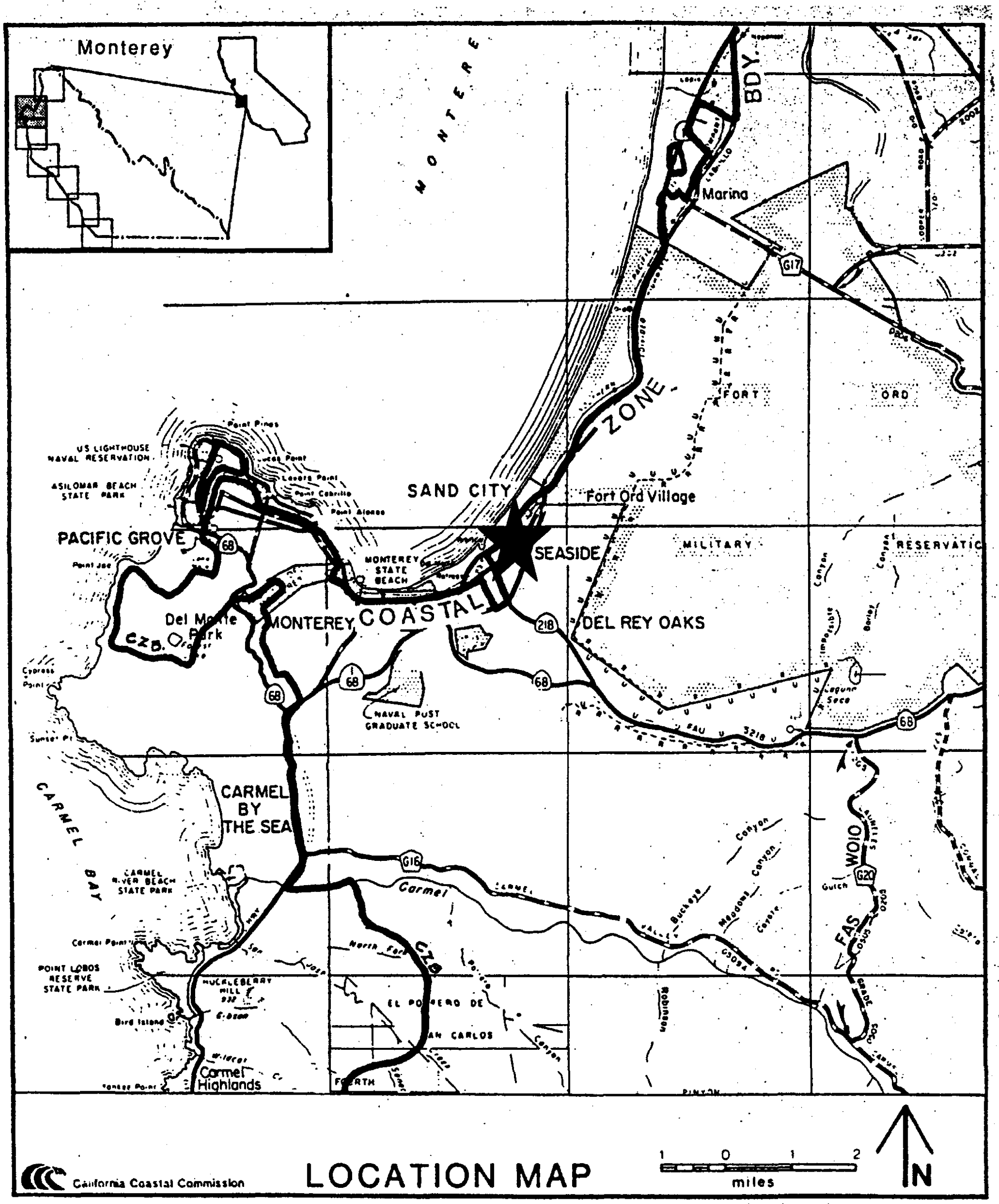
Exhibit A: Location Map

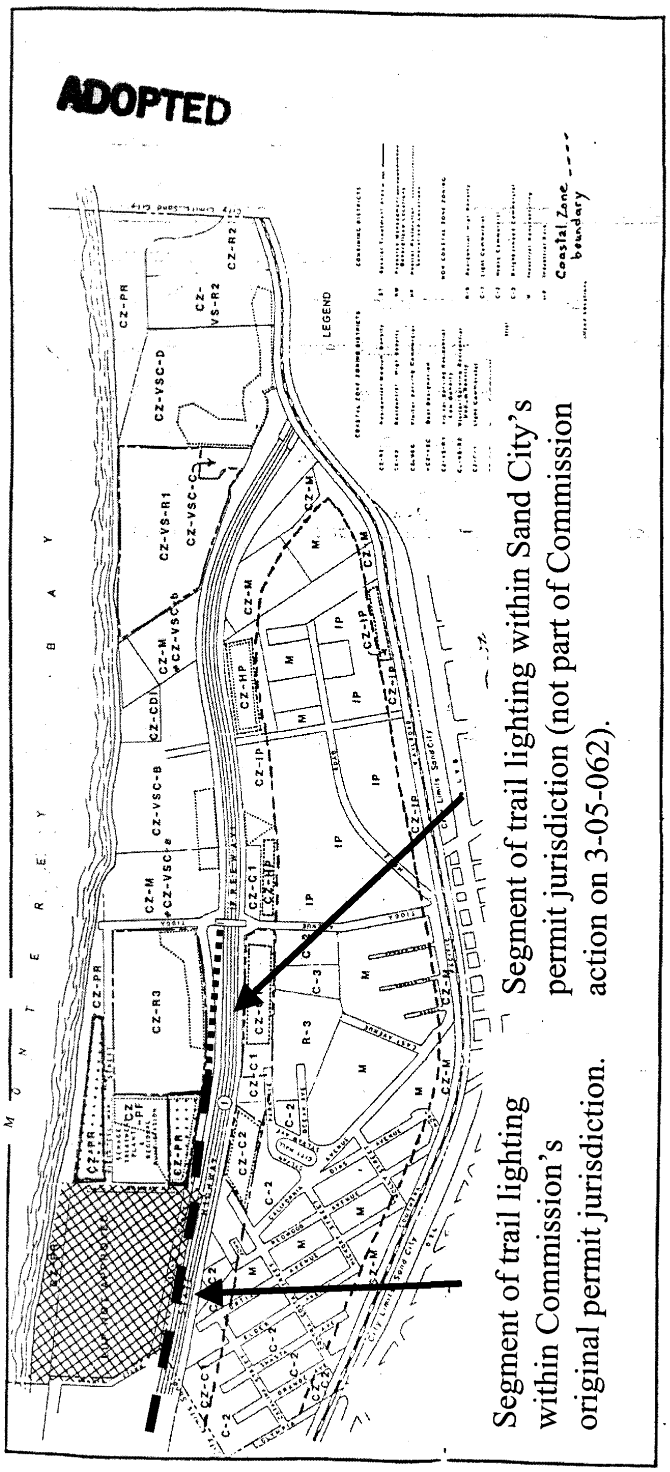


County of Monterey

Sheet 2 of 7

3-05-062
Sand City Rec Trail Lights
Page 1 of 2

California Coastal Commission



E X H I B I T B

AREAS EXCLUDED FROM APPROVAL

LUP not approved by Coastal Commission

IP lacks TDC program; LUP relates this area to above area

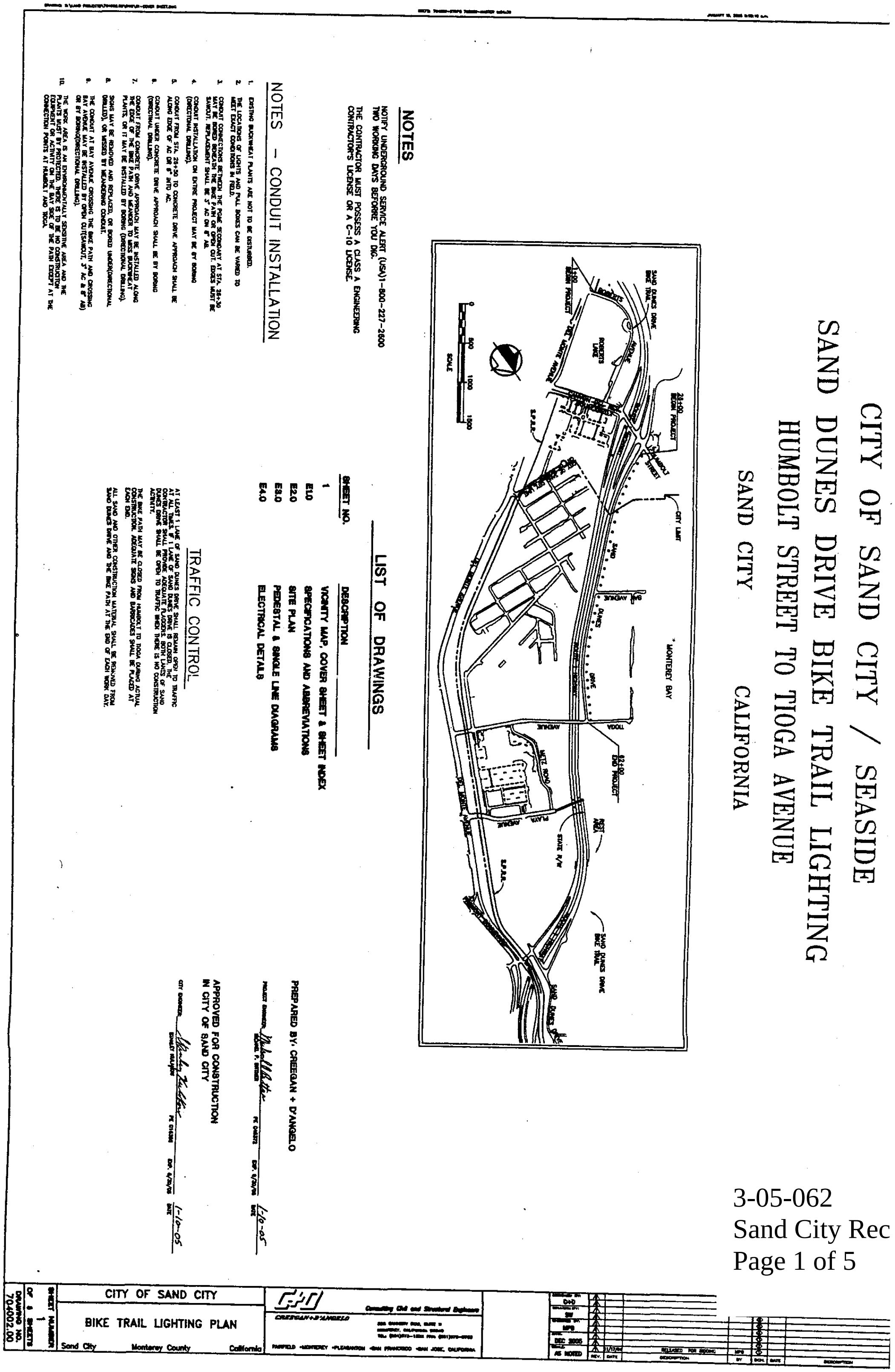
NOTE: See post-certification map for areas which permanently remain under Coastal Commission jurisdiction pursuant to Coastal Act Section 30519b and Section 30603a(1,2).

Exhibit A

Location Map
Coastal Rec Trail Relative to Coastal Zone Boundary and Area of Deferred Certification in Sand City

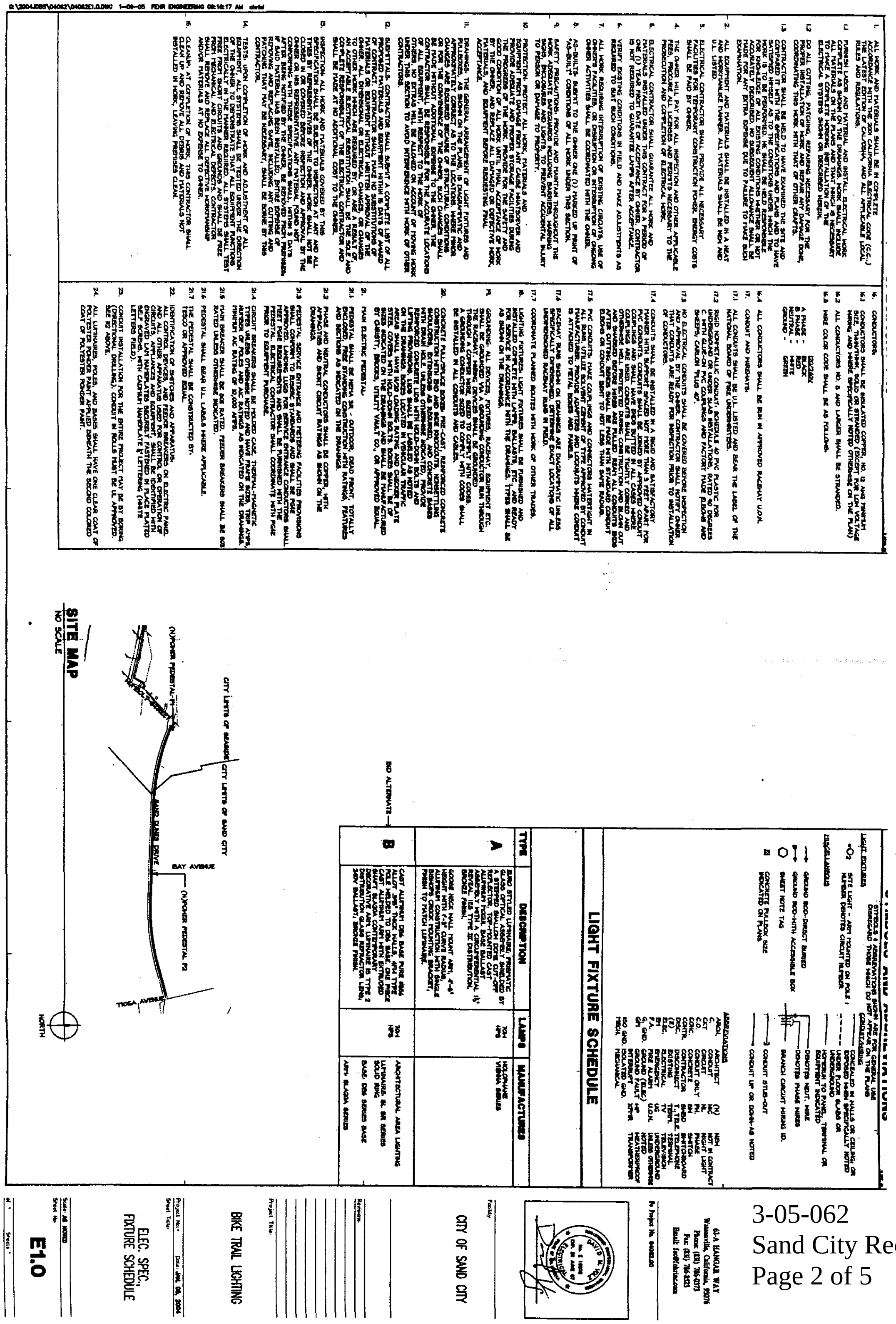
3-05-062
Sand City Rec Trail Lights
Page 2 of 2

