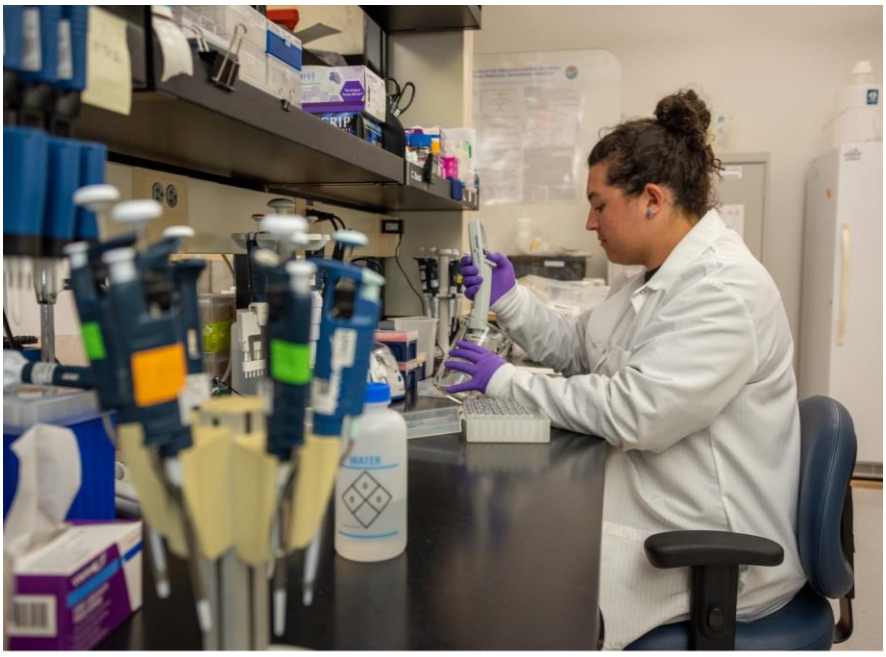
CHAPTER 5: COMMON THREATS AND STRESSORS

In the Supplemental Volume of this State Wildlife Action Plan (SWAP), each Species of Greatest Conservation Need (SGCN) is given its own species account or guild (group) account in which specific threats are identified along with targeted action items needed to mitigate for these threats. Sometimes lack of life history data or population size is the threat, creating uncertainty as to the species' true vulnerability in the face of compounding stressors. Additionally, whole taxa groups may face similar threats and are discussed in Chapter 4. Despite these individualistic concerns, common themes do emerge across all taxa groups which can be summarized in a standardized threat analysis, presented in Table 5-1. These standardized threats are loosely modeled after both NatureServe's Rank Calculator V.2.0 and those of the Conservation Measures Partnership (CMP; 2016), of which the latter can be accessed at Georgia's SWAP Revision Support Website. Both NatureServe and CMP developed their categories using the Salafsky et al. (2008) framework with modifications. Primary threats and stressors are overarching themes under which associated impacts are defined. Both levels are further elaborated on in the specific sections that follow. Many times, the same threats are repeated across some or all categories.

> "No matter how intently one studies the hundred little dramas of the woods and meadows, one can never learn all the salient facts about any one of them."
>
> **- Aldo Leopold**

Lack of Species Data

Sometimes the lack of information on a species (e.g. population size, distribution/range, life history details) is considered a threat because it is difficult to determine if a species is secure, rare, or declining. Sometimes narrow endemics are naturally rare and should be monitored but not considered under threat, while other species could be facing extinction and scientists not even know. Another challenge is taxonomic uncertainty arising from the lack of DNA studies to property determine species status and phylogeny. Questions pertaining to speciation include (1) when did two species diverge and (2) was it natural due to niche partitioning or human-induced through fragmentation and subsequent reduced gene flow? Other questions concerning (3) the relatedness to similar species may provide clues as to the best way to manage for a species or guild. In the South Carolina SWAP, taxa



A genetics researcher prepares a sample at the Marine Resources Research Institute. Photo by SCDNR-MRRI.

experts erred on the side of caution and included many data deficient species. As of 2024, only 13.5% of the State has been surveyed (leaving 86.5% unsurveyed) and with a focus in and around public lands (Joe Lemeris, GIS Data Manager, SCDNR, per. comm.). This creates a sampling bias as do records that come from road kills. Where these species would typically inhabit is likely nearby but not at the point of reference. Sometimes areas are surveyed outside of the season or time period when the target species would be using it. At other times, surveys may be conducted when a species is unidentifiable (e.g. juvenile phase instead of adult).

Additionally, especially in the case of insects, museum collections are incomplete in their identification records, requiring additional review by peers before digitization and sharing online with researchers. It is critical to have this baseline information in place so that when stressors from climate change and habitat fragmentation show faunal shifts, it is noticeable (deMaynadier et al. 2024).

