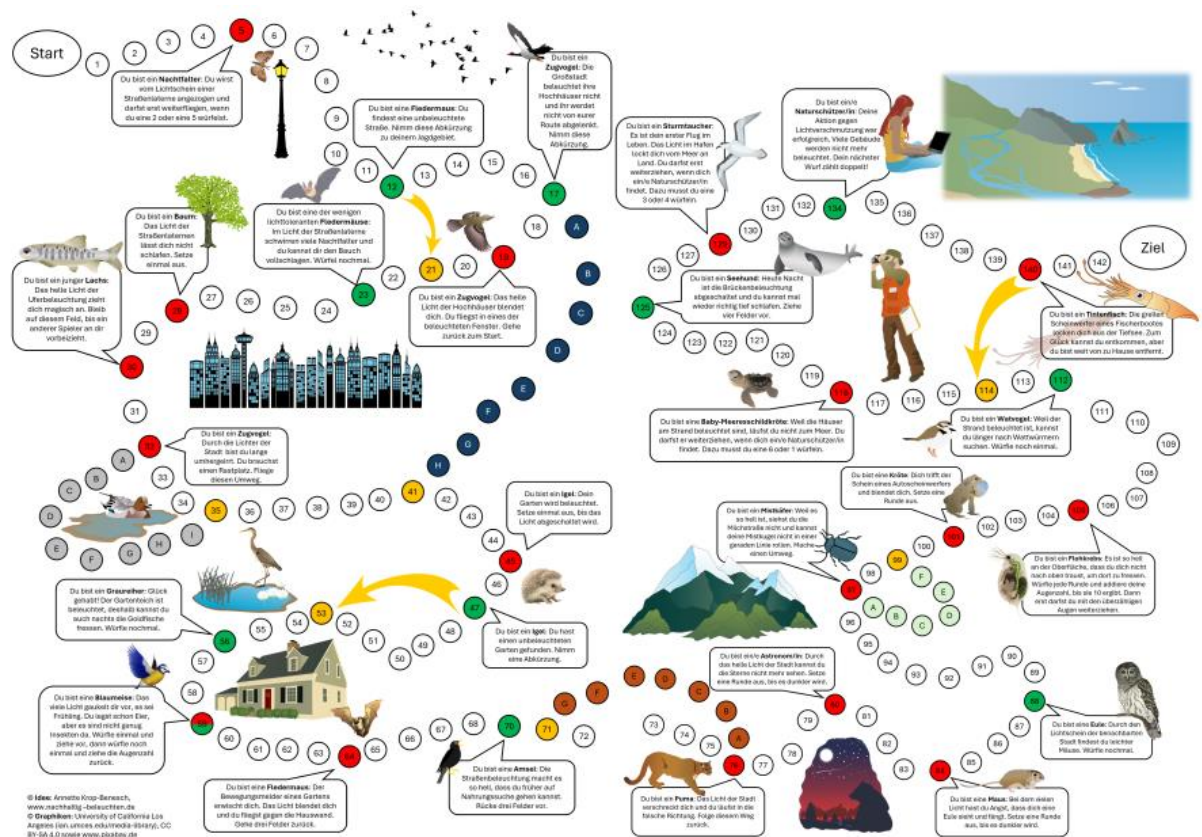
Hi there! Great that you found our light pollution board game. I developed it together with my children Benjamin (10 years) and Viviane (8 years) to help people of all ages to learn about light pollution. It's a sad topic, but we still think that it's easier to learn about it if you have some fun. In this booklet, you will find the rules for the game, but also information on light pollution and some advice on how to use light without causing too much damage.

We are always happy to get feedback about this game. We hope you enjoy it, but maybe you have some comments or ideas how to make the game better. You might even find some spelling mistakes and we would be very grateful to know about them. You can contact us at this email address info@nachhaltig-beleuchten.de.

You are welcome to share this game or the link to it with everyone who is interested, because we are happy about everyone who plays the game. We just ask you to keep our name on the board so people know who did the game. It's also good to download it from the original link in case we make any changes. If you would like to translate the game in your language, don't hesitate to contact us. It has developed into a crowd project and we hope to bring it to more countries in time.

Preparations

You need to print out the game board, get some pegs, and a die. Position the four pages of the board as it is shown in the picture below. Now you're ready to start!