Exhibit B: Site Plans and Elevations



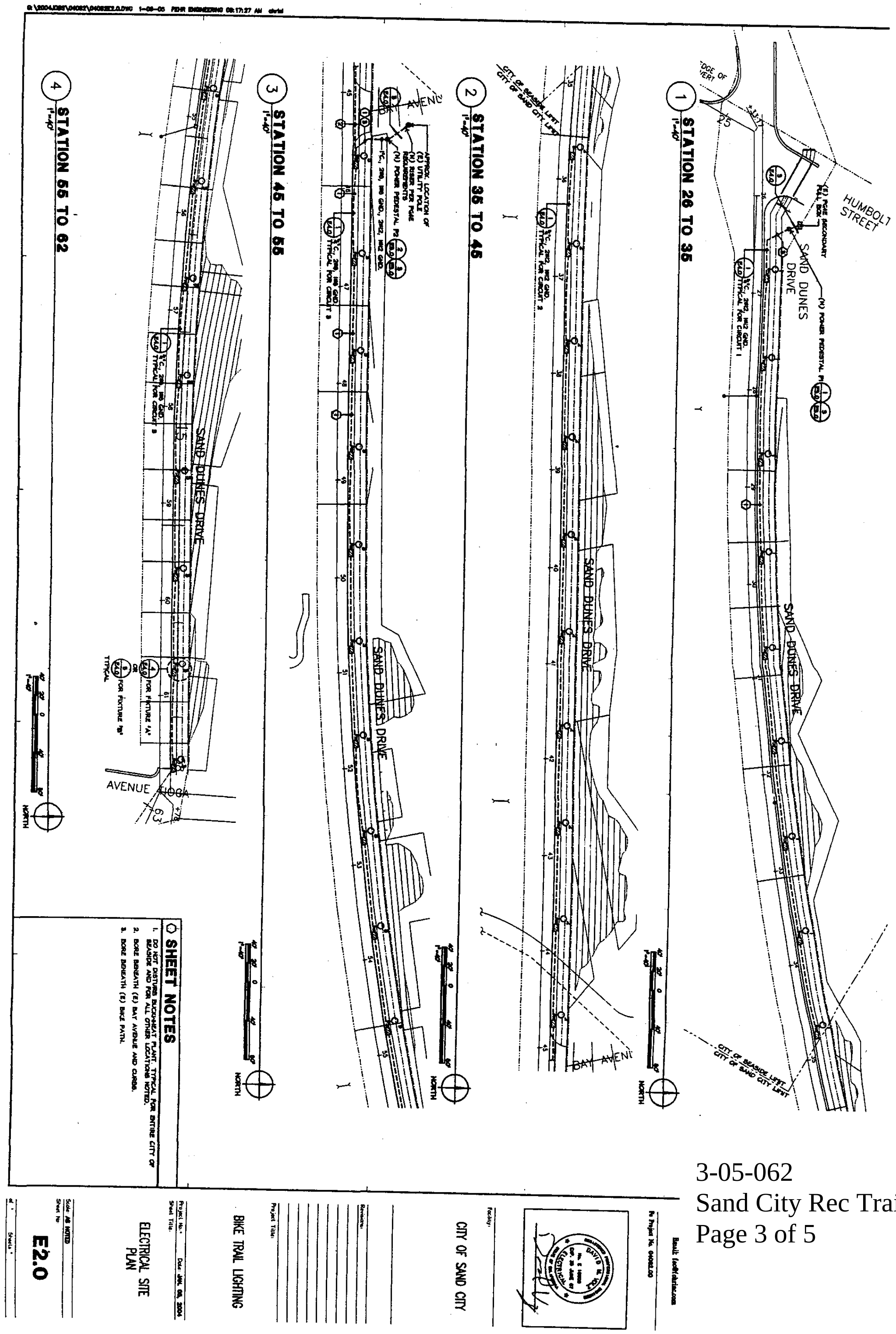
3-05-062
Sand City Rec Trail Lights
Page 1 of 5

Exhibit B: Site Plans and Elevations



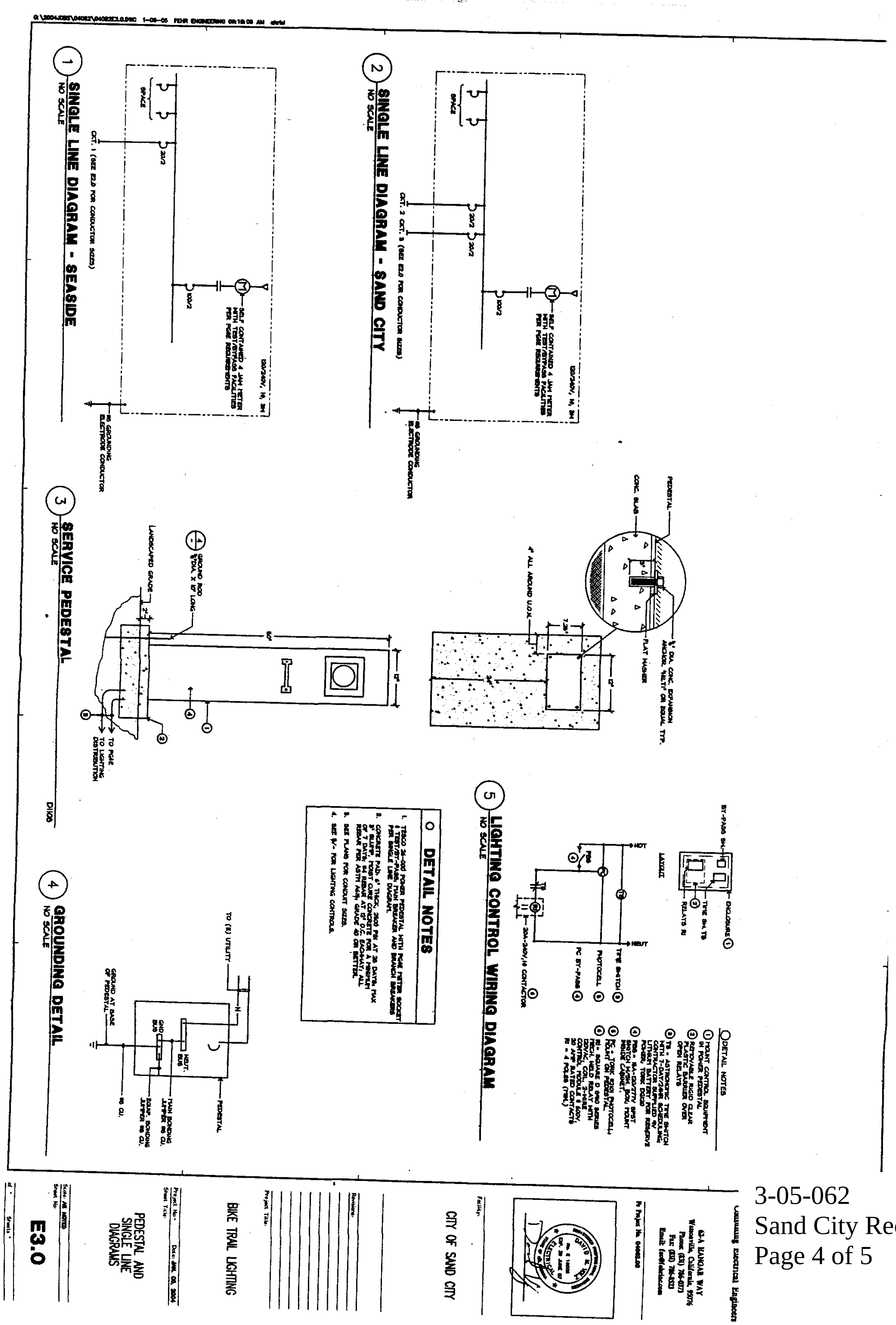
3-05-062
Sand City Rec Trail Lights
Page 2 of 5

Exhibit B: Site Plans and Elevations



3-05-062
Sand City Rec Trail Lights
Page 3 of 5

Exhibit B: Site Plans and Elevations



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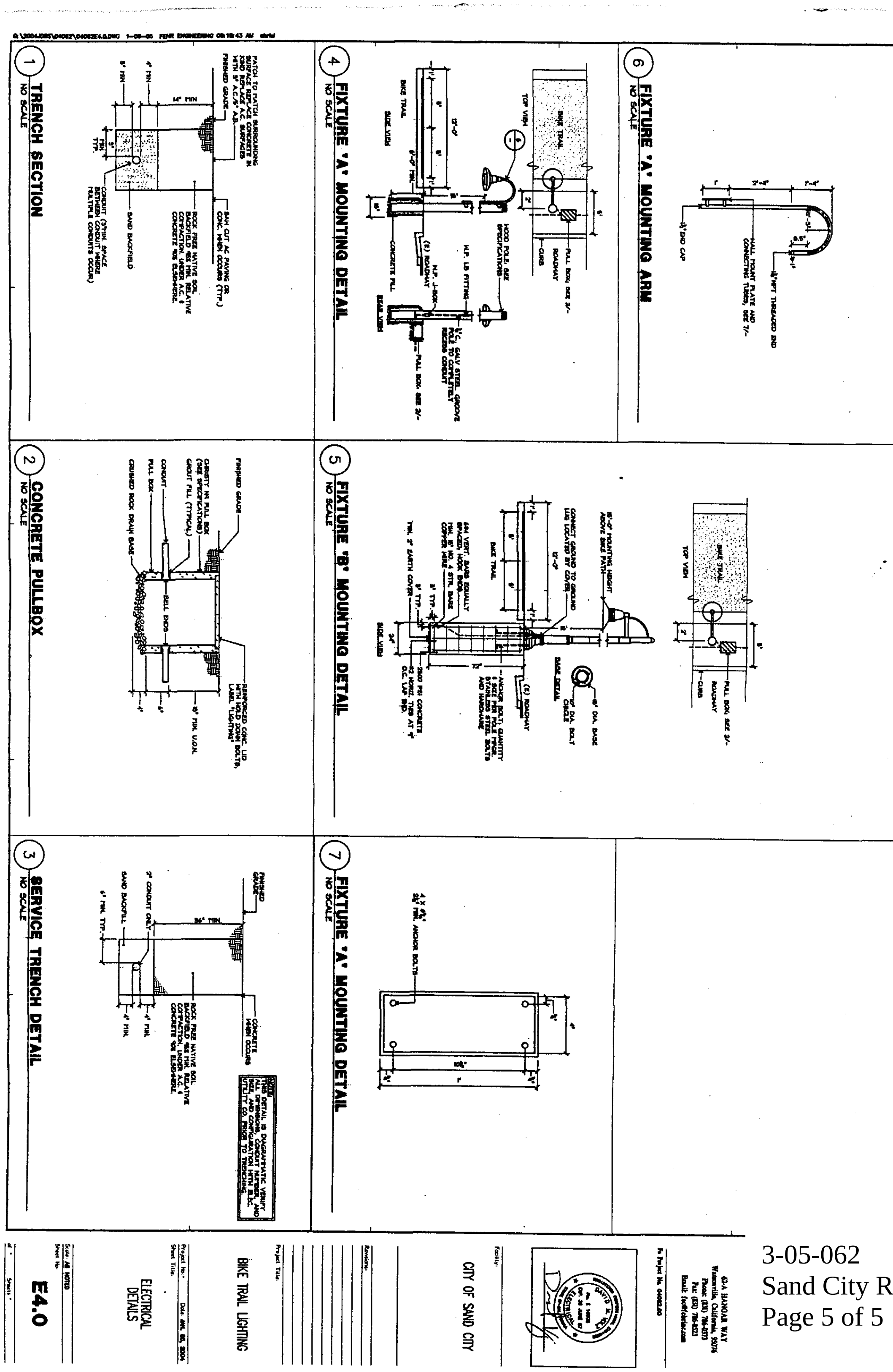
Sand City Rec Trail Lights
Page 4 of 5



3-05-062
Sand City Rec Trail Lights
Page 5 of 5

Exhibit C: Site Photographs

View of recreational trail from Bay Avenue looking north.

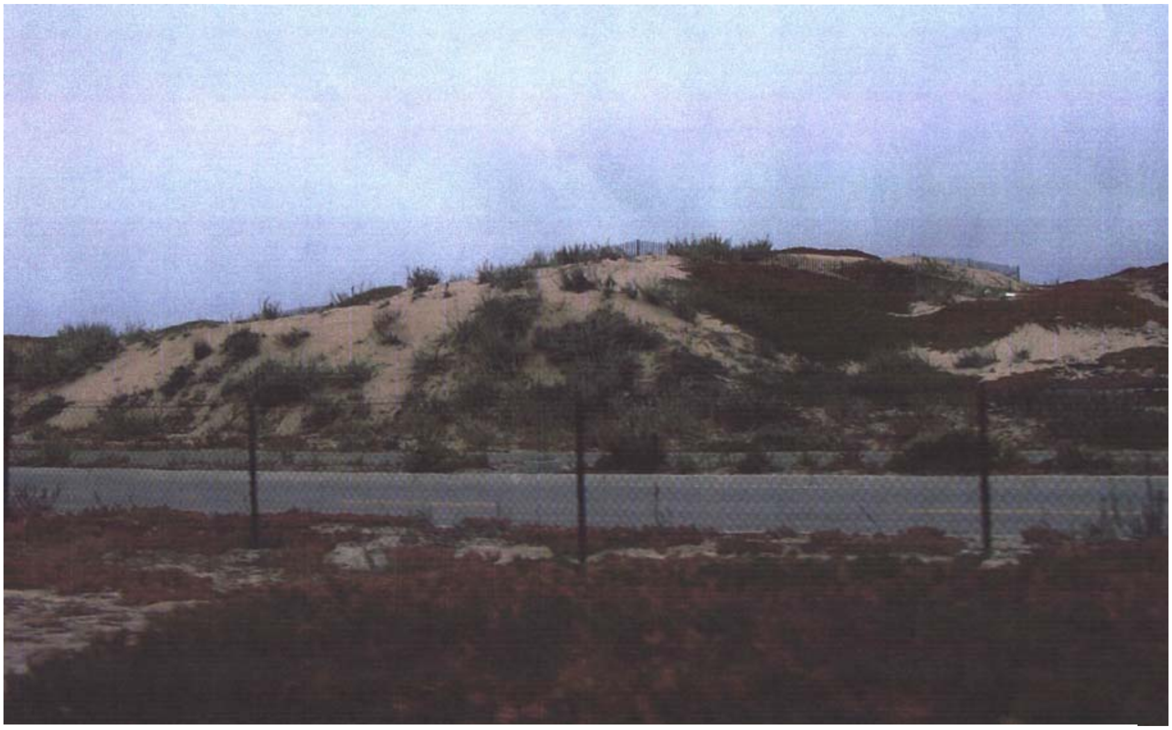
Same view of recreational trail from Bay Avenue but with overhead light standards in place.