Development and Infrastructure

Infrastructure resulting from modern human society includes homes, stores, factories, schools, healthcare facilities and the network of roads and utilities to link everything together and operate. Unfortunately, the footprint of this infrastructure mars the landscape and fragments, impairs, or outright destroys habitat for other species. Impacts may be direct from equipment maiming or killing animals and plants or indirect from the loss of species or prey habitat, leading to species displacement. For example, some species that require forest interior (e.g. Wood Thrush) or specialized habitats (e.g. Red-cockaded Woodpecker) may be displaced in favor of species more adapted to the urban environment. However, these species may become more concentrated and interact in ways not typically seen in their natural environments. Examples of this include larger than normal populations of Gray Squirrels, Opossums, Raccoons, or White-tailed Deer that are attracted to human dwellings, landscaping, and refuse.

Urban development fragments and degrades habitats. Photo by Morgan Smith.

As habitats become fragmented, especially from poorly planned development, intraspecific interactions, interactions between members of the same species, may be limited or nonexistent, decreasing gene flow and endangering isolated populations with extinction. The isolation of suitable habitats may be most problematic for small mammals, reptiles, and amphibians that have limited dispersal ability and may suffer high mortality when traveling through unsuitable habitats. Habitat fragmentation also hinders the use of prescribed fire. Therefore, most of the SGCN associated with fire-dependent communities decline as development encroaches. Also,

concerns about liability, air quality, social acceptance, and smoke management, as well as the lack of landowners with experience and equipment to conduct prescribed burns, has limited the use of fire on private lands.

Highway 17 cuts across vast marshland in the ACE Basin. Photo by Anna Smith, SCDNR.

Engineered structures over (i.e. bridges) or through (i.e. dams, culverts) waterways may affect the behaviors and movements of aquatic fauna (e.g. hinder fish passage) if not designed appropriately, while impervious surfaces will affect groundwater uptake, aquifer recharge, and other hydrologic processes. For example, fish passage is critical in mussel dispersal, since larval mussels are parasitic on the gills of host fishes and are dispersed by the fish prior to settlement. Impacts from hydropower development have substantially altered and degraded a significant portion of habitat for most native aquatic species with nearly 1,561 km (970 mi.) of streams within South Carolina impounded. Roughly 57 dams have been constructed on navigable streams during the last two centuries, and more than 900 smaller impoundments, including farm ponds, pepper the landscape, disrupting and fragmenting smaller streams. According to the National Aquatic Barrier Inventory & Prioritization Tool analysis for South Carolina, 18,149 dams have been inventoried but 62,983 culverts or other stream crossings have been identified that could also be potential barriers to aquatic connectivity. Poorly designed culverts can cause downstream scouring and upstream pooling so that the natural movement of sand and gravel is disrupted, impacting aquatic communities.

Piedmont Hydroelectric Project dam located on the Saluda River in the town of Piedmont, SC. Photo by Elizabeth Miller, SCDNR.

Figure 5-1 shows the extent of dams across the State of South Carolina. Dams result in a loss of connectivity and negatively affect aquatic biota both above and below the impoundment (Doeg and Koehn 1994; Kanehl et al. 1997; Tiemann et al. 2004) through direct loss of habitat as lotic habitat is converted to lentic habitat. This favors competitive, and often predacious, species (e.g. Largemouth Bass). In addition to direct loss of habitat, impoundments often impact the unimpounded stream reaches downstream through altered hydrologic and thermal regimes (Cushman 1985), modified stream channel morphology, and increased erosion and sedimentation (Watters 1996); all of which ultimately reduce suitable habitat for native aquatic fauna (Helfrich et al. 1999; Tiemann et al. 2004). Historic migrations of anadromous species (e.g. American Shad) have been disrupted by dams.