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Rules

Everyone rolls the die once and moves according to the number on the die. If you roll a six, you are not allowed to roll again. The first player to move onto the GOAL field wins. You can decide yourself if you need the exact number on the dice to reach that field or if you are allowed to enter with a higher number. (Please decide that before you start to play!) If you come to a red or green field, read the speech bubble and follow its instructions. If you want to know more about the events in those bubbles, check out the information booklet.

There are two fields with direct short-cuts. Slide along the yellow arrow to the next yellow field. On one field you have to slide along a blue arrow back to an earlier field and once again make your way along the coast.

Additionally, there are short-cuts and detours on which you have to roll the die. If you are allowed to use the short-cut for migratory birds, follow the blue fields. The detours are in grey, brown, and green. Follow these paths by rolling the die as usual until you reach the next yellow field on the main way.

On some fields you need to roll a defined number on the die. If you have succeeded, roll the die once more to move on. On one field you need to roll the dice and add up the points until you have reached 10. When you have succeeded you can use the surplus points to move on.

Enjoy your game!

Why do we need darkness?

Naturally it's dark at night. There is only the light of moon and stars. Nocturnal animals are well adapted to these low light levels. Their eyes are very light-sensitive or they use other senses to find their way. It might surprise you, but humans too can see a lot by the light of the full moon – at least as long as we are not blinded by a glaring light. Actually, if you're walking around with a torch, you will miss a lot. You will only be able to see what's inside your cone of light, everything else will appear pitch black. Our eyes need several minutes to adapt to darkness, but then we can see much more.

Diurnal animals – which includes us humans – sleep at night. To sleep well, we need darkness. Many humans – and animals, too – are disturbed by light, as much as we would be disturbed by noise. But we need darkness for an additional reason: Only in darkness does our brain produce the hormone melatonin which we, like all animals, need for healthy sleep. This is the reason why so many people sleep with their blinds down and switch off artificial light. For some people, even the light of the full moon is too bright. You see, darkness is really important!

These days, we have lots of artificial light to brighten up the night. This allows us to stay awake much longer. But this light also changes nature. For a long time, scientists didn't know how important darkness is and how harmful artificial light can be. We only understand slowly how dangerous light pollution is for nature and our health. At the same time, we develop ways to get around with less light.

In this board game you can learn about some of the impacts of artificial light on animals and plants. If you want to know more, keep on reading.

Become a protector of the night

Everyone can help to protect the night. If you have your own house or garden, think about how to use light. Switch it off when you don't need it and use generally less and warmer light. Talk to other people about light pollution, because many people haven't heard about it and think artificial light is a great thing (which it is, but with side effects). Even many conservationists only care about the energy consumption of light, but not about the impact of light itself. But this is important to know, because even the light from solar lamps is harmful.

Lots of people are afraid of the dark, especially if they only know artificially illuminated nights. It's true that we can't see as well at night as we can see with daylight. Frequently people say that there are criminals hiding in the dark or that we have less accidents on bright streets. However, many places are not illuminated at night but are safer than other, brightly lit places.

The truth about light and crime is complex. Unfortunately, light is no real protection against crime, and too much light can be a traffic hazard. Our eyes need much less light than many people believe and glaring light can blind us. Many people who are used to natural darkness feel comfortable without artificial light. A growing number of people is actually fighting for more darkness.

Are you curious? Then find a place you know well that is dark, e.g. your garden or a place in the fields without streetlights and switch off your torch. It will take you some minutes, but as soon as you are adapted to the darkness, an entirely new world will unfold around you. The light of the full moon is so bright that you can see your shadow!

Maybe you even get the chance to go to a dark sky park. In these areas the public illumination is done in way that you have a chance to experience the night and see exciting things.

Do I really need light everywhere?

LEDs are very energy-efficient and therefore we bring light into many places without asking us, if it is really needed. Artificial light is convenient and can be very beautiful, but simply because we like it doesn't mean that it's okay to harm nature. The light from Los Angeles is so bright that it can be seen as light pollution in a distance of more than 200 km. In our towns the streetlights are often so bright that we don't need extra light to find our way through our front garden.

All the illumination of our buildings is a problem too. Sure, an illuminated castle or skyscraper can look amazing, but is that worth killing insects, birds, and bats? And do we need to illuminate buildings the entire night?