Exhibit C: Site Photographs

View of sand dunes and Monterey Bay as seen from Highway 1 south.

Same view of sand dunes and Monterey Bay with overhead light standards.

Exhibit C: Site Photographs



Sand dune feature as seen from Highway 1.

Same sand dune feature with light standard as seen from Highway 1.

Exhibit C: Site Photographs

View of overhead light standards proposed by the Applicants along the southern end of the pedestrian and bicycle trail near the City of Seaside.

Exhibit D: Bollard Style Lights

Wood pole bollard style light installed adjacent to the recreational trail north of Tioga Avenue.

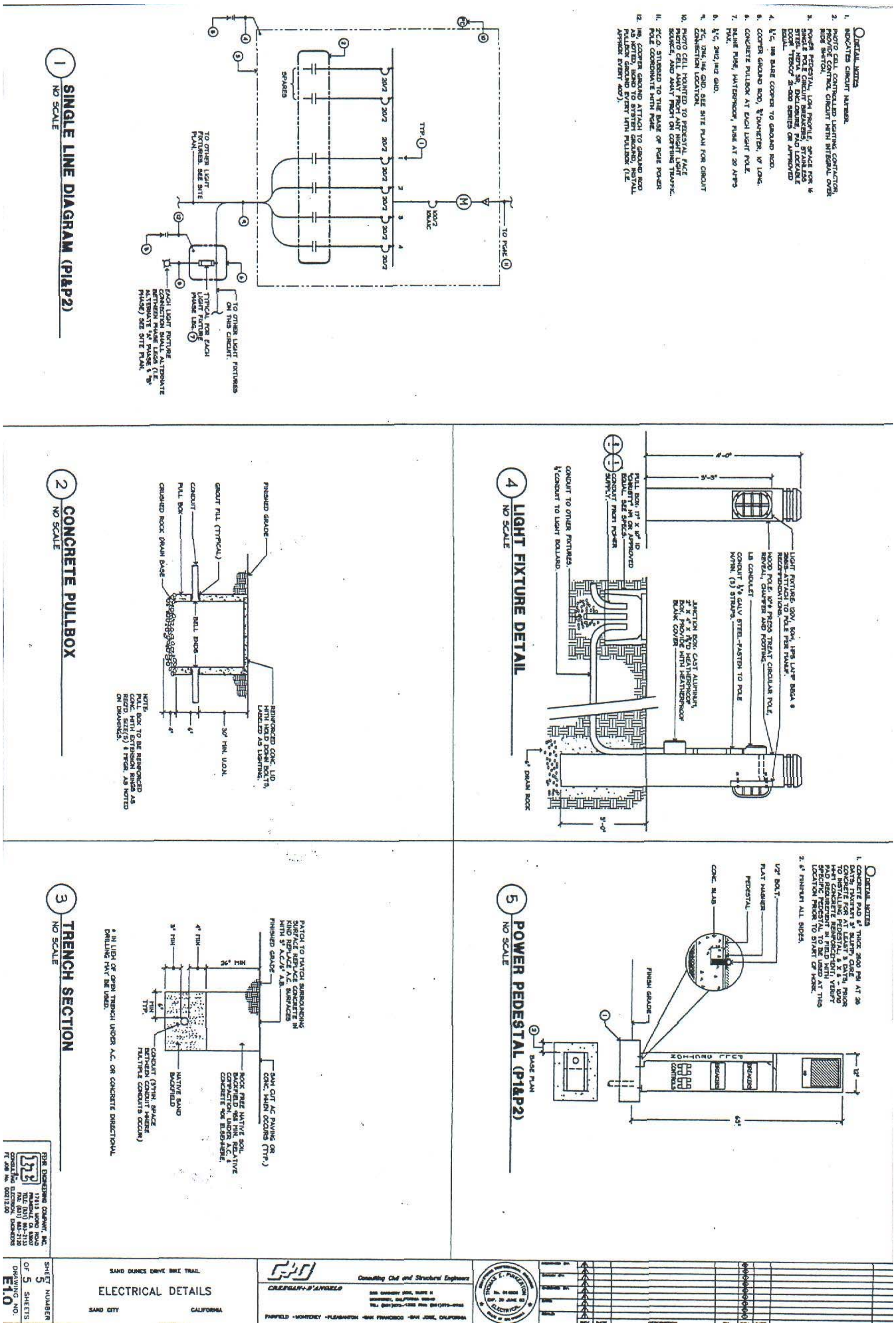
Exhibit D: Bollard Style Lights

View of bollard style lights along the recreational trail north of Tioga Avenue.

Another view of the bollards north of Tioga Avenue. Note the difference in visual impact between the bollard style lights and a typical overhead light standard.

California Coastal Commission

Exhibit D: Bollard Style Lights



TAMC
TRANSPORTATION AGENCY
FOR MONTEREY COUNTY

Regional Transportation Planning Agency • Congestion Management Planning
Local Transportation Commission • Monterey County Service Authority for Freeways & Expressways

November 3, 2005

Mr. Steve Monowitz
Chief of Permitting
California Coastal Commission
425 Front Street, Suite 300
Santa Cruz, California 95060

RE: Bicycle/Pedestrian Trail Lighting, Sand City/Seaside area

Dear Mr. Monowitz:

The Transportation Agency for Monterey County (TAMC) is writing to support the approval of a coastal development permit for the low profile, 15 foot, Coastal Village trail lights as proposed by the City of Sand City along the Monterey Bay Coastal Trail. This trail is an important regional bicycle and pedestrian facility, used by thousands of people each year, and proper and consistent lighting is a necessary feature for the trail. Adequate lighting will increase the level and frequency of public coastal access, an on-going purpose of the California Coastal Commission.

TAMC staff believes that these lights provide an essential safety element to the commuter and recreational trail through this area. These lights provide a high degree of visibility for cyclists and pedestrians who use this facility during the nighttime. This feature is especially important during the winter months when commuters are traveling to and from work before the sun comes up and after the sun goes down.

These lights are superior to the bollard-style lighting because they light a greater area of the trail, allowing users to see potential danger from farther away. By sending lighting directly onto the trail, these lights will minimize impacts on potential habitat areas. Bollard-style lighting is also more susceptible to damage by vandals, because the lower lights are easier to reach.

TAMC appreciates the California Coastal Commission's attention to this important bicycle and pedestrian project in Monterey County. Please have your staff contact Walt Allen, Bicycle and Pedestrian Coordinator, at 831-775-4412, if you wish to discuss this project further.

Sincerely,

Wm. Reichmuth, P.E.
Executive Director

C: Mr. Steve Matarazzo, Sand City

55-B Plaza Circle, Salinas, CA 93901-2902 • Tel: (831) 775-0903 • Fax: (831) 775-0897 • Website: www.tamcmonterey.org

UNIVERSITY POLICE DEPARTMENT

CALIFORNIA STATE UNIVERSITY, MONTEREY BAY
100 CAMPUS CENTER, BUILDING 82F
SEASIDE CA 93955 (831) 582-3360 Fax: (831) 582-3384

November 13, 2006

RECEIVED
NOV 21 2006
CALIFORNIA
COASTAL COMMISSION
CENTRAL COAST AREA

California Coastal Commissioners
45 Fremont Street
Suite 2000
San Francisco, California 94105

Dear Coastal Commissioners:

I am writing to request that you approve the coastal development permit for the cities of Sand City and Seaside to retain the low-profile, coastal village lights installed along Sand Dunes Drive and elsewhere in that vicinity. These lights cause no environmental damage and provide sufficient night-time security that is needed in an area where there are no residential or commercial tenants to act as stewards of public safety. The bollard light replacement suggested by your staff would be insufficient for public safety purposes in this dune-backed area where nefarious characters can hide without detection.

The Monterey Peninsula has already been subjected to crimes against persons in the form of attempted rapes and attempted homicides along certain stretches of the Monterey recreational trail that were not lighted. The area of light currently provided by Sand City is an important commuter route, and during the winter months where lighting is especially needed for the night-time working hours, students from California State University at Monterey Bay (CSUMB) use the bicycle path as a transportation route to their hospitality-related jobs in Seaside, Monterey and Pacific Grove. Also, two major hotels are located in close proximity to the trail where visitors use it for recreational and exercise-purposes, even at night. Due to bike path assaults in Pacific Grove and Monterey, lights have now been installed or are proposed in those effected locations. The Sand City-installed lights are similar in scale to existing bike path lights in Monterey.

In conclusion, I respectfully request in the interest of public safety that you allow the retention of the current bike trail lights in Sand City and the City of Seaside. They cause no harm, they assist in preventing harm.

Sincerely,

Fred Hardee, Chief of Police
California State University, Monterey Bay

MONTEREY COUNTY

THE BOARD OF SUPERVISORS

RECEIVED
SEP 1 2 2006
CALIFORNIA
COASTAL COMMISSION
CENTRAL COAST AREA

September 12, 2006

Meg Caldwell, Chair
California Coastal Commission
559 Nathan Abbott Way
Own House Room 6
Stanford, CA 94306

Re: **Support Retention of Low Profile Coastal Village Bike Path Lighting City of Sand City**

Dear Chair Caldwell:

The Monterey County Board of Supervisors supports the approval of an application from the City of Sand City for the retention of low profile coastal village bike path lighting that lines Sand Dunes Drive, south of its intersection with Tioga Avenue in the cities of Seaside and Sand City. The California Coastal Commission is scheduled to consider this matter at its September 14, 2006 meeting.

Retention of the low profile coastal village bike path lighting is requested for the following reasons:

1) The lighting provides illumination on an isolated area of the bike trail, and is therefore vital to public safety;
2) The lighting does not block or impact any coastal views; and
3) The alternative bollard style lighting is prone to vandalism.

In conclusion, the Monterey County Board of Supervisors appreciates this opportunity to comment on this matter, and once again urges your support for retention of low profile coastal village bike path lighting as requested by the City of Sand City.

Sincerely,

Jerry C. Smith
Chair, Board of Supervisors

cc: Board of Supervisors
Lew C. Bauman, County Administrative Officer
Nicholas E. Chiulos, Interim Chief of Intergovernmental Affairs
David K. Pendergrass, Mayor – City of Sand City
Kelly Morgan, City Manager – City of Sand City
Debbie Hale, Executive Director - TAMC

[illegible]

Michael Watson

From: Travis Longcore [longcore@urbanwildlands.org]
Sent: Monday, September 11, 2006 4:54 PM
To: Michael Watson
Subject: Sand City Lighting

Dear Mr. Watson,

Please communicate the following comments on behalf of The Urban Wildlands Group to the full Coastal Commission regarding? **Application No. 3-05-62 (City of Sand City, Sand City)**? Application of City of Sand City after-the-fact permit to install overhead lighting along Sand City/Seaside Coastal, regional bike path, at Sand Dunes Drive (between Humboldt Street & Tioga Avenue), Sand City, Monterey County.

I am co-editor of the peer-reviewed book Ecological Consequences of Artificial Night Lighting and author of the most recent peer-reviewed summary article on this topic.? I have attached that article and two reviews of the book for your information and to establish my expertise on this topic.

The Urban Wildlands Group supports the staff recommendation for the removal of the overhead lighting at Sand Dunes Drive and the implementation of performance standards for on any replacement lighting.??

Dune environments are particularly sensitive to the adverse effects of artificial lighting because they are open with little vegetative cover.? As established in a number of habitats and in a least a dozen scientific articles, small mammals such as native mice and kangaroo rats are less active under artificial lights.? This reduces their uptake of food.? For a coastal dune ESHA, this would clearly be an adverse impact.? I have attached a paper explicitly showing this phenomenon for rare beach mice in Florida, but the same type of disruption would occur in California dunes.

Additional lighting is usually beneficial to predators, and avian nest predators such as crows and ravens threaten the recovery of western snowy plovers.? Crows are known to roost in areas with higher ambient nighttime lighting.? Increased lighting near beaches that might support plovers should therefore be discouraged.?

We recommend that the conditions on lighting be modified to better protect natural resources in the following ways.

1.? The amount of light should be limited by lumens (a measurement of light) rather than wattage (a measurement of energy).? Alternatively, the condition should specific light no greater than that produced by a 25 W incandescent bulb (for example).

2.? Spectrum should be limited to yellow.? This wavelength attracts the fewest insects, which are attracted to shorter wavelengths.

3.? Specific limitations should be placed on the shielding of lights to ensure that they are limited only to the path and that surrounding areas experience no direct glare.

Finally, if lighting can be avoided altogether it should be.??

Thank you for considering these comments and forwarding them and the attached information to the Commission to aid in its deliberations.

Sincerely,
Travis Longcore

Ecological light pollution

Travis Longcore and Catherine Rich

Ecologists have long studied the critical role of natural light in regulating species interactions, but, with limited exceptions, have not investigated the consequences of artificial night lighting. In the past century, the extent and intensity of artificial night lighting has increased such that it has substantial effects on the biology and ecology of species in the wild. We distinguish "astronomical light pollution", which obscures the view of the night sky, from "ecological light pollution", which alters natural light regimes in terrestrial and aquatic ecosystems. Some of the catastrophic consequences of light for certain taxonomic groups are well known, such as the deaths of migratory birds around tall lighted structures, and those of hatchling sea turtles disoriented by lights on their natal beaches. The more subtle influences of artificial night lighting on the behavior and community ecology of species are less well recognized, and constitute a new focus for research in ecology and a pressing conservation challenge.