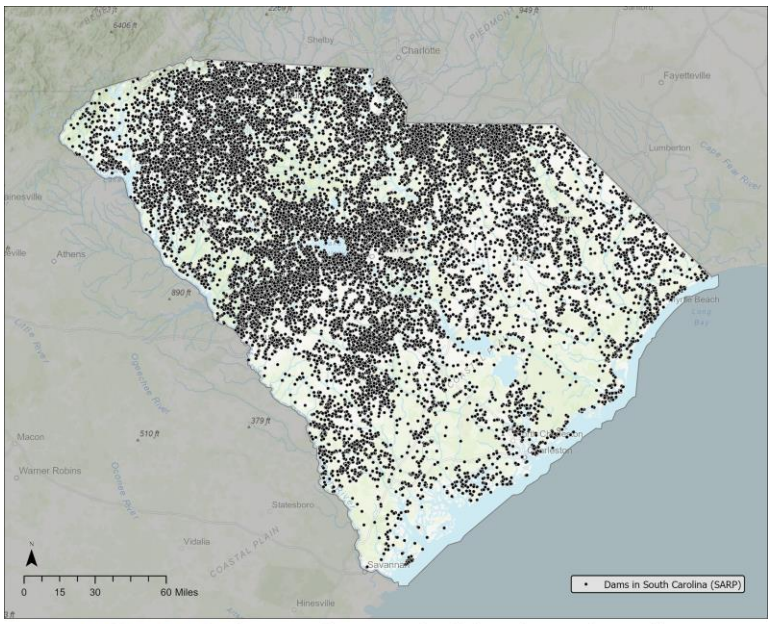
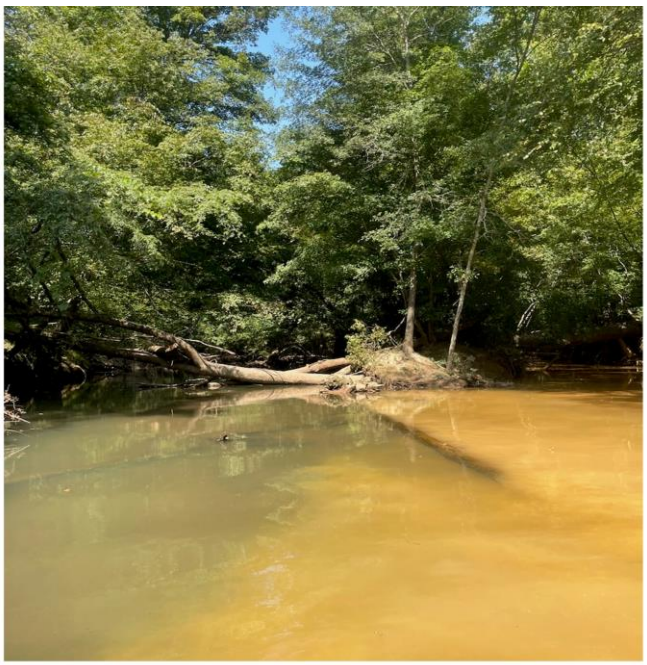


FIGURE 5-1: The extensive network of dams in South Carolina. Map provided by the Southeast Aquatic Research Partnership (SARP).

Destabilized soils from eroded landscapes and earth moving during construction create sedimentation problems in these same waterways. There can be altered sediment regimes where too much sediment enters waterbodies, smothering benthic species or clouding waters which alters photosynthetic processes and visibility. Sediments also can interfere with plankton's absorption of sunlight for nutrients, affecting the food chain. Sometimes sedimentation is blocked from accumulating, degrading downstream habitats that require these depositions as a substrate. Point-source discharges from industrial, municipal, and commercial sources add a variety of pollutants to receiving streams, rivers, and lates. These are in the form of stormwater run-off and releases of effluents, chemicals, and thermal discharges that impact species and habitats where they enter into the aquatic environment but also dissipate to impact other portions of the aquatic system. Non-point source pollution as effluents, sewage from compromised septic systems, and chemicals can leach into



Ineffective silt fencing resulted in stormwater runoff impacts from suspended sediments as the confluence of Six Mile Creek (non-turbid) and Tar Kiln Branch (turbid) in Lancaster County, SC. Photo by Ericah Beason, SCDNR.

waterways for flow overland during rain events. In the case of thermal discharges, expelled water may be colder or warmer than the surrounding water which could have deleterious effects on aquatic life. One such example is the unnatural congregation of warm water species (i.e. Florida Manatee) around warm water discharges so that they become trapped and die from temperature drops when seasonal shifts occur. Polluted waters not only affect wildlife but also human recreation such as swimming and fishing (consumption advisories).

Transportation and Service Corridors

With development comes the infrastructure required to service urban and suburban centers. As highways, bridges, and canals are built, there is direct mortality on plants and animals. Upkeep of human environments such as ditching agricultural fields or forest lands, dredging shipping lanes, removing in-stream structure (e.g. downed logs), and removing shoals and sandbars alters natural habitats, having direct negative impacts on entire communities of plants and animals. For example, as power line rights-of-ways (ROWs) and roadsides are mowed or sprayed through various vegetation management regimes, native species may be lost, directly impacting the associated plants and insects. Equipment that is not properly cleaned can introduce non-native, invasive seeds and other plant parts that can root in once pristine environments and subsequently invade and degrade these landscapes. Routine road maintenance (e.g. repaving, de-icing) uses pollutants including chemicals and salt compounds that are released into the environment. Airport runways must be kept devoid of wildlife to avoid disruption of air traffic while flight paths must avoid bird strikes.