Also, many people enjoy walking through dark areas at night. If we install light everywhere, it would be really difficult to go to a place where you can see the stars and experience natural, soothing darkness. It's already hard to see the stars from a town, but we could create places from which you can see the stars between many towns if we wouldn't illuminate each interurban bike path.

One place where light is especially harmful is in nature reserves, because nature also needs to be protected at night. If you illuminate a frog pond then you cause almost as much damage as if you would take away the water. No conservationist would allow somebody to take the water from a pond, but we take the darkness from the nocturnal habitats by illuminating ponds, insect hotels, and nesting boxes.

Nature and those of us who love nature need darkness at night. For those who feel unsafe in the dark there will still be enough illuminated areas away from natural areas. Let's keep dark spaces for nature!

Guideline for nature-aware illumination

There is an easy and important rule: only illuminate where you really need it to keep people safe. Illumination is always harmful to the environment, and there is no environmentally or insect-friendly light, no matter what you read on the package.

But sometimes we need light. Here is some advice how to reduce its negative impact:

- **Switch the light off whenever you don't need it.** In many places we have illumination even if nobody is there. Timer can make sure that the light is switched off during such times. In places with infrequent use, motion detectors can help to have light if someone is around but keep it dark during the rest of the time. This way you can also save energy.
- **Only make it as bright as you need, not brighter.** Quite often we make places much brighter than needed. This is especially the case with fuel stations, shopping windows, or billboards. They can even blind us, so everything around them seems to be pitch black. We then react by making the surroundings brighter instead of taking away those unnecessary bright lights. This can be very dangerous in traffic, because car drivers cannot see what's inside the darker areas although the light there would be bright enough. A pedestrian who can see everything would not be seen by a car driver passing a bright fuel station. Less but more evenly distributed light would be much better for our vision.
- **Shield all your light sources.** Many lanterns like light balls send light into the sky, but this light is of no use for us, especially if the light is on a high pole. If we shield these lights, we can save lots of light (and thus energy) and reduce light pollution while it's still bright enough underneath the lanterns.
- **Use „warm“ light.** The use of LEDs has increased because they are energy-efficient. LEDs have different colour temperatures. The light of cold LEDs ranges from white to blue, while warm light is yellow, orange, and red. Every light, no matter which colour temperature is harmful to nature, but it has been shown that the warmer the light, the less harmful it is to animals. This is especially true for the orientation of birds and insects, or for the disturbance of day-night-rhythms – also for us humans. Cold LEDs are used more often because they are more energy-efficient. However, energy-efficiency is not the most important aspect (especially if it leads to using more light and thus the same amount of total energy), and has to be balanced with the direct harm the light causes to animals. For this reason, we need a balance between energy-efficiency and the protection of biodiversity. Currently, a good solution is to use warm-white light (2200 to 2700 Kelvin) and in any case to use light sparsely and only on the surface where it is needed. If you want a really cozy atmosphere, you can use so-called amber-LEDs with 1800 Kelvin. If you look at your whole light installation, well planned light can save even more energy than using an efficient LED that over-brightly illuminates the entire surrounding.

Background information about the game events

Field 5: Do you know the saying “Drawn to the light like a moth”? We don’t know why **insects** fly toward the light, but many of them, especially moths, beetles, and mayflies, are magically drawn to the light. An orange-coloured street light can attract insects from up to 20 m, white street lights probably from either further away. The brighter and whiter a light, the higher its attractivity. The insects circle in the light instead of feeding or pollinating plants. They lose lots of time and energy, many die from exhaustion or burn in the heat.

Field 12: Some **bats** hunt insects around lights, but no bat species likes to fly along illuminated roads. Most likely they don’t want to be attacked by owls. Many bats live in cities and villages. In the evenings they fly from their sleeping quarters to lakes and meadows for hunting. On these journeys they prefer unilluminated routes, and if they can’t find them, they need to fly detours or can’t reach a good hunting area anymore. In that case they need to leave an area to avoid starving.

Field 17: Most **migratory birds**, especially small songbirds, fly at night. Beside landmarks and Earth’s magnetic field, they use the light of moon and stars to find their way. Bright lights attract them like it attracts insects. Scientist have observed that birds fly detours of several kilometers into bright cities. They lose valuable time and energy, and need longer stopovers. Nobody knows how many birds reach their destination too late or not at all, because the light has lured them from their way.