Front Ecol Environ 2004; 2(4): 191–198

As diurnal creatures, humans have long sought methods to illuminate the night. In pre-industrial times, artificial light was generated by burning various materials, including wood, oil, and even dried fish. While these methods of lighting certainly influenced animal behavior and ecology locally, such effects were limited. The relatively recent invention and rapid proliferation of electric lights, however, have transformed the nighttime environment over substantial portions of the Earth's surface.

Ecologists have not entirely ignored the potential disruption of ecological systems by artificial night lighting. Several authors have written reviews of the potential effects on ecosystems or taxonomic groups, published in the "gray" literature (Health Council of the Netherlands 2000; Hill 1990), conference proceedings (Outen 2002; Schmiedel 2001), and journal articles (Frank 1988; Verheijen 1985; Salmon 2003). This review attempts to integrate the literature on the topic, and draws on a conference organized by the authors in 2002 titled *Ecological Consequences of Artificial Night Lighting*. We identify the roles that artificial night lighting plays in changing ecological interactions across taxa, as opposed to reviewing these effects by taxonomic group. We first discuss the scale and extent of ecological light pollution and its relationship to astronomical light pollution, as well as the measurement of light for ecological research. We then address the recorded and potential influences of artificial night lighting within the nested hierarchy of behavioral and population ecology, community ecology, and ecosystem ecology. While this hierarchy is somewhat artificial and certainly mutable, it illustrates the breadth of potential consequences of ecological light pollution. The important effects of light on the physiology of organisms (see Health Council of the Netherlands 2000) are not discussed here.

In a nutshell:

- Ecological light pollution includes chronic or periodically increased illumination, unexpected changes in illumination, and direct glare
- Animals can experience increased orientation or disorientation from additional illumination and are attracted to or repulsed by glare, which affects foraging, reproduction, communication, and other critical behaviors
- Artificial light disrupts interspecific interactions evolved in natural patterns of light and dark, with serious implications for community ecology

The Urban Wildlands Group, PO Box 24020, Los Angeles, CA 90024-0020 (longcore@urbanwildlands.org)

Astronomical and ecological light pollution: scale and extent

The term "light pollution" has been in use for a number of years, but in most circumstances refers to the degradation of human views of the night sky. We want to clarify that this is "astronomical light pollution", where stars and other celestial bodies are washed out by light that is either directed or reflected upward. This is a broad-scale phenomenon, with hundreds of thousands of light sources cumulatively contributing to increased nighttime illumination of the sky; the light reflected back from the sky is called "sky glow" (Figure 1). We describe artificial light that alters the natural patterns of light and dark in ecosystems as "ecological light pollution". Verheijen (1985) proposed the term "photopollution" to mean "artificial light having adverse effects on wildlife". Because photopollution literally means "light pollution" and because light pollution is so widely understood today to describe the degradation of the view of the night sky and the human experience of the night, we believe that a more descriptive term is now necessary. Ecological light pollution includes direct glare, chronically increased illumina-

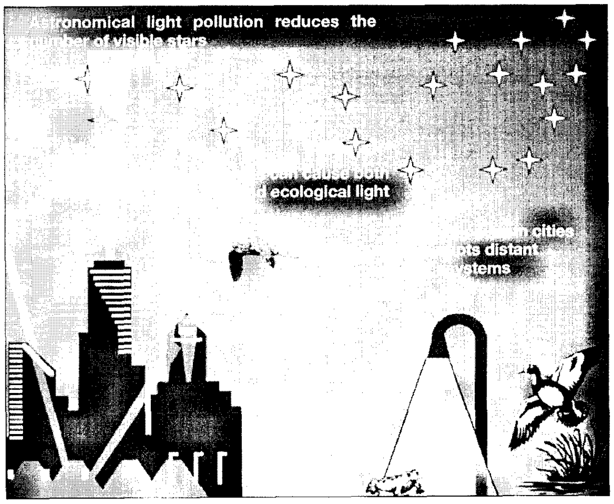


Figure 1. Diagram of ecological and astronomical light pollution.

tion, and temporary, unexpected fluctuations in lighting. Sources of ecological light pollution include sky glow, lighted buildings and towers, streetlights, fishing boats, security lights, lights on vehicles, flares on offshore oil platforms, and even lights on undersea research vessels, all of which can disrupt ecosystems to varying degrees. The phenomenon therefore involves potential effects across a range of spatial and temporal scales.

The extent of ecological light pollution is global (Elvidge *et al.* 1997; Figure 2). The first atlas of artificial night sky brightness illustrates that astronomical light pollution extends to every inhabited continent (Cinzano *et al.* 2001). Cinzano *et al.* (2001) calculate that only 40% of Americans live where it becomes sufficiently dark at night for the human eye to make a complete transition from cone to rod vision and that 18.7% of the terrestrial surface of the Earth is exposed to night sky brightness that is polluted by astronomical standards. Ecosystems may be affected by these levels of illumination and lights that do not contribute to sky glow may still have ecological consequences, ensuring that ecological light pollution afflicts an even greater proportion of the Earth. Lighted fishing fleets, offshore oil platforms, and cruise ships bring the disruption of artificial night lighting to the world's oceans.

The tropics may be especially sensitive to alterations in natural diel (ie over a 24-hour period) patterns of light and dark because of the year-round constancy of daily cycles (Gliwicz 1999). A shortened or brighter night is more likely to affect tropical species adapted to diel patterns with minimal seasonal variation than extratropical species adapted to substantial seasonal variation. Of course, temperate and polar zone species active only during a portion of the year would be excluded from this generalization. Species in temperate zones will also be susceptible to disruptions if they depend on seasonal day length cues to trigger critical behaviors.

■ Measurements and units

Measurement of ecological light pollution often involves determination of illumination at a given place. Illumination is the amount of light incident per unit area – not the only measurement relevant to ecological light pollution, but the most common. Light varies in intensity (the number of photons per unit area) and spectral content (expressed by wavelength). Ideally, ecologists should measure illumination in photons per square meter per second with associated measurements of the wavelengths of light present. More often, illumination is measured in lux (or footcandles, the non-SI unit), which expresses the brightness of light as perceived by the human eye. The lux measurement places more emphasis on wavelengths of light that the human eye detects best and less on those that humans perceive poorly. Because other organisms perceive light differently – including wavelengths not visible to humans – future research on ecological light pollution should identify these responses and measure light accordingly. For example, Gal *et al.* (1999) calculated the response curve of mysid shrimp to light and reported illumination in lux adjusted for the spectral sensitivity of the species.

Ecologists are faced with a practical difficulty when communicating information about light conditions. Lux is the standard used by nearly all lighting designers, lighting engineers, and environmental regulators; communication with them requires reporting in this unit. Yet the use of lux ignores biologically relevant information. High-pressure sodium lights, for instance, will attract moths because of the presence of ultraviolet wavelengths, while low-pressure sodium lights of the same intensity, but not producing ultraviolet light, will not (Rydell 1992). Nevertheless, we use lux here, both because of the need to communicate with applied professionals, and because of its current and past widespread usage. As this research field develops, however, measurements of radiation and spectrum relevant to the organisms in question should be used, even though lux will probably continue to be the preferred unit for communication with professionals in other disciplines.

Ecologists also measure aspects of the light environment other than absolute illumination levels. A sudden change in illumination is disruptive for some species (Buchanan 1993), so percent change in illumination, rate, or similar measures may be relevant. Ecologists may also measure luminance (ie brightness) of light sources that are visible to organisms.

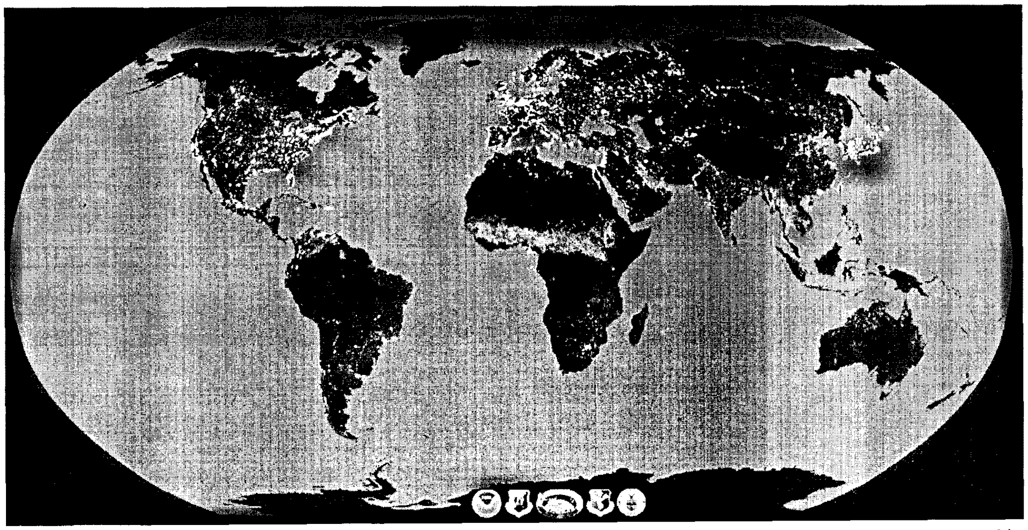


Figure 2. Distribution of artificial lights visible from space. Produced using cloud-free portions of low-light imaging data acquired by the US Air Force Defense Meteorological Satellite Program Operational Linescan System. Four types of lights are identified: (1) human settlements – cities, towns, and villages (white), (2) fires – defined as ephemeral lights on land (red), (3) gas flares (green), and (4) heavily lit fishing boats (blue). See Elvidge et al. *(2001) for details. Image, data processing, and descriptive text by the National Oceanic and Atmospheric Administration's National Geophysical Data Center.*

■ Behavioral and population ecology

Ecological light pollution has demonstrable effects on the behavioral and population ecology of organisms in natural settings. As a whole, these effects derive from changes in orientation, disorientation, or misorientation, and attraction or repulsion from the altered light environment, which in turn may affect foraging, reproduction, migration, and communication.

Orientation/disorientation and attraction/repulsion

Orientation and disorientation are responses to ambient illumination (ie the amount of light incident on objects in an environment). In contrast, attraction and repulsion occur in response to the light sources themselves and are therefore responses to luminance or the brightness of the source of light (Health Council of the Netherlands 2000).

Increased illumination may extend diurnal or crepuscular behaviors into the nighttime environment by improving an animal's ability to orient itself. Many usually diurnal birds (Hill 1990) and reptiles (Schwartz and Henderson 1991), for example, forage under artificial lights. This has been termed the "night light niche" for reptiles and seems beneficial for those species that can exploit it, but not for their prey (Schwartz and Henderson 1991).

In addition to foraging, orientation under artificial illumination may induce other behaviors, such as territorial singing in birds (Bergen and Abs 1997). For the northern mockingbird (*Mimus polyglottos*), males sing at night before mating, but once mated only sing at night in artificially lighted areas (Derrickson 1988) or during the full moon. The effect of these light-induced behaviors on fitness is unknown.

Constant artificial night lighting may also disorient organisms accustomed to navigating in a dark environment. The best-known example of this is the disorientation of hatchling sea turtles emerging from nests on sandy beaches. Under normal circumstances, hatchlings move away from low, dark silhouettes (historically, those of dune vegetation), allowing them to crawl quickly to the ocean. With beachfront lighting, the silhouettes that would have cued movement are no longer perceived, resulting in disorientation (Salmon *et al.* 1995). Lighting also affects the egg-laying behavior of female sea turtles. (For reviews of effects on sea turtles, see Salmon 2003 and Witherington 1997).

Changes in light level may disrupt orientation in nocturnal animals. The range of anatomical adaptations to allow night vision is broad (Park 1940), and rapid increases in light can blind animals. For frogs, a quick increase in illumination causes a reduction in visual capability from which the recovery time may be minutes to hours (Buchanan 1993). After becoming adjusted to a light, frogs may be attracted to it as well (Jaeger and Hailman 1973; Figure 3).

Birds can be disoriented and entrapped by lights at night (Ogden 1996). Once a bird is within a lighted zone at night, it may become "trapped" and will not leave the lighted area. Large numbers of nocturnally migrating birds are therefore affected when meteorological conditions bring them close to lights, for instance, during inclement weather or late at night when they tend to fly lower.

*Figure 3. Attraction of frogs to a candle set out on a small raft. Illustration by Charles Copeland of an experiment in northern Maine or Canada described by William J Long (1901). Twelve or fifteen bullfrogs (*Rana catesbeiana*) climbed on to the small raft before it flipped over.*

Within the sphere of lights, birds may collide with each other or a structure, become exhausted, or be taken by predators. Birds that are waylaid by buildings in urban areas at night often die in collisions with windows as they try to escape during the day. Artificial lighting has attracted birds to smokestacks, lighthouses (Squires and Hanson 1918), broadcast towers (Ogden 1996), boats (Dick and Donaldson 1978), greenhouses, oil platforms (Wiese *et al.* 2001), and other structures at night, resulting in direct mortality, and thus interfering with migration routes.

Many groups of insects, of which moths are one well-known example (Frank 1988), are attracted to lights. Other taxa showing the same attraction include lacewings, beetles, bugs, caddisflies, crane flies, midges, hoverflies, wasps, and bush crickets (Eisenbeis and Hassel 2000; Kolligs 2000; Figure 4). Attraction depends on the spectrum of light – insect collectors use ultraviolet light because of its attractive qualities – and the characteristics of other lights in the vicinity.

Courtesy of PJ DeVries

Figure 4. *Thousands of mayflies carpet the ground around a security light at Millecoquins Point in Naubinway on the Upper Peninsula of Michigan.*

Nonflying arthropods vary in their reaction to lights. Some nocturnal spiders are negatively phototactic (ie repelled by light), whereas others will exploit light if available (Nakamura and Yamashita 1997). Some insects are always positively phototactic as an adaptive behavior and others always photonegative (Summers 1997). In arthropods, these responses may also be influenced by the frequent correlations between light, humidity, and temperature.

Natural resource managers can exploit the responses of animals to lights. Lights are sometimes used to attract fish to ladders, allowing them to bypass dams and power plants (Haymes *et al.* 1984). Similarly, lights can attract larval fish to coral reefs (Munday *et al.* 1998). In the terrestrial realm, dispersing mountain lions avoid lighted areas to such a degree that Beier (1995) suggests installing lights to deter them from entering habitats dead-ending in areas where humans live.