Likewise, shipping lanes within the jurisdictional limit of the State of South Carolina can become lethal to marine mammals and sea turtles that may be struck by boats. In fact, watercraft interactions are the number one cause of mortality for sea turtles in South Carolina (M. Pate, SCDNR, pers. comm.). Coupled with shifts in species distributions from climate changes, whale strikes are expected to increase (Redfern et al. 2020). The mere wave action from passing ships and smaller recreational boat traffic can erode marshes and shorelines.

A cargo ship enters the port of Savannah. Photo by Keith Bradley, SCDNR

Beach Nourishment, Shoreline Stabilization, and Shoreline Modification

Storm surges, subsidence, sea level rise, and altered sedimentation regimes (e.g. lake and dam creation blocking rivers; coastal development) all modify South Carolina's beaches and dunes and cause erosion. Beaches are naturally dynamic ecosystems, and without the ability to move and shift, they can become degraded. When people develop the dune systems by building houses on these shifting sands, beach houses may begin to lose their foundations while important tourist

beaches may shrink in size as hard structures prevent the sand from shifting backwards. In addition to loss of sand under these structures, suitable habitat for beach-dependent species is lost. Beach renourishment from sand pumped from offshore or estuarine sites is frequently required to restore dune systems and beach flats, but renourishment is a temporary solution to a long-term problem. Dredge equipment can injure or kill aquatic organisms through direct uptake in the suction field generated. The spoil that is then deposited on beaches often smothers existing marine invertebrates, thus negatively impacting the system and its inhabitants in the short term (Peterson et al. 2000) and the long term (Jutte et al. 1999). Foraging species may no longer find the habitat or food resources they need on these "improved" stretches of beach until the system recovers. Studies have shown that Piping Plover, which have high site fidelity, suffer nutritional stress when traditional feeding grounds are no longer viable; this stress is manifested in telomere shortening and aging (Chaplin et al. 2024).

Beach renourishment in progress on DeBordieu Beach on Pawley's Island, SC.
Photo by Michelle Pate, SCDNR.

South Carolina's coastline is 187 miles from end-to-end, while its convoluted tidal shoreline is much longer at 2,876 miles (NOAA 2024). Exposed beachfront constitutes around 200 miles, and over 3.5% is estimated to be armored in some way with bulkheads, seawalls, revetment, and riprap (Beauvais and Byers 2024). Other structures include piers, boardwalks, housing and commercial development, jetties, and groins. Hardened structures designed for shoreline and channel protection disrupt the natural processes of sand movement along beaches and can therefore contribute significantly to beach erosion which is already significant in South Carolina. One study (Jackson 2017) found that from the 1930s to 2000s, 44-55% of the State's coast experienced erosion. Seawalls and bulkheads in inland waterways can protect the immediate shoreline while potentially exacerbating erosion of the nearby, unprotected shoreline. Such structures also interfere with the nesting of sea turtles either by totally displacing nesting sites or by rendering them more susceptible to flooding. Additionally, private docks and armored shorelines can often change wave action and catch tidewrack which can smother otherwise healthy marsh grasses (Will Doer, SCDNR pers. comm.). Wave abatement structures, although useful in some instances to prevent erosion into

fragile marsh habitats, are another version of man-made hardscaping or "gray" infrastructure. "Soft" or natural solutions typically have fewer negative impacts to species and habitats.

Agriculture

Center point irrigation agriculture is extensive on some South Carolina landscapes, fragmenting wildlife habitat. Photo from Google Maps.

Agriculture can take the form of animal operations like cattle farms, chicken houses, or row crops. Although South Carolina's economy benefits in part from agriculture, the industry still can directly or indirectly threaten wildlife populations. As farm fields have grown in size and field edges and borders are rarely kept in the rough, wildlife has lost habitat or has become blocked from accessing suitable habitat. "Clean" farming, while making farming practices more efficient, has created a loss of diversity in both insects and plants that then sustain other taxa like birds, reptiles, amphibians, small mammals. For example, ground-nesting bees are at risk from extensive ground disturbance (Harmon-Threatt 2020) during agricultural operations and other earth-moving activities. Drainage ditches further divide acreage. During the past century, many streams were channelized to improve drainage of croplands. Channelized streams lead to increased erosion and increased sedimentation of the receiving streams (Etnier and Starnes 1993). The result of channelization was changing many streams into straight, shallow ditches with severely depressed populations of aquatic fauna. Large farming operations often require water withdrawls from rivers and aquifers for irrigation which can affect water levels, impacting aquatic habitats and drinking water availability, especially in times of drought. During


Extensive agricultural fields representing "clean farming." Photo provided by Billy Dukes, SCDNR.

the summer months, some streams are completely dewatered due to uncontrolled irrigation of croplands. Furthermore, many pond-owners will close their drain structures during dry periods to try to maintain aesthetic water levels, thereby dewatering the stream below their dam.