Field 19: For many **migratory birds** flying into cities means death. Blinded by facade lighting, billboards, or skybeams they crash into buildings or collide with other birds. Sometimes you can hear their cries of fear. Every year millions of birds die that way or are heavily injured. There have been occasions when hundreds of birds crashed into an illuminated glass screen or even against a smaller window in a single night.

Field 23: Although **bats** don’t like to fly along illuminated paths there are some species like the pipistrelles that hunt the disoriented insects at streetlights. They are easy prey because their defense mechanisms don’t work in the light. Other bat species like the mouse-eared bats don’t hunt in the light. They stay in the dark, but there are fewer insects, so they stay hungry. In areas with lots of light, these light-intolerant bat species are absent, the biodiversity is poorer.

Field 28: **Trees** don’t sleep like humans, but they still need some rest during the night. In darkness, they regenerate from photosynthesis and repair UV-damage on their leaves. However, this does not work properly if trees are illuminated during the night. The leaves get brown spots and die prematurely. By the way: Illuminated leaves don’t realise that days grow shorter in autumn. The trees don’t shed these leaves in time and can be damaged by frost. In spring, the trees bud too early – and the buds can also be damaged by late frost.

Field 30: **Salmon** hatches in rivers and travels along them to the ocean. Normally, they rest at night, but if they are in illuminated areas they stay active after sunset. They need extra energy for this, and it is very dangerous: Grey herons, which normally are diurnal, use the extra light for a late shift and catch the young salmon. Seals, too, have been observed to hunt at night if there is artificial light.

Field 32: Migratory birds are often distracted by the lights of big cities. The birds fly detours of many kilometers and circle for hours above cities. Many die in collisions with buildings and billboards, while the ones that escape are weak and need extra rest. Indeed, more birds are resting close to bright cities although these areas are not good for resting. There is not enough food for all the birds and diseases spread easier because the birds are so close together. Areas close to cities are usually polluted and have a high density of predators like rats, foxes, and racoons. Since the birds rest longer than they would naturally, they arrive too late at their destination. Breeding times are delayed, and local food webs are changed.

Fields 45 und 47: Most people welcome **hedgehogs** to their gardens because they eat many pest species. Unfortunately, only few gardens have enough shrubs and food for hedgehogs. Young hedgehogs need to travel long distances to find a new home, and even adult hedgehogs need large home ranges. When they walk around they like to stay in the dark, where they can hide from owls, cats, foxes, and other predators. Garden lights make it harder to stay in the dark, and hedgehogs need to make long detours. Low light sources like solar lamps shine directly in the hedgehog's eyes and blind it. It takes many minutes before it can see again, minutes in which it will be stressed because it can't see what's happening around it. For this reason, hedgehog-friendly gardens have no lights.

Field 56: Normally, **grey herons** sleep at night, but they have learnt to use artificial light for late shifts. They wait on illuminated ponds and riverbanks for fish that naturally would sleep at these times too (s. Field 30). This is an advantage for the herons, because they can catch more, but it is a problem for the fish, because even at night they aren't safe. So, if you have a fishpond and don't want to invite the herons for a late-night feast, use no lights at your pond.

Field 59: When the days get longer, **songbirds** (and many other birds and mammals) know that spring is coming. Their bodies prepare for reproduction weeks before they mate. Males look for good territories and start to sing to attract females. But in areas with streetlights, daylength doesn't change during the year. Many species, including blue tits, robins, and blackbirds, start their mating period too early.

It can indeed be an advantage if eggs are laid earlier than usual. If weather is warmer due to climate change, they might even have enough time for an additional clutch. Unfortunately, artificial light also has its disadvantages: Young blue tits in the vicinity of streetlights are more demanding for food, so their mothers get less sleep. The young ones, however, don't grow faster. So far, we don't know how good their survival chances are. It's also unclear if there is enough food available. The young birds need insects, but these might not emerge early enough. Too much light interferes with the bird's sleep, which harms the health of the adult birds. Their immune system is weakened, and they are more vulnerable to diseases.

Field 64: Bats are amazing night flyers! Thanks to echolocation, they can find their way – and their meals - in total darkness. But using echolocation is tiring. Imagine you would have to shout at full strength all the time! Also, many moths can hear the bat calls and avoid the bats. Thus, if there is enough light, bats also use their eyes, especially if they are travelling from their day quarters to their hunting areas. Bat eyes are very light sensitive. If suddenly they are blinded by the headlight of a car or a motion-detector-controlled spotlight, they are blinded, so they might crash into obstacles and get injured.