Reproduction

Reproductive behaviors may be altered by artificial night lighting. Female *Physalaemus pustulosus* frogs, for example, are less selective about mate choice when light levels are increased, presumably preferring to mate quickly and avoid the increased predation risk of mating activity (Rand *et al.* 1997). Night lighting may also inhibit amphibian movement to and from breeding areas by stimulating phototactic behavior. Bryant Buchanan (pers comm) reports that frogs in an experimental enclosure stopped mating activity during night football games, when lights from a nearby stadium increased sky glow. Mating choruses resumed only when the enclosure was covered to shield the frogs from the light.

In birds, some evidence suggests that artificial night lighting affects the choice of nest site. De Molenaar *et al.*

(2000) investigated the effects of roadway lighting on black-tailed godwits (*Limosa l. limosa*) in wet grassland habitats. Breeding densities of godwits were recorded over 2 years, comparing lighted and unlighted conditions near a roadway and near light poles installed in a wet grassland away from the road influence. When all other habitat factors were taken into account, the density of nests was slightly but statistically lower up to 300 m away from the lighting at roadway and control sites. The researchers also noted that birds nesting earlier in the year chose sites farther away from the lighting, while those nesting later filled in sites closer to the lights.

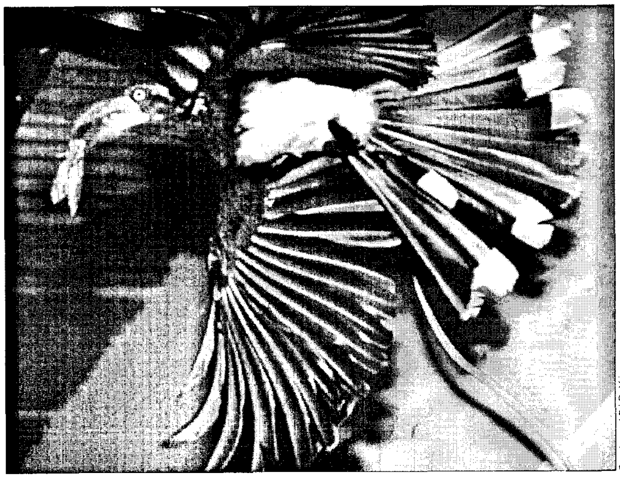


Figure 5. *Crowned hornbill (*Tockus alboterminatus*) hawking insects at a light at the Kibale Forest National Park, Uganda.*

Communication

Visual communication within and between species may be influenced by artificial night lighting. Some species use light to communicate, and are therefore especially susceptible to disruption. Female glow-worms attract males up to 45 m away with bioluminescent flashes; the presence of artificial lighting reduces the visibility of these communications. Similarly, the complex visual communication system of fireflies could be impaired by stray light (Lloyd 1994).

Artificial night lighting could also alter communication patterns as a secondary effect. Coyotes (*Canis latrans*) group howl and group yip-howl more during the new moon, when it is darkest. Communication is necessary either to reduce trespassing from other packs, or to assemble packs to hunt larger prey during dark conditions (Bender *et al.* 1996). Sky glow could increase ambient illumination to eliminate this pattern in affected areas.

Because of the central role of vision in orientation and behavior of most animals, it is not surprising that artificial lighting alters behavior. This causes an immediate conservation concern for some species, while for other species the influence may seem to be positive. Such "positive" effects, however, may have negative consequences within the context of community ecology.

■ Community ecology

The behaviors exhibited by individual animals in response to ambient illumination (orientation, disorientation) and to luminance (attraction, repulsion) influence community interactions, of which competition and predation are examples.

Competition

Artificial night lighting could disrupt the interactions of groups of species that show resource partitioning across illumination gradients. For example, in natural communities, some foraging times are partitioned among species that prefer different levels of lighting. The squirrel treefrog (*Hyla squirrela*) is able to orient and forage at lighting levels as low as 10^{-5} lux and under natural conditions typically will stop foraging at illuminations above 10^{-3} lux (Buchanan 1998). The western toad (*Bufo boreas*) forages only at illuminations between 10^{-1} and 10^{-5} lux, while the tailed frog (*Ascaphus truei*) forages only during the darkest part of the night at below 10^{-5} lux (Hailman 1984). While these three species are not necessarily sympatric (ie inhabiting the same area), and differ in other niche dimensions, they illustrate the division of the light gradient by foragers.

Many bat species are attracted to insects that congregate around light sources (Frank 1988). Although it may seem that this is a positive effect, the increased food concentration benefits only those species that exploit light sources and could therefore result in altered community structure. Faster-flying species of bats congregate around lights to feed on insects, but other, slower-flying species avoid lights (Blake *et al.* 1994; Rydell and Baagøe 1996).

Changes in competitive communities occur as diurnal species move into the "night light niche" (Schwartz and Henderson 1991). This concept, as originally described, applies to reptiles, but easily extends to other taxa, such as spiders (Frank pers comm) and birds (Hill 1990; Figure 5).

Predation

Although it may seem beneficial for diurnal species to be able to forage longer under artificial lights, any gains from increased activity time can be offset by increased predation risk (Gotthard 2000). The balance between gains from extended foraging time and risk of increased predation is a central topic for research on small mammals, reptiles, and birds (Kotler 1984; Lima 1998). Small rodents forage less at high illumination levels (Lima 1998), a tendency also exhibited by some lagomorphs (Gilbert and Boutin 1991), marsupials (Laferrier 1997), snakes (Klauber 1939), bats (Rydell 1992), fish (Gibson 1978), aquatic invertebrates (Moore *et al.* 2000), and other taxa.

Unexpected changes in light conditions may disrupt predator–prey relationships. Gliwicz (1986, 1999) describes high predation by fish on zooplankton during nights when the full moon rose hours after sunset. Zooplankton had migrated to the surface to forage under cover of darkness, only to be illuminated by the rising moon and subjected to intense predation. This "lunar light trap" (Gliwicz 1986) illustrates a natural occurrence, but unexpected illumination from human sources could disrupt predator–prey interactions in a similar manner, often to the benefit of the predator.

Available research shows that artificial night lighting disrupts predator–prey relationships, which is consistent with the documented importance of natural light regimes in mediating such interactions. In one example, harbor seals (*Phoca vitulina*) congregated under artificial lights to eat juvenile salmonids as they migrated downstream; turning the lights off reduced predation levels (Yurk and Trites 2000). Nighttime illumination at urban crow roosts was higher than at control sites, presumably because this helps the crows avoid predation from owls (Gorenzel and Salmon 1995). Desert rodents reduced foraging activity when exposed to the light of a single camp lantern (Kotler 1984). Frank (1988) reviews predation by bats, birds, skunks, toads, and spiders on moths attracted to artificial lights. Mercury vapor lights, in particular, disrupt the interaction between bats and tympanate moths by interfering with moth detection of ultrasonic chirps used by bats in echolocation, leaving moths unable to take their normal evasive action (Svensson and Rydell 1998).

From these examples, it follows that community structure will be altered where light affects interspecific interactions. A "perpetual full moon" from artificial lights will favor light-tolerant species and exclude others. If the darkest natural conditions never occur, those species that maximize foraging during the new moon could eventually be compromised, at risk of failing to meet monthly energy budgets. The resulting community structure would be simplified, and these changes could in turn affect ecosystem characteristics.

■ Ecosystem effects

The cumulative effects of behavioral changes induced by artificial night lighting on competition and predation have the potential to disrupt key ecosystem functions. The spillover effects from ecological light pollution on aquatic invertebrates illustrates this point. Many aquatic invertebrates, such as zooplankton, move up and down within the water column during a 24-hour period, in a behavior known as "diel vertical migration". Diel vertical migration presumably results from a need to avoid predation during lighted conditions, so many zooplankton forage near water surfaces only during dark conditions (Gliwicz 1986). Light dimmer than that of a half moon ($<10^{-1}$ lux) is sufficient to influence the vertical distribution of some aquatic invertebrates, and indeed patterns of diel vertical migration change with the lunar cycle (Dodson 1990).

Moore *et al.* (2000) documented the effect of artificial light on the diel migration of the zooplankton *Daphnia* in the wild. Artificial illumination decreased the magnitude of diel migrations, both in the range of vertical movement and the number of individuals migrating. The researchers hypothesize that this disruption of diel vertical migration may have substantial detrimental effects on ecosystem health. With fewer zooplankton migrating to the surface to graze, algae populations may increase. Such algal blooms would then have a series of adverse effects on water quality (Moore *et al.* 2000).

The reverberating effects of community changes caused by artificial night lighting could influence other ecosystem functions. Although the outcomes are not yet predictable, and redundancy will buffer changes, indications are that light-influenced ecosystems will suffer from important changes attributable to artificial light alone and in combination with other disturbances. Even remote areas may be exposed to increased illumination from sky glow, but the most noticeable effects will occur in those areas where lights are close to natural habitats. This may be in wilderness where summer getaways are built, along the expanding front of suburbanization, near the wetlands and estuaries that are often the last open spaces in cities, or on the open ocean, where cruise ships, squid boats, and oil derricks light the night.

■ Conclusions

Our understanding of the full range of ecological consequences of artificial night lighting is still limited, and the field holds many opportunities for basic and applied research. Studies of natural populations are necessary to investigate hypotheses generated in the laboratory, evidence of lunar cycles in wild populations, and natural history observations. If current trends continue, the influence of stray light on ecosystems will expand in geographic scope and intensity. Today, 20% of the area of the coterminous US lies within 125 m of a road (Riiters and Wickham 2003). Lights follow roads, and the proportion of ecosystems uninfluenced by altered light regimes is decreasing. We believe that many ecologists have neglected to consider artificial night lighting as a relevant environmental factor, while conservationists have certainly neglected to include the nighttime environment in reserve and corridor design.

Successful investigation of ecological light pollution will require collaboration with physical scientists and engineers to improve equipment to measure light characteristics at ecologically relevant levels under diverse field conditions. Researchers should give special consideration to the tropics, where the constancy of day–night lighting patterns has probably resulted in narrow niche breadths relative to illumination. Aquatic ecosystems deserve increased attention as well, because despite the central importance of light to freshwater and marine ecology, consideration of artificial lighting has so far been limited. Research on the effects of artificial night lighting will enhance understanding of urban ecosystems – the two National Science Foundation (NSF) urban Long Term Ecological Research sites are ideal locations for such efforts.

Careful research focusing on artificial night lighting will probably reveal it to be a powerful force structuring local communities by disrupting competition and predator–prey interactions. Researchers will face the challenge of disentangling the confounding and cumulative effects of other facets of human disturbance with which artificial night lighting will often be correlated, such as roads, urban development, noise, exotic species, animal harvest, and resource extraction. To do so, measurements of light disturbance should be included routinely as part of environmental monitoring protocols, such as the NSF's National Ecological Observatory Network (NEON). Future research is likely to reveal artificial night lighting to be an important, independent, and cumulative factor in the disruption of natural ecosystems, and a major challenge for their preservation.

Ecologists have studied diel and lunar patterns in the behavior of organisms for the greater part of a century (see Park 1940 and references therein), and the deaths of birds from lights for nearly as long (Squires and Hanson 1918). Humans have now so altered the natural patterns of light and dark that these new conditions must be afforded a more central role in research on species and ecosystems beyond the instances that leave carcasses on the ground.

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■ References

Beier P. 1995. Dispersal of juvenile cougars in fragmented habitat. *J Wildlife Manage* 59: 228–37.

Bender DJ, Bayne EM, and Brigham RM. 1996. Lunar condition influences coyote (*Canis latrans*) howling. *Am Midl Nat* 136: 413–17.

Bergen F and Abs M. 1997. Etho-ecological study of the singing activity of the blue tit (*Parus caeruleus*), great tit (*Parus major*) and chaffinch (*Fringilla coelebs*). *J Ornithol* 138: 451–67.

Blake D, Hutson AM, Racey PA, *et al.* 1994. Use of lamplit roads by foraging bats in southern England. *J Zool* 234: 453–62.

Buchanan BW. 1993. Effects of enhanced lighting on the behaviour of nocturnal frogs. *Anim Behav* 45: 893–99.

Buchanan BW. 1998. Low-illumination prey detection by squirrel treefrogs. *J Herpetol* 32: 270–74.

Cinzano P, Falchi F, and Elvidge CD. 2001. The first world atlas of the artificial night sky brightness. *Mon Not R Astron Soc* 328: 689–707.

De Molenaar JG, Jonkers DA, and Sanders ME. 2000. Road illumination and nature. III. Local influence of road lights on a black-tailed godwit (*Limosa l. limosa*) population. Wageningen, The Netherlands: Alterra.

Derrickson KC. 1988. Variation in repertoire presentation in northern mockingbirds. *Condor* 90: 592–606.

Dick MH and Donaldson W. 1978. Fishing vessel endangered by crested auklet landings. *Condor* 80: 235–36.

Dodson S. 1990. Predicting diel vertical migration of zooplankton. *Limnol and Oceanogr* 35: 1195–1200.

Eisenbeis G and Hassel F. 2000. Zur Anziehung nachtaktiver Insekten durch Straßenlaternen – eine Studie kommunaler Beleuchtungseinrichtungen in der Agrarlandschaft Rheinhessens [Attraction of nocturnal insects to street lights – a study of municipal lighting systems in a rural area of Rheinhessen (Germany)]. *Natur und Landschaft* 75: 145–56.

Elvidge C, Baugh KE, Kihn EA, and Davis ER. 1997. Mapping city lights with nighttime data from the DMSP Operational Linescan System. *Photogramm Eng Rem S* 63: 727–34.

Elvidge CD, Imhoff ML, Baugh KE, *et al.* 2001. Nighttime lights of the world: 1994–95. ISPRS *J Photogramm Rem S* 56: 81–99.

Frank KD. 1988. Impact of outdoor lighting on moths: an assessment. *J Lepidop Soc* 42: 63–93.

Gal G, Loew ER, Rudstam LG, and Mohammadian AM. 1999. Light and diel vertical migration: spectral sensitivity and light avoidance by *Mysis relicta*. *Can J Fish Aquat Sci* 56: 311–22.

Gibson RN. 1978. Lunar and tidal rhythms in fish. In: Thorpe JE (Ed). Rhythmic activity of fishes. London: Academic Press.