Nationwide, pollution from agricultural sources is the greatest impairment to streams and lakes (EPA 2023). Runoff pollution of herbicides, fungicides, insecticides, and fertilizers can find their way into creeks and other water bodies. Excess nutrients (e.g. fertilizers) can directly kill aquatic organisms or create algal blooms that then cause fish kills. Fecal coliform from chicken houses and cattle and swine farms adds further run-off pollutants to waterbodies sickening wildlife. Tilling of row crops and livestock accessing streams can lead to erosion and sediment run-off into streams, further fouling waterways. Modern soil conservation practices, such as the creation of Streamside Management Zones (SMZs), have reduced those impacts but sedimentation from legacy crop and pasture siltation still continues in South Carolina streams.

Mining Operations

Mining is an intensive practice that removes all vegetation and topsoil from the specified area in order to extract mineral from beneath the ground. Besides direct mortality and habitat destruction from the clearing operation, hydrologic alterations may occur at the aquifer level. Erosion, sinkholes, and contaminants in the form of chemicals, sediments, and heavy metals can degrade the landscape. Pollutants can leave lasting impacts to soils and water, making both uninhabitable or unhealthy to species that would otherwise use these resources. Heavy metals (e.g. mercury) from past and present mining operations can bioaccumulate in fish and other aquatic organisms, impacting food chains and resulting in fish consumption advisories under 303(d) impaired waterways designations. For example, bats can accumulate metal pollutants through their food chain, and heavy metals from industrial waste can also affect the water quality and invertebrates that bats eat (Zuckal and Bandouchova 2015). Sand mining is a common type of mining operation in South Carolina with physical impacts on instream habitat including increasing bedload materials, turbidity, changing substrate type and stability, and altering stream morphology (Nelson 1993).

Sand mining is common in the Coastal Plain of South Carolina and can impact unique habitats such as this Carolina bay in Horry County, SC. Photo provided by the Coastal Conservation League.

Solar Farms

Utility-scale solar has rapidly taken off in South Carolina within the last decade. As of July 31, 2023, according to the South Carolina Energy Office, 1,864 megawatts (MW) of utility-scale solar has been installed in South Carolina. One megawatt of solar production requires approximately five acres of land, which equates to approximately 9,000 acres in solar. In 2014, the General Assembly passed the Distributed Energy Resource Program Act (Act 236) which incentivized utilities to purchase utility-scale solar. Due to Act 236 and the need to reduce carbon footprints and increase renewable energy as a part of utilities' electricity portfolios, the development of utility-scale solar will not slow down anytime soon. The increase in solar generation means a new land use on South Carolina's landscape competing with the needs of natural resources, and while renewable energy is beneficial to natural resources, some solar farms can adversely affect valuable natural resources if not properly planned and constructed. Impacts to natural resources from the construction, operation, and maintenance of solar farms include: the removal of forests and riparian buffers; creation of monotypic habitat; introduction of invasive species; use of herbicides; creation of large, clear open spaces that may be barriers to dispersal; and barriers created from fencing. In South Carolina, agricultural lands are often targeted by solar companies, but in recent years, the State has seen large (4,000-5,000 acre) silviculture tracts being targeted as well. Therefore, the SCDNR worked with Audubon South Carolina to pass the Solar Habitat Act in 2018. This legislation allowed SCDNR to establish guidance for assisting solar developers in establishing their solar site as pollinator friendly habitat and to work with Clemson University to establish a framework for a voluntary solar habitat certification program (Solar Habitat Program). The Solar Habitat Program can help encourage offsets to some negative impacts of solar and provide benefits to wildlife.

In Orangeburg County, a solar farm with its array of panels, can be seen from Interstate 26. Photo from Google Earth.

Wind Energy Facilities

The Carolina Long Bay Area is predominantly off the Coast of North Carolina but close to the South Carolina border. The State of South Carolina has been engaged in conversations as the

Wilmington East Wind Energy Area has been leased to two developers for the development offshore wind. In 2020, due to concerns regarding oil and gas development on the tourism industry and coastal environments in Florida, Georgia, and South Carolina, then President Trump signed a memorandum instructing the Secretary of the Interior to prohibit drilling in these state waters for a period of 10 years (from July 1, 2022 to June 20, 2032). Until this moratorium is lifted, the potential development of offshore wind energy is limited. However, there is always the potential as wind technologies improve that South Carolina could be a target for future land-based wind. Wind development has the potential to cause direct mortality to a variety of bird and bat species, with some studies showing an attraction by bats to wind turbines (Cryan and Barclay 2009). Indirect mortality to bats due to disruption of echolocation is another threat to the species. With offshore wind, similar direct mortality impacts exist above the waves, but underwater the infrastructure and electromagnetic fields associated with those structures can alter and disrupt the behavior of many fish and shellfish species in addition to direct impacts to Essential Fish Habitat and the South Atlantic Fishery Management Council's Habitats of Particular Concern.