Field 64: Do you know about the timing of the morning chorus? Each **songbird** starts to sing at a certain light level. One of the earliest singers in Europe are robins, shortly followed by blackbirds.

In areas with artificial light, robins start to sing up to two hours, blackbirds about 90 minutes before sunrise. This theoretically means more time to forage, but also less time for sleep. “City blackbirds” get about one hour less sleep than “country blackbirds”. For great tits, the difference between urban and rural birds can be up to seven hours. These birds need lots of extra energy, or their immune system will be weakened. So, at first these extra hours look like an advantage, but in the long run they might not be good for the birds.

Field 76: When the sun sets in the evening, the world changes. Only few humans are out in the wilderness now, and the darkness offers safety for larger animals like deer and wild cats. They have learnt that humans mean danger and that an encounter can meet death for the animal. Studies in California have shown that **mountain lions** avoid areas with artificial light and walk extensive detours. In a habitat that is fragmented and limited by streets, settlements, and human recreation activities, artificial light is an additional problem for these amazing wild cats.

Field 80: How many **star constellations** do you know? Have you ever seen the Milky Way? Since we can remember, humans love the stars. Many cultures, e.g. the North American indigenous people, believe that our ancestors descended from the stars. For them, the night sky is what churches are for us: sacred places of worship, only not made by humans, but an ancient part of nature. Light pollution makes the stars invisible, and old myths disappear with them.

The urge to reach the stars is a strong driving force in the development of modern technologies and helps us to understand our place in the universe. While our ancestors believed for centuries that we would be the center of creation, we understand now that we only have a small, fragile, very precious planet to survive on. There is no planet B to settle on after we have destroyed this one. To remember how special Earth is, we need to look up into the stars.

Many astronomers use radio telescopes for their research, but optic telescopes are also indispensable. This doesn't mean only the big ones. Each night, thousands of hobby astronomers scan our skies with their small telescopes for asteroids. They are our early-warning system in case of an asteroid on collision course. But because of all the artificial light in the sky it's getting harder to spot these small objects. Additionally, there is a growing number of satellites from megaconstellations like Starlink. They overlap the natural celestial lights, so soon it will be impossible to spot dangerous objects. And seriously, what is more impressive than watching a natural night sky with thousands of twinkling stars and even a few galaxies, which we can see with binoculars?

Field 64 and 88: Almost one third of all mammals are nocturnal, especially small species like **mice**. Darkness protects them from predators like owls. **Owls** have incredible hearing, so they can hunt in the dark. Nonetheless, they have excellent eyes and are more successful with moon light. For this reason, in moonlit nights mice stay in their dens longer and find less food. They can do that for a few nights each month, but on lit places there isn't enough time left for foraging and the mice starve. Consequently, there will be less mice and in the next step less owls.

Field 97: If you are a **dung beetle**, there is nothing more valuable than, well, dung. You will form a big dung ball, roll it to a safe place, and put your egg into it. The larva will feed on the dung. In Africa, dung heaps are not as common as you might think. Dung beetles fight for the valuable material and even steal another beetle's dung balls. For this reason, they try to get away from a dung heap as fast as possible, preferably in a straight line. To avoid walking in circles, they use the night sky for orientation. The dim light of the Milky Way is enough to keep them on a straight line. Unfortunately, city lights are so bright, that even in national parks more than 100 km away from a city the skies are too bright to see the Milky Way.

Field 101: Most **amphibians** (frogs, toads, newts, salamanders) are nocturnal. Sunlight will dry out their sensitive skin and they are easier spotted by predators. If their light sensitive eyes are hit by a spotlight, they are blind for up to an hour. It's even worse if the light stays: the amphibians will sit in the spotlight because they can't see what's in the darkness – but they are clearly visible to cats, foxes, and owls.

Field 105: Scuds are microscopic organisms that keep our ponds and lakes clean. When it gets dark, they raise to the surface and feed on algae. Something similar takes place every night in our oceans. Each night, tons of small crayfish, fish larvae, squids, and other microscopic organisms, the so-called zooplankton, ascends from several hundreds of meters to feed at the surface. In the morning, they return to the deep sea, transporting food to a place that never sees any light. It is the world's biggest migration and movement of biomass. But the small water organisms are very light sensitive. A torchlight or the glow of a nearby city is bright enough to scare them away. Waterfront illumination or the ultra-bright light of fishingboats and offshore platforms will suppress the nocturnal movement of the zooplankton. Consequently, less alga will be eaten, there will be algae bloom, and the inhabitants of the deep sea will stay hungry.