Gilbert BS and Boutin S. 1991. Effect of moonlight on winter activity of snowshoe hares. *Arctic Alpine Res* 23: 61–65.

Gliwicz ZM. 1986. A lunar cycle in zooplankton. *Ecology* 67: 883–97.

Gliwicz ZM. 1999. Predictability of seasonal and diel events in tropical and temperate lakes and reservoirs. In: Tundisi JG, Straskraba M (Eds). Theoretical reservoir ecology and its applications. São Carlos: International Institute of Ecology.

Gorenzel WP and Salmon TP. 1995. Characteristics of American Crow urban roosts in California. *J Wildlife Manage* 59: 638–45.

Gotthard K. 2000. Increased risk of predation as a cost of high growth rate: an experimental test in a butterfly. *J Anim Ecol* 69: 896–902.

Hailman JP. 1984. Bimodal nocturnal activity of the western toad (*Bufo boreas*) in relation to ambient illumination. *Copeia* 1984: 283–90.

Haymes GT, Patrick PH, and Onisto LJ. 1984. Attraction of fish to mercury vapor light and its application in a generating station forebay. *Int Rev Hydrobiol* 69: 867–76.

Health Council of the Netherlands. 2000. Impact of outdoor lighting on man and nature. The Hague: Health Council of the Netherlands. Publication No. 2000/25E.

Hill D. 1990. The impact of noise and artificial light on waterfowl behaviour: a review and synthesis of the available literature. Norfolk, United Kingdom: British Trust for Ornithology Report No. 61.

Jaeger RG and Hailman JP. 1973. Effects of intensity on the phototactic responses of adult anuran amphibians: a comparative survey. *Z Tierpsychol* 33: 352–407.

Klauber LM. 1939. Rattlesnakes: their habits, life histories, and influence on mankind. Berkeley, CA: University of California Press.

Kolligs D. 2000. Ökologische Auswirkungen künstlicher Lichtquellen auf nachtaktive Insekten, insbesondere Schmetterlinge (Lepidoptera) [Ecological effects of artificial light sources on nocturnally active insects, in particular on moths (Lepidoptera)]. *Faunistisch-Ökologische Mitteilungen Suppl* **28**: 1–136.

Kotler BP. 1984. Risk of predation and the structure of desert rodent communities. *Ecology* **65**: 689–701.

Laferrier J. 1997. The influence of moonlight on activity of wooly opossums (*Caluromys philander*). *J Mammal* **78**: 251–55.

Lima SL. 1998. Stress and decision-making under the risk of predation: recent developments from behavioral, reproductive, and ecological perspectives. *Adv Stud Behav* **27**: 215–90.

Lloyd JE. 1994. Where are the lightningbugs? *Fireflyer Companion* **1**: 1, 2, 5, 10.

Long WJ. 1901. Wilderness ways. Boston, MA: Ginn and Company.

Moore MV, Pierce SM, Walsh HM, *et al.* 2000. Urban light pollution alters the diel vertical migration of *Daphnia*. *Verh Internat Verein Limnol* **27**: 779–82.

Munday PL, Jones GP, Ohman MC, and Kaly UL. 1998. Enhancement of recruitment to coral reefs using light-attractors. *B Mar Sci* **63**: 581–88.

Nakamura T and Yamashita S. 1997. Phototactic behavior of nocturnal and diurnal spiders: negative and positive phototaxes. *Zool Sci* **14**: 199–203.

Ogden LJE. 1996. Collision course: the hazards of lighted structures and windows to migrating birds. Toronto, Canada: World Wildlife Fund Canada and Fatal Light Awareness Program.

Outen AR. 2002. The ecological effects of road lighting. In: Sherwood B, Culter D, and Burton JA (Eds). Wildlife and roads: the ecological impact. London, UK: Imperial College Press.

Park O. 1940. Nocturnalism — the development of a problem. *Ecol Monogr* **10**: 485–536.

Rand AS, Bridarolli ME, Dries L, and Ryan MJ. 1997. Light levels influence female choice in Tungara frogs: predation risk assessment? *Copeia* **1997**: 447–50.

Riiters KH and Wickham JD. 2003. How far to the nearest road? *Front Ecol Environ* **1**: 125–29.

Rydell J. 1992. Exploitation of insects around streetlamps by bats in Sweden. *Funct Ecol* **6**: 744–50.

Rydell J and Baagøe HJ. 1996. Gatlampor ökar fladdermössens predation på fjärilar [Streetlamps increase bat predation on moths]. *Entomol Tidskr* **117**: 129–35.

Salmon M. 2003. Artificial night lighting and sea turtles. *Biologist* **50**: 163–68.

Salmon M, Tolbert MG, Painter DP, *et al.* 1995. Behavior of loggerhead sea turtles on an urban beach. II. Hatchling orientation. *J Herpetol* **29**: 568–76.

Schmiedel J. 2001. Auswirkungen künstlicher Beleuchtung auf die Tierwelt – ein Überblick [Effects of artificial lighting on the animal world – an overview]. *Schriftenreihe Landschaftspflege und Naturschutz* **67**: 19–51.

Schwartz A and Henderson RW. 1991. Amphibians and reptiles of the West Indies: descriptions, distributions, and natural history. Gainesville, FL: University of Florida Press.

Squires WA and Hanson HE. 1918. The destruction of birds at the lighthouses on the coast of California. *Condor* **20**: 6–10.

Summers CG. 1997. Phototactic behavior of *Bemisia argentifolii* (Homoptera: Aleyrodidae) crawlers. *Ann Entomol Soc Am* **90**: 372–79.

Svensson AM and Rydell J. 1998. Mercury vapour lamps interfere with the bat defence of tympanate moths (*Operophtera* spp; Geometridae). *Anim Behav* **55**: 223–26.

Verheijen FJ. 1985. Photopollution: artificial light optic spatial control systems fail to cope with. Incidents, causations, remedies. *Exp Biol* **44**: 1–18.

Wiese FK, Montevecchi WA, Davoren GK, *et al.* 2001. Seabirds at risk around offshore oil platforms in the North-west Atlantic. *Mar Pollut Bull* **42**: 1285–90.

Witherington BE. 1997. The problem of photopollution for sea turtles and other nocturnal animals. In: Clemmons JR and Buchholz R (Eds). Behavioral approaches to conservation in the wild. Cambridge, UK: Cambridge University Press.

Yurk H and Trites AW. 2000. Experimental attempts to reduce predation by harbor seals on out-migrating juvenile salmonids. *Trans Am Fish Soc* **129**: 1360–66.

ECOLOGY

The Dark Side of Night Lighting

David Hill

Ecological Consequences of Artificial Night Lighting

Catherine Rich and Travis Longcore, Eds.

Island, Washington, DC, 2005. 478 pp. $65, £46.50. ISBN 1-55963-128-7. Paper, $29.95, £21.50. ISBN 1-55963-129-5.

The aura of light that hangs over a city on an otherwise dark night brings into sharp focus the impact *Homo sapiens* is having on Earth. A satellite view of the planet at night reveals swathes and pimples of light, clearly identifying hot spots of human activity—Europe, the United States, India, and Japan. The light is a sign of our species extending its influence, packing action into every hour of the day and night.

"Artificial night lighting" seems a rather passive description for something that, as we can easily perceive, has such a pervasive effect on our fellow species. Based on expert reviews of the responses of a wide range of organisms, *Ecological Consequences of Artificial Night Lighting* offers a unique insight into how these effects manifest themselves. The volume's six sections cover mammals, birds, reptiles and amphibians, fishes, invertebrates, and plants. Each begins with a vignette on ecology at night, either excerpted from earlier accounts (e.g., writings by Alexander von Humboldt and Henry David Thoreau) or experiences described for the book (e.g., short essays by Bernd Heinrich and Carl Safina). The editors, Catherine Rich and Travis Longcore (who run the Urban Wildlands Group, a nonprofit conservation organization in Los Angeles), have a passion for the aesthetic qualities of night skies free from photopollution. For my part, I share their enthusiasm for a world in which humans have a much smaller ecological footprint. But the reality is that our constant drive for development, wealth creation, and all the associated ancillary insanities of consumption results in less wilderness, less wildlife, and less peace.

Rich's love of "empty" space—which, of course, from a wildlife perspective is the antithesis of empty—where species have adapted to nocturnal life strategies shines through in her preface. In their introduction, she and Longcore cite calculations that 44% of Americans live in locations where it does not become sufficiently dark for the human eye to complete the transition from cone to rod vision (*1*). The diurnal and nocturnal components of the 24-hour cycle are now blurred across large parts of the globe (almost entirely in developed countries) because of our "need" for light. The editors note that nearly 19% of Earth's terrestrial surface "experiences night sky brightness that is polluted by astronomical standards." What effect are these undark skies having on the wildlife and the ecosystem functions and services on which we depend? Providing the best examination to date of this question, the book synthesizes current thinking on a topic of considerable, if often unrecognized, importance to conservation professionals. Nearly all environmental impact assessments should include an analysis of the effects of lighting, both specific to the development of a particular site and cumulative, but very few do. Our own diurnal perspective on life blinds us, and so we forget the vast number of species that rely on darkness—to hide, to catch prey, to mate, to interact.

The book provides the scientific foundation for understanding the impacts of night lighting and then acting on research findings to reduce or, better still, avoid its damaging effects on wildlife. Although the first review of the mechanisms by which animals are attracted to lights appeared in 1958 (*2*) and its author coined the term "photopollution" in 1985 (*3*), only within the last decade has there been much research on the ecological consequences. Bearing in mind that (as noted in the book) humans have long influenced animal behavior with light (for example, the use of campfires to keep predators at bay), the dramatic increase in electrical lighting in the past 40 years is a relatively rapid change for wildlife to accommodate.

For such a new area of research, the work is fairly thorough, and the book provides many useful pointers for management. For example, road lighting may not deter vehicle collisions with mammals, and may even exacerbate the problem, because many nocturnal mammals use only the rod system for sight and bright lighting saturates their retinas. In contrast, some species of bats seem to benefit from street lighting, as they preferentially feed on insects attracted to lights, although these favored bats may in turn displace other insectivorous species that do not forage at lights through interspecific competition. Jens Rydell concludes that the replacement of mercury vapor lamps with high-pressure sodium vapor lamps (which attract fewer insects) benefits both bats and insects.

Sidney Gauthreaux and Carroll Belser's consideration of the effects of lighting on migrating birds makes particularly pertinent reading. They find that the increasing use of artificial lighting is having an adverse effect on bird populations, especially on species that typically migrate at night. Mass mortalities of birds attracted to lights were noted at lighthouses and lightships in the mid-1800s, but the relatively recent expansion of cities, the escalating height of lit buildings, and the ongoing spread of communications towers across the land are having an increasingly damaging impact on birds. Aircraft warning lights placed on such towers lead to the deaths of hundreds of thousands of nocturnal migrants each year. Most mortality occurs on nights when the moon is new or only slightly illuminated. The authors describe practical measures—such as replacing red lights, which disorientate birds, with white—with the potential for substantially reducing such losses of migrating birds.

Sea turtles are another taxon for which the effects of artificial lighting are comparatively well studied. Michael Salmon's review of research in Florida suggests the benefits of using embedded road lights (rather than poled streetlights) and replacing traditional coastal lighting, which attracts and tragically disorients turtle hatchlings. The message is clear—keep the nesting beaches dark at night.

R. N. Cohen's *Wolf Moon* (detail).

Through their examples and discussions, the individual chapters provide consistently intriguing analyses that demonstrate the wide impact of light pollution. So much of the book is of direct relevance to the environmental advice we try to give in the United Kingdom that I expect it will be helpful around the globe. *Ecological Consequences of Artificial Night Lighting* is an excellent reference that will undoubtedly raise awareness of the need to conserve energy, do proper impact assessments, and turn the lights down.

References

1. P. Cinazo, F. Falchi, C. D. Elvidge, *Mon. Not. R. Astron. Soc.* **328**, 689 (2001).
2. F. J. Verheijen, *Arch. Ned. Zool.* **13**, 1 (1958).
3. F. J. Verheijen, *Exp. Biol.* **44**, 1 (1985).

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wait to get back to Arizona or Sonora to renew my acquaintance with these amazing lizards.

REFERENCES

Bogert, C.M., Martín del Campo, R., 1956. The Gila Monster and its allies. Bull. Amer. Mus. Nat. Hist. 109, 1–238.
Bogert, C.M., Martín del Campo, R., 1993 reprint. The Gila Monster and its Allies. SSAR (Society of the Study of Amphibians and Reptiles). pp. xx+242.

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The beautiful cover of this book brings home just what it is that we give up when we flood the night with artificial light. Astronomers have been increasingly vocal about the loss of dark sky to light pollution, but what are the ecological consequences of artificial light for organisms that have evolved with natural patterns of light and dark?

Catherine Rich and Travis Longcore became so intrigued by this question that they organised an international conference on the topic, held at UCLA in February 2002. They tracked down and invited specialists from a diversity of fields, many of whom have contributed to this book. Although it addresses a single theme, it considers the implications of artificial night lighting for a wide range of organisms.

Following an introduction by the editors, the book's 15 chapters are divided into six parts on the basis of taxonomy: mammals, birds, reptiles and amphibians, fishes, invertebrates and plants. Research in some of these areas has been quite sparse, but much of the news is bad. It has been recognised for a long time that the migration of many birds and insects can be disrupted by night lighting, with birds particularly susceptible to the siren's lure of lights on tall structures such as communications masts and light houses. Thoughts on mitigating practices are a welcome element in most of the chapters. It is well known that newly hatched sea turtles can be disorientated by lighting, resulting in abnormally high mortality rates. In his chapter on this topic, Michael Salmon explains the nature of the problem but then goes on the explore and evaluate means for avoiding or reducing it, such as the use of lighting embedded in road surfaces where they pass near nesting beaches.

For some groups, night lighting proves a mixed blessing. Female Tungara frogs (*Physalaemus pustulosus*) spend less time selecting a mate when an area is illuminated, which is probably a bad thing, but many species of frog have been found to forage on the rich pickings beneath street lamps. Some species of bat also preferentially hunt around those lamps that attract insects, which may benefit the bats but is not such good news for the insects. Reading this book one cannot help but feel that it is the insects that are most severely affected by lighting that draws many species in to an exhausted death or the jaws of a predator. James E. Lloyd's chapter is devoted to insects that use bioluminescence to find a mate and of all the species in the book they are the ones that leave the reader with the greatest sense of injustice: they "invented" night lighting and now face severe declines in population because they cannot compete with our outpourings.