Wind turbines have been proposed along the Atlantic Coast, causing concern for impacts on wildlife.
Photo by Nina_Ali, Flickr, public domain

Silviculture

Although timber production is a renewable resource, corporate and private timber managers that fail to follow Best Management Practices (BMPs) – or do so minimally – can have deleterious impacts on landscape diversity through habitat destruction and degradation. There can be initial mortality from timber harvests and site preparation using drum chopping and chemical applications. Often natural phases in the life cycle of pine plantations can be less beneficial to wildlife and understory plants than others. Pine plantations are monocultures that limit diversity, and without proper management, can be biological deserts. Inappropriate stocking rates or thin cycles can stress trees, leading to disease outbreaks or susceptibility to beetle infestations. Planting off-site tree species can result in weak stands or reduced use by native animals. Fire suppression in woodlands that are reliant on fire for seed germination, duff removal, and herbaceous layer heterogeneity can reduce diversity of both plants and animals present. These woodlands also become more at risk for catastrophic wildfires.

Timber harvests are a normal silvicultural practice, but they do alter habitats and can potentially injure or kill wildlife. Photo by SCFC.

Runoff pollution from chemicals and fertilizers can degrade nearby waterbodies with aquatic species impacts. Tree species and density can alter hydrologic regimes as they pull water from the soil. Ditching and bedding can also alter the hydrology. Along with soil disturbance in the stands, inappropriate stream crossings for logging equipment can increase siltation into waterways. Logging equipment, if not cleaned properly, can move invasive plant species into previously unaffected sites. A National Woodland Owners Association study on family forest owners found that only 11% had a forest management plan in place on their properties (Penn State Extension 2023). Without a professional management plan, many of the above-mentioned threats can degrade wildlife habitat instead of enhancing it.

Pollution

Pollution, in general, is discussed as a part of many of the other threat categories. It can take many forms – light, air, sound, water, soil, and thermal – and is also a secondary threat of many other primary threats. Chemicals can cause direct mortality or cellular damage resulting in mutations or reduced fecundity. Trophic cascades, in which contaminants bioaccumulate and are passed up the food chain, can lead to detrimental food web impacts, behavioral abnormalities, and whole life cycle disruptions. Habitats may become degraded to the point of being inhospitable.

Light pollution is evident over urban centers where humans have modified the light levels, causing behavioral disruptions in sensitive species such as sea turtles (Witherington et al. 2014), amphibians, migratory birds, bats, and insects. Navigation, (e.g. hatchling sea turtles and migratory birds) may be impaired and mate recognition through bioluminescence may be compromised (e.g. fireflies).

Light pollution such as that emanating from this gas station on Edisto Island, SC can affect hatchling sea turtles that confuse the lights with moonlight on the ocean. Photo by Michelle Pate, SCDNR.

Air can become polluted through particulate matter like smoke, byproducts of manufacturing, and vehicle emissions. This can impact the health of both people and wildlife, but it can also damage vegetation like crops and trees. However, some air pollution may be necessary in some instances. In 2024, the Environmental Protection Agency (EPA) instituted a new lower threshold of 12 micrograms per cubic meter of fine particulate matter (PM2.5) to maintain the National Ambient Air Quality Standards (EPA 2024). “Exceptional events” may affect air quality but are still necessary as part of an ecosystem management regime. Prescribed fire is needed on the landscape, to not only mitigate for wildfire risks and maintain resilient landscapes, but to help promote healthy air quality. (S. Cammack, GADNR, pers. comm.). These burns mimic natural events that would have occurred from lightning strikes and allowed to burn unimpeded post-European civilization when the human population was much lower and there were fewer structures on the landscape.

Sound can also be a pollutant in both terrestrial and aquatic systems. Species calling for mates may not be able to hear answering calls; likewise, prey species may not be able to hear predators approaching. In marine environments, sonar and naval weapon discharges can damage or impair the hearing of cetaceans, disrupting behavior.