Field 113: Wading birds use their long, curved beaks to catch lugwurms and other invertebrates in the mudflats. Some wader species use their sense of touch to find their meals, other rely on their eyes and only feed during the day. Artificial illumination allows these birds to forage for a longer time. However good for the individual bird in that moment, this means that more lugwurms are eaten and the ecosystem gets out of balance. Also, illuminated areas might not be the best place to be for a birds. They are close to human settlements, ports, and industrial installations. Water and mud are often polluted and there is a high chance to be attacked by rats or foxes.

Field 118: It's not easy to be a sea turtle. Of 1,000 eggs, only two turtles will survive long enough to have offsprings themselves. Their fight for survival starts at the beach. The freshly hatched turtles need to reach the ocean as fast as possible, while crabs, gulls, raccoons, and other predators try to catch them. In the ocean, they are hunted by fish, sharks, dolphins, and sea birds. Normally, the light of moon and stars guides them to the ocean. The water reflects this light, so the ocean is the brightest area. Unfortunately, on today's beaches, the lights from coastal towns and houses is much brighter, so many hatchlings move into the wrong direction. If they aren't eaten or run over by a car, they end up in swimming pools or dry out on the streets. In Florida alone, approximately 100,000 hatchlings are distracted by artificial light each year.

Field 125: To get enough good sleep, **seals**, like all diurnal animals, need darkness at night. And you need good sleep for a successful fishing trip the next day. Therefore, seals are grateful if the illumination of the neighbouring bridge doesn't brighten up their sleeping place the entire night.

Field 129: Shearwaters and petrels are excellent flyers who spent almost their entire life on the open ocean. They only come to the coast to raise their chicks in burrows. Shortly before the young birds are ready to leave their nests, the parents leave so the young birds are on their own for their maiden flight. The fledglings follow the light of the moon and the stars onto the open ocean – but not if there are illuminated settlements, ports, or industrial facilities. Artificial light attracts young shearwaters, and landing brings them into mortal danger. They are built for flying, not for getting into the air from the ground, so they need a free area and supporting winds to lift their bodies into the air. Both is almost impossible to find close to human installations, so the birds are trapped on the ground, where they are easy prey for predators, are run over by cars, starve, or die of dehydration. Each year, conservationists pick up thousands of birds and return them to the ocean.

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However, no matter how hard they work, as long as our coasts are as brightly illuminated as they are now, young shearwaters and petrels will die. According to shearwater experts, light pollution is a bigger threat to the survival of this highly endangered bird group than plastic waste or overfishing.

Field 134: There is a growing number of people who call for better, more night-aware illumination. Cities, communities, and shops reduce their illumination or switch off their lights completely at night. Some cities have stopped to illuminate their skylines during bird migration time. Close to beaches the lights are designed in a way that is less disrupting to sea turtles. Instead of bright light festivals, there are dark sky or star events. There are even dark sky parks in which the night is protected by special lighting design.

You can help to protect the night too. Tell others about light pollution, why too much light is bad for all of us, and how we can use light in a better way. The protection of the night starts right in front of our own door with very small things: simply switch off your lights if you don't need them.

Field 140: Almost finished! But, alas, light is everywhere, even in the vast ocean. Gigantic spotlights lure fish and squids into the huge nets of fishing boats. These lights are so bright that they can be seen from space. Open sea birds like albatross, puffins, petrels, and shearwater follow the lights. There are stories about more than 1,000 birds that landed on a small fishing boat and almost made it capsize.

References

All information about light pollution in this game is based on scientific studies. The idea of this game was developed by biologist and light pollution expert Annette Krop-Benesch, Benjamin Krop and Viviane Krop.

Graphics – if not mentioned otherwise – are taken from IAN/UMCES Symbol and Image Libraries, CC BY-SA 4.0. The following pictures have been downloaded from www.Pixabay.de: [Bear underneath stars \(kreize001\)](#), [blue tit \(OpenClipart-Vectors\)](#), [hedgehog \(Alan Frijns\)](#), [lantern \(OpenClipart-Vectors\)](#), [city skyline \(OpenClipart-Vectors\)](#).