Most of the 25 authors are professional ecologists and academics from North America, but their topics are of global significance. The chapters are rich in detail and draw on a wide spectrum of innovative research and case studies of attempts to mitigate the effects of artificial night lighting. There is a good range of informative diagrams, tables and black and white photographs to illustrate the chapters and each has its own list of cited literature that would be an invaluable reference source for anyone seeking further information or considering research in this relatively neglected field. As the editors point out, our own diurnal habits have favoured ecological research in the daylight and it takes a special level of motivation and commitment to take on the night shift.

This is a book with a mission and a soul. At the front of each part is an extract of prose from one of a variety of authors that make us remember that nights are meant to be dark, beautiful and exciting. It is an academic book, but one that is written and presented in such a way that it will appeal to anyone with an interest in ecology.

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Research Note

Effects of Coastal Lighting on Foraging Behavior of Beach Mice

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Abstract: *Introduction of artificial light into wildlife habitat represents a rapidly expanding form of human encroachment, particularly in coastal systems. Light pollution alters the behavior of sea turtles during nesting; therefore, long-wavelength lights—low-pressure sodium vapor and bug lights—that minimize impacts on turtles are required for beach lighting in Florida (U.S.A.). We investigated the effects of these two kinds of lights on the foraging behavior of Santa Rosa beach mice (*Peromyscus polionotus leucocephalus*). We compared patch use and giving-up densities of mice for experimental food patches established along a gradient of artificial light in the field. Mice exploited fewer food patches near both types of artificial light than in areas with little light and harvested fewer seeds within patches near bug lights. Our results show that artificial light affects the behavior of terrestrial species in coastal areas and that light pollution deserves greater consideration in conservation planning.*

Key Words: artificial illumination, foraging behavior, light pollution, *Peromyscus polionotus leucocephalus*, Santa Rosa beach mice

Efectos del Alumbrado Costero sobre el Comportamiento de Forrajeo de Ratones de Playa

Resumen: *La introducción de luz artificial al hábitat de vida silvestre representa una forma de intrusión humana que se expande rápidamente, particularmente en sistemas costeros. Durante la anidación, la polución por luz altera el comportamiento de tortugas marinas; por tanto, para la iluminación de playas en Florida (E. U. A) se requieren luces de longitud de onda larga - luces de vapor de sodio de baja presión y contra insectos - que minimizan impactos sobre las tortugas. Investigamos los efectos de estos dos tipos de luces sobre el comportamiento de forrajeo de ratones de playa de Santa Rosa (*Peromyscus polionotus leucocephalus*). Comparamos el uso de parches y las densidades de rendición de ratones en parches alimenticios experimentales establecidos a lo largo de un gradiente de luz artificial en el campo. Los ratones utilizaron menos parches de forrajeo cercanos a ambos tipos de luz artificial que en áreas con poca iluminación y cosecharon menos semillas en parches cercanos a luces contra insectos. Nuestros resultados muestran que la luz artificial afecta el comportamiento de especies terrestres en áreas costeras y que la polución por luz merece mayor consideración en la planificación de la conservación.*

Palabras Clave: comportamiento de forrajeo, iluminación artificial, polución por luz, ratones de playa (*Peromyscus polionotus leucocephalus*)

Introduction

Alteration of nighttime light levels by artificial illumination is a worldwide phenomenon and a rapidly expanding form of human encroachment on natural environments. Recent global-scale analyses of artificial sky brightness indicate that almost 20% of the Earth's land area is subjected to light pollution, and in many countries light pollution affects 100% of the surface area (Cinzano et al. 2001). Artificial illumination has increased with human population growth, but in some countries, such as the United States, per capita outdoor lighting has risen more dramatically.

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For over three decades, astronomers have called for policies to limit artificial light (Riegel 1973). In contrast, light pollution has received little attention as a threat to ecological systems, perhaps in part because the effects of artificial light on ecological systems are largely unknown.

Light in natural environments influences numerous ecological processes directly and indirectly and, as a result, the effects of light pollution may be significant and widespread. For example, starlight provides essential navigational cues for the long-distance migration of birds (Akesson et al. 2001). Ambient light entrains circadian rhythms, controls diel migrations of pelagic organisms, influences the ability of nocturnal predators to detect and capture prey, and alters the risk environment for prey (Buchanan 1993; Lima 1998; Ringelberg 1999). Studies of sea turtles provide the strongest evidence of impacts of artificial illumination on wildlife (Witherington & Martin 2000). Beachfront lighting deters sea turtles from coming onto beaches to nest and disorients hatchlings (Peters & Verhoeven 1994). Also, lights attract birds and insects that forage and migrate at night, resulting in substantial mortality from collisions with structures in the vicinity of lights (Le Corre et al. 2002).

Because of extensive development, coastal beaches and barrier islands are among the areas most affected by light pollution. Two types of long-wavelength lights—low-pressure sodium vapor lights and incandescent yellow bug lights—are mandated for beach lighting in Florida because long-wavelength lights have spectral properties that reduce orientation problems for sea turtles (Witherington & Martin 2000). The effects of artificial lighting on terrestrial species in coastal habitats have not been addressed, even though these habitats contain species of critical conservation concern, such as beach mice (*Peromyscus polionotus*).

Eight subspecies of beach mice occur in small, isolated populations in the coastal dunes of Alabama and Florida. All extant subspecies, except the Santa Rosa beach mouse (*P. p. leucocephalus*), are threatened or endangered (Humphrey 1992). Beach mice are susceptible to habitat loss and fragmentation from coastal development and hurricanes, and introduced predators pose a serious threat to all populations (Oli et al. 2001). Artificial light can exacerbate these problems. Light modifies predation risk by influencing the visual abilities of predators and prey (Lima & Dill 1990). Natural illumination influences activity levels, foraging behavior, and habitat use by nocturnal rodents (Wolfe & Summerlin 1989; Kotler et al. 1991). Behavioral changes associated with illumination are likely an antipredator response because the perceived risk of predation increases with increasing light (Lima & Dill 1990). We hypothesize that artificial illumination associated with coastal development alters the behavior of beach mice in ways that negatively affect resource acquisition. We conducted field experiments to assess the effects of the types of lighting mandated for sea turtles on the foraging behavior of Santa Rosa beach mice. Our study provides the first baseline data for evaluation of impacts of lighting policies designed for one species on a nontarget species of conservation concern; to our knowledge, it documents for the first time the effects of artificial light on terrestrial species in coastal systems.

Methods

We compared patch use and giving-up density (GUD), the density of resources in a patch at which foraging ceases (Brown 1988), for beach mice foraging in experimental resource patches (trays with seeds) subjected to low-pressure sodium vapor lights, incandescent yellow bug lights, or only new moon conditions (control). Giving-up density provides an index of foraging costs, including metabolic costs, predation risk, and missed opportunity costs (i.e., lost opportunity to engage in other activities that enhance fitness). If artificial light increases the costs of foraging—by increasing predation risk, for example—mice should cease foraging in patches under light at higher densities of resources than in patches not subject to artificial light. Assumptions of GUDs have been tested on species similar to beach mice (Morris 1997). This method provides a useful assay for anthropogenic impacts on foraging behavior (Bowers & Breland 1996).

We conducted illumination experiments from February to April 2002 at four sites along Santa Rosa Island, Florida. The island is a mosaic of primary dunes (sparsely vegetated dunes adjacent to high tide line), open sand, and vegetation patches, predominately sea oats (*Uniola paniculata* L.), dune panic grass (*Panicum amarum* Ell.), and gulf bluestem (*Schizachyrium maritimum* [Chapman] Nash). Beach mice occur throughout the dunes. At each site, we established two linear arrays of experimental resource patches a minimum of 20 m apart in sparse bluestem. We randomly chose one array to receive low-pressure sodium vapor lights and bug lights, and the other array served as a dark control. We mounted lights on a 3-m pipe at a randomly chosen end of the treatment array to create a light gradient. We used two 40-W bug lights (Phillips Longer Life Bug-a-way) or one 18-W low-pressure sodium vapor light (LPS 1000 Series, Harris Lighting, Monroe, North Carolina) to achieve a 12-m illumination radius. Lights were powered by generators placed 300 m from arrays. We collected data within 3 days of a new moon to standardize natural illumination. We applied each light treatment at each site for 3 consecutive nights with order of treatments determined randomly. Because of generator failure, we collected data at two sites only 2 nights per treatment.

Each array of resource patches contained 18 plastic trays filled with 5 g of oven-dried millet mixed into 3 L of beach sand placed in pairs at 2-m intervals along a 16-m transect. To allow access to trays by beach mice but not other granivores (cotton rats [*Sigmodon hispidus*] and ghost crabs [*Ocypode quadrata*]), we covered trays with plastic lids, cut small entrance holes (4 × 4 cm) in lids for mice, and elevated trays approximately 9 cm from the ground. Wooden dowels served as ramps for mice to reach trays. In the light array, we placed the first pair of trays (0 m) beneath the light. We randomly chose one end of the dark array to represent the 0-m distance. Prebaiting preceded each data session for 1-2 weeks to ensure that resource patches were discovered by mice. During experiments, trays were left out overnight and lights were run dusk to dawn. The following day, we removed seeds remaining in trays and rebaited trays. Collected seeds were dried at 65° C, cleaned of debris, and weighed.

To assess patch use, we calculated the proportion of patches at which foraging occurred for each distance along transects by summing the number of trays visited by mice for all nights of the experiment at each distance and dividing by the total number of possible trays foraged (i.e., two trays × number nights in experiment). We estimated giving-up densities by averaging grams of seeds remaining in each resource patch for all nights that mice foraged in the patch. Seeds remaining in a patch reflect the GUD of the final forager to visit the patch. We excluded patches that did not exhibit signs of foraging by beach mice from GUD analyses. All nights were combined for both analyses because initial analyses did not detect temporal trends in data. Prior to analysis, we also averaged GUDs for the two foraging trays at each distance along the 16-m transects. Sites were replicates ($n = 4$) for all analyses of patch use and GUDs.

We tested for effects of illumination (light or dark), light type, and distance from light source on patch use with logistic-regression analysis (SAS Institute 2000). We examined effects of illumination and distance from the light source on GUDs for each light type with linear mixed models (SAS Institute 2000). Site and site-by-illumination terms were included as random factors to account for the split-split plot design of the experiment. We used Fisher's least-significant-difference (LSD) tests for pairwise comparisons of GUDs along light gradients. Because we predicted a priori, based on field studies of predation risk, that mice would respond negatively to light, we used one-tailed LSD tests.

Results

Patch use was affected significantly by presence of illumination, light type, and distance from light source (Table 1). Mice foraged at a significantly higher proportion of patches in dark arrays than in light arrays, and mice foraged at a higher proportion of patches illuminated by bug lights than at patches illuminated by low-pressure sodium vapor lights (Fig. 1). Effects of lights on visitation of patches were observed only within 4 m of the light source. Over the experimental period, mice visited 82% of the resource patches within 4 m of bug lights and 65% of the patches within 4 m of low-pressure sodium vapor lights.

Table 1. Results of logistic-regression analysis for effects of illumination (present or absent), light type, and distance from light source on proportion of patches foraged by beach mice.*

Parameter	*Estimate*	*SE*	Z	p
Intercept	−0.82	0.84	−0.10	0.92
Illumination	2.93	0.88	3.33	0.0009
Light type	1.34	0.47	2.84	0.005
Distance	0.36	0.05	6.63	<0.0001

**Sites are replicates* ($n = 4$).

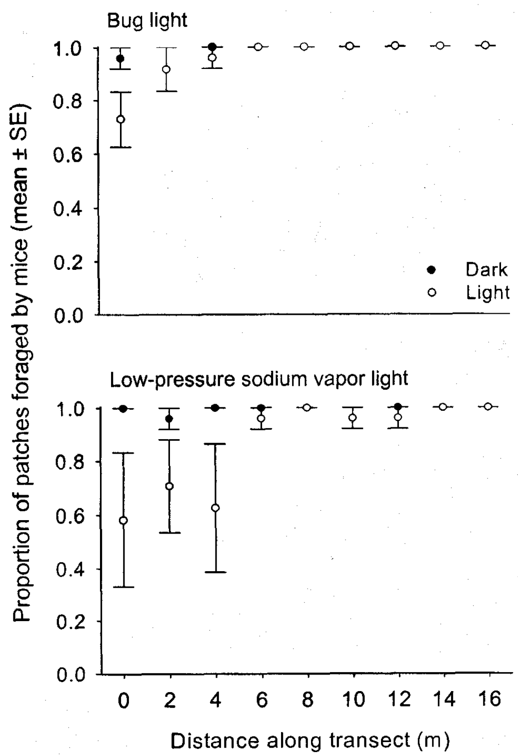

Figure 1. ***Proportion of experimental resource patches foraged by mice (mean ± SE) along a light gradient that extended from the base of an artificial light source (0 m) to 16 m (light array) and along 16-m transects with no lights that served as dark controls (dark array). The light symbol is shown for locations where mice foraged similar proportions of patches in dark and light arrays.***

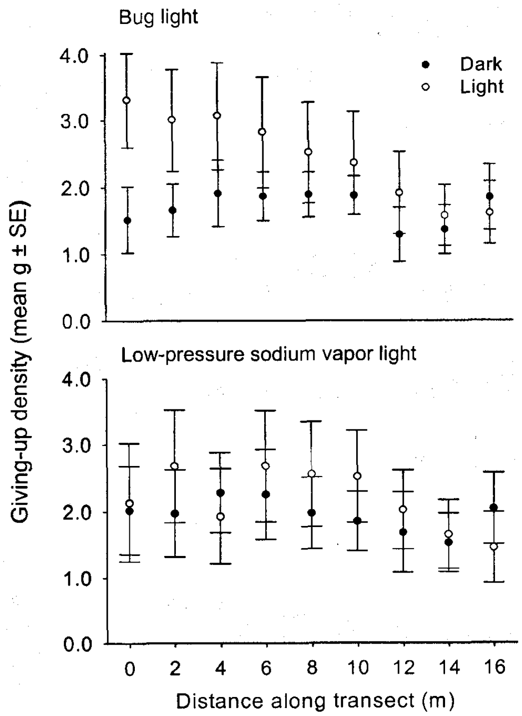

Figure 2. Giving-up density—density of resources in a patch at which foraging ceases (mean ± SE)—in experimental resource patches located at 2-m intervals along a light gradient extending from the base of artificial lights (0 m) to 16 m (light array) and along 16-m transects with no lights that served as dark controls (dark array).