Runoff from roads can bring oil, gas, and other residues into waterways. Photo generated by AI at www.freepik.com

Threats to aquatic resources in South Carolina include sediments, chemical pollutants, heavy metals, fecal coliform, and microplastics (synthetic polymer fragments and fibers < 5 mm in size). Sediments reaching waterways from

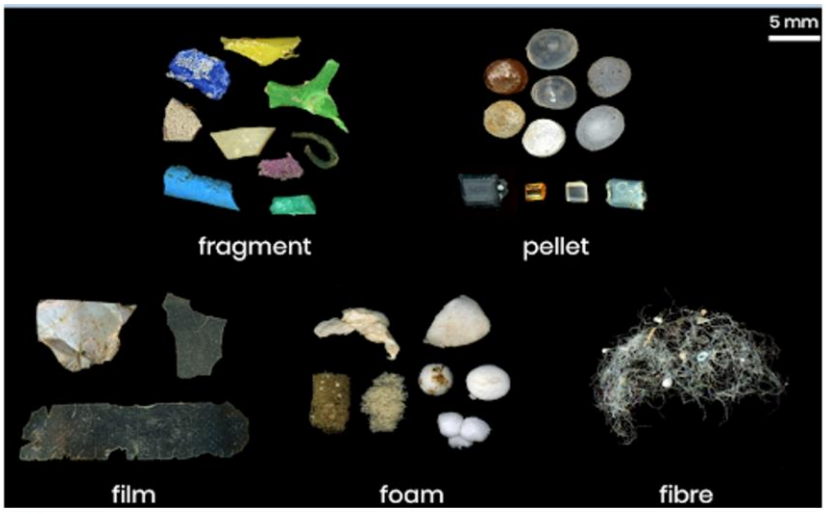
erosion and other ground disturbances can interfere with plankton's absorption of sunlight for nutrients, affecting the food chain. Stormwater runoff carrying chemical pollutants from roads, developments, and agricultural fields can add poisons and excess nutrients (e.g. fertilizers) to aquatic systems, directly killing aquatic organisms or creating algal blooms that then cause fish kills. Native freshwater mussel assemblages across the State are largely dependent on suitable, pollutant-free, stable habitats with adequate access to appropriate host fishes (Ericah Beason, SCDNR, per. comm.). Heavy metals from past and present mining operations can bioaccumulate in fish and other aquatic organisms, impacting food chains and resulting in fish consumption advisories under 303(d) impaired waterways designations. Impervious surfaces disrupt groundwater recharge to aquifers and impact overland flows. Fecal coliform contamination from bacterial runoff from farms (e.g. cattle, swine, and chickens) or from compromised septic systems can sicken wildlife when they contaminate waterways.

Soil can contain the remains of chemicals and other pollutants which can reduce the capacity of plants to thrive, thus creating an impoverished habitat that cannot support higher life forms. The worst examples are brownfields which are abandoned commercial or industrial sites (e.g. gas stations, textile mills) which may require excavation and removal of the toxins. Examples include chlorinated solvents, lead, and petroleum products.

Thermal pollution comes from the discharge of cooled or warmed water into another body of water from power plants, industrial machinery, or even from runoff from host surfaces like pavement. These discharges cause changes to the habitat near the effluent and perhaps beyond as well as the potential for thermal shock in some aquatic animals. Animal behavior can be modified as they either seek the temperature change or avoid it. Whole communities may shift based on these changes in temperature.

Litter

Akin to pollution is the dumping of solid refuse into the environment, collectively called litter. Accumulation of detritus can smother habitats or degrade them. Direct mortality or injury to animals can occur when they become entangled or trapped within litter. Sometimes litter is mistaken for food and ingested, impairing the health of the animal through obstruction, impaired digestive organ function, or absorption of toxins.



There are a wide variety of microplastic contaminants in natural systems. Photo provided by Miriam Boucher (Clemson University) with original information sourced from Alexander Kunz, microplastics researcher in Taiwan.

Abandoned fishing gear, or ghost gear, impacts 45% of all marine mammals on the IUCN Red List of Threatened Species (Ocean Conservancy 2022). A new contaminant, microplastics (synthetic polymer fragments and fibers < 5 mm in size), is being found in waterways in higher and higher concentrations. Trophic transfer occurs in aquatic organisms with unknown health impacts to these species and higher trophic level consumers of these contaminated species (Rochman et al. 2019, Wang et al. 2020).

Invasive Species

The United States Register of Introduced and Invasive Species (US-RIIS) lists 15,264 non-native species in the United States (including Alaska and Hawaii), of which 3,885 (25%) are invasive (Simpson et al. 2021), and the number is steadily increasing. Of this, the conterminous United States has 8,657 non-native species, 2,169 (25%) are invasive (Simpson et al. 2021). The majority of invasive species are plants. Many of these invasive species represent serious threats to agriculture, horticulture, or forestry. Other non-native species are more likely to impact natural communities and individual populations of native wildlife species. Some estimates suggest that 90% of introduced species have resulted in detrimental effects on native wildlife (Hutchins 2011). Invasive and non-native species constitute a significant threat to South Carolina's biological diversity with the exact number unknown. Many native species are declining due to increasing competition or habitat degradation from invasive and non-native species of plants, animals, and pathogens. Some species are still being assessed for their impact severity to South Carolina's ecosystems and if they could be naturally occurring or introduced from abroad.