Mice removed significantly more seeds from resource patches (i.e., GUDs decreased) as distance from the light source increased under the bug light treatment ($F_{8,48} = 2.97, p < 0.009$; Fig. 2a). Giving-up densities from patches located 0–10 m from the bug light were significantly higher than GUDs from patches located 14–16 m from the bug light, and GUDs at 0–6 m also were different from GUDs at 12 m (Fisher's LSD tests, all $p < 0.05$). Giving-up densities were not affected by distance from light source with low-pressure sodium vapor lights ($F_{8,46} = 1.17, p < 0.34$; Fig. 2b). No significant differences were found in GUDs with distance along the dark array for either light type (Fisher's LSD tests, all $p > 0.05$).

Discussion

Foraging decisions represent tradeoffs between immediate benefits associated with intake of energy and nutrients and long-term costs, such as predation risk, that influence the fitness of organisms (Lima 1998). These decisions are modulated by environmental factors, such as light, temperature, and presence of conspecifics, that modify costs associated with foraging. Consistent with our hypothesis, artificial light altered foraging behavior of beach mice in two ways that affected resource acquisition. First, mice reduced patch use near low-pressure sodium vapor and bug lights. Second, mice harvested fewer seeds from exploited patches near bug lights than from areas with no artificial light. These patterns suggest that beach mice assess risk at two scales, first by choosing which patches to forage and second by deciding how long to forage within a patch.

Under the light regime we used, both light types affected patch choice by mice only within about 4–6 m of the light source, suggesting that the effects of "turtle-friendly" lighting on beach mice could be localized. However, bug lights altered foraging activity within exploited patches up to 10 m from the light. We do not know why the two light types affected mice differently, but spectral properties of the lights differ. Low-pressure sodium vapor lights emit light only in the yellow spectrum; bug lights emit a broader range of wavelengths.

Our research was conducted at the microhabitat scale and may underestimate impacts of artificial lighting on mice at larger scales. First, experiments were conducted in areas with vegetative cover. Mice may perceive heightened predation risk from illumination at greater distances from the source in the absence of vegetation and, as demonstrated under natural illumination (Bowers 1988), may exhibit stronger behavioral responses to light in open areas than in cover. Open areas comprise a large part of beach mouse habitat, particularly following severe storms. Second, mice avoided areas affected by 1–2 low-wattage light bulbs. Taller, higher-intensity lights and multiple light sources are common in substantial portions of beach mouse habitat and may have more pronounced impacts on mouse behavior than the 18- to 40-W bulbs we tested. In addition, negative impacts of artificial lighting may extend beyond alteration of foraging behavior. If beach mice decrease their use of habitat exposed to artificial light, artificial lighting may alter movement of mice between vegetation patches and within open microhabitat and may diminish landscape connectivity.

Because light levels influence predation risk in many species (e.g., fish, Clark & Levy 1988; rodents, Clarke 1983; Kotler et al. 1991; birds, Lima 1998), behavioral responses to artificial light, such as those we detected for beach mice, are likely to be common across a range of taxa. Based on the growing number of taxonomic groups for which detrimental effects of artificial light have been documented, the diversity of impacts, and the continued expansion of light pollution in natural environments, impacts of artificial light on ecological systems clearly deserve more attention than they have received in conservation research and planning.

Acknowledgments

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Literature Cited

Akesson, S., G. Walinder, L. Karlsson, and S. Ehnbom. 2001. Reed warbler orientation: initiation of nocturnal migratory flights in relation to visibility of celestial cues at dusk. Animal Behaviour **61**:181-189.

Bowers, M. A. 1988. Seed removal experiments on desert rodents: the microhabitat by moonlight effect. Journal of Mammalogy **69**:201-204.

Bowers, M. A., and B. Breland. 1996. Foraging of gray squirrels on an urban-rural gradient: use of the GUD to assess anthropogenic impact. Ecological Applications **6**:1135-1142.

Brown, J. S. 1988. Patch use as an indicator of habitat preference, predation risk, and competition. Behavioral Ecology and Sociobiology **22**:37-47.

Buchanan, B. W. 1993. Effects of enhanced lighting on the behaviour of nocturnal frogs. Animal Behaviour **45**:893-899.

Cinzano, P., F. Falchi, and C.D. Elvidge. 2001. The first world atlas of the artificial night sky brightness. Monthly Notices of Royal Astronomical Society **328**:689-707.

Clark, C. W., and D. A. Levy. 1988. Diel vertical migrations by juvenile sockeye salmon and the antipredation window. The American Naturalist **131**:271-290.

Clarke, J. A. 1983. Moonlight's influence on predator-prey interactions between short-eared owls (*Asio flammeus*) and deermice (*Peromyscus maniculatus*). Behavioral Ecology and Sociobiology **13**:205-209.

Humphrey, S. R., editor. 1992. Rare and endangered biota of Florida. 1. Mammals. University Press of Florida, Gainesville.

Kotler, B. P., J. S. Brown, and O. Hasson. 1991. Factors affecting gerbil foraging behavior and rates of owl predation. Ecology **72**:2249-2260.

Le Corre, M., M. Ollivier, S. Ribes, and P. Jouventin. 2002. Light-induced mortality of petrels: a 4-year study from Réunion Island (Indian Ocean). Biological Conservation **105**:93-102.

Lima, S. L. 1998. Non-lethal effects in the ecology of predator-prey interactions: What are the ecological effects of anti-predator decision-making? BioScience **48**:25-34.

Lima, S. L., and L. M. Dill. 1990. Behavioral decisions made under the risk of predation: a review and prospectus. Canadian Journal of Zoology **68**:619-640.

Morris, D. W. 1997. Optimally foraging deer mice in prairie mosaics: a test of habitat theory and absence of landscape effects. Oikos **80**:31-42.

Oli, M., N. R. Holler, and M. C. Wooten. 2001. Viability analysis of endangered Gulf Coast beach mice (*Peromyscus polionotus*) populations. Biological Conservation **97**:107-118.

Peters, A., and K. J. F Verhoeven. 1994. Impact of artificial lighting on the seaward orientation of hatchling loggerhead turtles. Journal of Herpetology **28**:112-114.

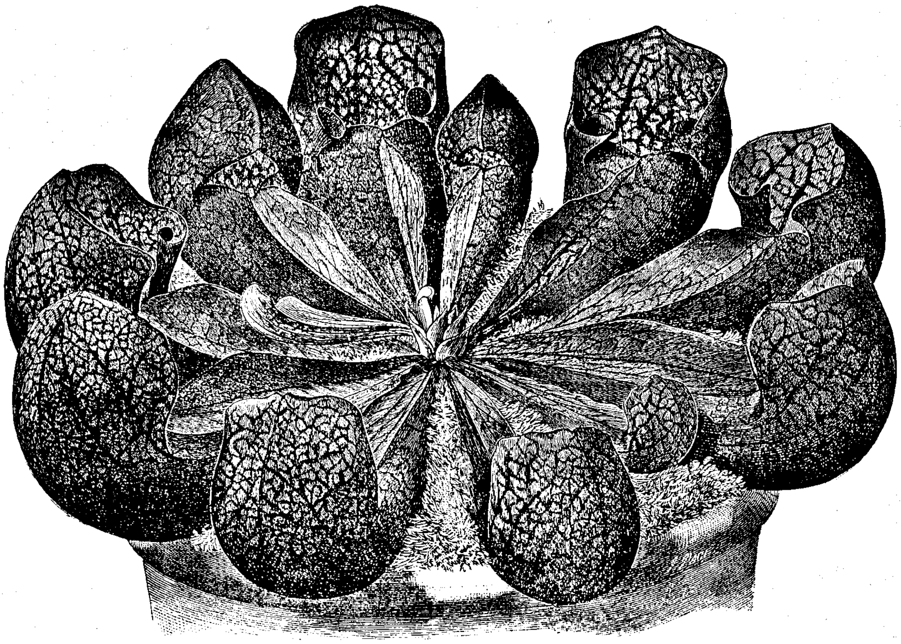
Riegel, K. W. 1973. Light pollution. Science **179**:1285-1291.

Ringelberg, J. 1999. The photobehaviour of *Daphnia* spp. as a model to explain diel vertical migration in zooplankton. Biological Reviews of the Cambridge Philosophical Society **74**:397-423.

SAS Institute. 2000. SAS for Windows. Version 8.0. SAS Institute, Cary, North Carolina.

Witherington, B. E., and R. E. Martin. 2000. Understanding, assessing, and resolving light-pollution problems on sea-turtle nesting beaches. Technical report TR-2. Florida Marine Research Institute, Florida Fish and Wildlife Conservation Commission, Tallahassee.

Wolfe, J. L., and C. T. Summerlin. 1989. The influence of lunar light on nocturnal activity of the old-field mouse. Animal Behaviour **37**:410-414.



TAMC
TRANSPORTATION AGENCY
FOR MONTEREY COUNTY

Regional Transportation Planning Agency • Congestion Management Planning
Local Transportation Commission • Monterey County Service Authority for Freeways & Expressways

September 5, 2006

Meg Caldwell, Chair
California Coastal Commission
559 Nathan Abbott Way
Owen House Room 6
Stanford, CA 94305

RE: Support of Bicycle/Pedestrian Trail Lighting in Sand City/Seaside area

Dear Chair Caldwell:

The Transportation Agency for Monterey County is writing to support the approval of an application from Sand City to retain the low profile Coastal Village trail lights installed along the Sand City/Seaside Coastal area, at Sand Dunes Drive (between Humboldt Street and Tioga Avenue). The California Coastal Commission is scheduled to review this application at the September 14th meeting.

Proper and consistent lighting is an important and necessary feature for bicycle and pedestrian trails. The bicycle and pedestrian path helps to reduce impacts to the environment associated with automobile use such as global warming. The trail is a key component of the Monterey Bay Coastal Trail, and an important regional bicycle and pedestrian facility. Thousands of people use the facility each year for commuting to work, bicycling for recreation or walking. Adequate lighting on the trail will increase the level and frequency of public coastal access, a goal of the California Coastal Commission.

Low profile Coastal Village trail lights provide an essential safety element to the commuters and recreational trail users in this area. These lights offer a better nighttime environment in this remote area than the bollard style lights, which shine in the eyes of cyclists. A higher degree of visibility for cyclists and pedestrians will prevent accidents and crimes on the trail. Commuters, such as workers in the Monterey hotel industry, are often traveling to and from work before sunrise and after sunset using the trail from Marina or Seaside. The lighting feature is crucial, especially during winter months given the shorter daylight hours. Furthermore, bollard-style lighting is more susceptible to damage by vandals, because the lower lights are easier to reach.

55-B Plaza Circle, Salinas, CA 93901-2902 • Tel: (831) 775-0903 • Fax: (831) 775-0897 • Website: www.tamcmonterey.org

The Transportation Agency appreciates the California Coastal Commission's attention to this matter and requests support of the existing lighting. Should you have any questions or concerns, please contact Kaki Chen of the Transportation Agency staff at (831) 775-4413.

Sincerely,

W.B. "Butch" Lindley
Chair, Transportation Agency for Monterey County

cc: Mr. Steve Matarazzo, Sand City
Supervisor Dave Potter, Central Coast Representative, California Coastal Commission
Mark Watson, Staff, California Coastal Commission

RESOLUTION NO. 001-2006
THE TRANSPORTATION AGENCY FOR MONTEREY COUNTY
BICYCLE AND PEDESTRIAN FACILITIES ADVISORY COMMITTEE

RESOLUTION OF THE TRANSPORTATION AGENCY FOR MONTEREY COUNTY BICYCLE AND PEDESTRIAN FACILITIES ADVISORY COMMITTEE SUPPORTING THE CITY OF SAND CITY IN THEIR INSTALLATION OF LOW-PROFILE COASTAL VILLAGE LIGHTS ALONG THE MONTEREY REGIONAL BIKE TRAIL.

WHEREAS, the City of Sand City during the mid 1990s successfully constructed the 1.5 mile "missing link" to the Monterey Regional Recreational trail; and

WHEREAS, as a part of that project, lighting was deemed necessary in order to provide public safety to recreational users and commuters who use the bike trail; and

WHEREAS, alternative modes of transportation will be a continuing public need to help ease clogged freeways and roadways of the Monterey Peninsula; and

WHEREAS, the low profile, coastal village bike trail lights installed south of Tioga Avenue in Sand City and the City of Seaside, are considered to be attractive elements of landscape architecture that provide visual cues to motorists and tourists that there are other methods of travel available along this part of Monterey County; and

WHEREAS, the City of Sand City has provided Coastal Commission staff with a biological opinion that the installed, low profile lights will not cause an impact to the environment; and

WHEREAS, to change-out the lights to bollard type lights as recommended by the coastal commission staff, or, alternatively, to remove the lights, would cost the City of Sand City in excess of $200,000, and said funds are not provided in their fiscal year 2006 -07 budget.

NOW, THEREFORE, BE IT RESOLVED that the Transportation Agency for Monterey County Bicycle and Pedestrian Facilities Advisory Committee hereby requests that the California Coastal Commission, through approval of the Sand City Coastal Development Permit application, allow the existing bike trail lights south of Tioga Avenue to remain in place as a further gesture of its partnership with local governments to increase coastal access in an environmentally responsible way.

RECEIVED
SEP 12 2006
CALIFORNIA
COASTAL COMMISSION
CENTRAL COAST AREA

RESOLUTION NO. 001-2006 Support City of Sand Cit y in their installation of low-profile coastal village lights along the Monterey Regional Bike Trail

PASSED AND ADOPTED this Wednesday, September 6, 2006 by the following vote:

AYES: E. Petersen, F. Pinto, M. Pommerich, A.J. Farrar, M. Crisan, T. Crivello, B. Kelley

NOES: None

ABSTAIN: T. Jensen

ABSENT: E. Tafoya, S. Carew, M. Castillo, A. Hedegard, D. Craft

RECUSE: M. McCormick

BOB KELLEY, ACTING CHAIR
TRANSPORTATION AGENCY FOR MONTEREY COUNTY
BICYCLE AND PEDESTRIAN FACILITIES ADVISORY COMMITTEE

ATTEST:

Rita Goel for

DEBRA L. HALE, EXECUTIVE DIRECTOR
TRANSPORTATION AGENCY FOR MONTEREY COUNTY