Kudzu smothering native trees and forbs in rural Oconee County, SC.
Photo by Anna Smith, SCDNR.

What makes a species invasive depends on many things, including its ability to effectively compete for resources and survive the climate of the region such as seasonal temperature changes. The United States Fish and Wildlife Service (2024) categorizes non-native species on their risk of becoming invasive into high, low, or uncertain. A high-risk species is one that already established in one location globally and has a well-documented history of being invasive. A low-risk species is one where there is not evidence of global invasiveness and its establishment is doubtful. An uncertain-risk species needs more study to determine its establishment potential. Risk screening factors may include the species' detectability, ability to reproduce, disperse, carry disease, compete with native species, threaten listed species, impact the economy, and impact human health and safety (FL FWC 2023). An added complication is the definition of "exotic" species which, through range expansion, may naturally move into South Carolina (e.g. Nine-banded Armadillo). This challenges land managers to redefine natural communities and what constitutes "non-native."

Wildlife, water, wind, and humans can act as vectors, inadvertently bringing new species into an area. Sometimes these new species do not compete with the existing community, but often they do. Seeds, tubers, and even animals or parasites can enter South Carolina at ports, hitch a ride on equipment or animal fur, and can come in packing material, dredge spoil, nursery plants, botanical gardens, ballast water, bait buckets, root balls, mulch, and even in the bark of other trees (i.e. Cabbage Palms transplanted from Florida). Sometimes humans deliberately bring them in for landscaping (e.g. Bradford/Callery Pear, Common Periwinkle, Chinese Wisteria), erosion control (e.g. Kudzu), as livestock (e.g. feral hogs and goats), or as pets (e.g. tegu, aquarium fish and plants) which are then released when they are no longer wanted. Sadly, many species once encouraged by wildlife professionals have been found to be deleterious through invasiveness. These include Bicolor Lespedeza, Sawtooth Oaks, and Autumn Olive which were all considered plantings for wildlife forage and are cited in numerous management plans. Even domestic animals can become invasives. Free-ranging cats and feral cat colonies have had enormous impacts on native wildlife with estimates of 1.2 billion birds and 12.3 billion mammals taken by cats annually in the United States (Loss et al. 2013).

Species can escape and become invasive, competing with native wildlife for resources, displacing them, and destroying habitat. Sometimes there is direct mortality (e.g. Hemlock Wooly Adelgid, American Chestnut Blight) on native species as a consequence. New genetic material may be introduced to a

Wild hogs are an invasive species found in many counties in South Carolina. Photo taken by Jeff Blake (OSI) in Florence County, SC.

population resulting in hybridization and a loss of unique genetic lineages. Exotic species bring with them their own pathogens, parasites, and diseases that may enter the local population against which they may have no defenses. Management to recapture sites already affected by non-native, invasive species presents an enormous on-going effort. The economic impact of some common invasive species is profound: $19 billion for rats, $17 billion for feral cats, and $800 million for feral swine (Pimentel et al. 2000). Terrestrial and aquatic plants affecting South Carolina are listed in Appendices 3A and 3B while invasive animals are listed in Appendix 4.

In the case of non-native plants, they can occur in either terrestrial or wetland habitats. Such species can dominate or displace native vegetation and can occur in nearly single-species stands that present a lowered structural diversity and less desirable wildlife habitat. Both tidal low-salinity marshes and wetlands and littoral (shallow water) areas in ponds and impoundments can be densely covered with these species (e.g. Hydrilla and Phragmites). Dense colonies of these plants may restrict hydrological flows and capture sediment, thereby increasing the rate of eutrophication and contributing to low dissolved oxygen (McCann et al. 1996, Aulbach-Smith and deKozlowski 1996). Forested wetlands and coastal forests with damp (hydric or mesic) soils may be heavily populated with Chinese Tallowtree (*Triadica sebiferum*), which quickly becomes established and out-competes more desirable native plants (J.W. McCord, SCDNR, pers. obs.).

Bamboo sold at garden centers can escape from landscaping and degrade native habitats.
Photo by Anna Smith, SCDNR

It isn't always non-native, invasive species that can wreak havoc on the biodiversity and integrity of an ecosystem. Native plants can become a nuisance when their populations increase above normal levels. Examples include Sweet Gum, Rhododendron, and native varieties of *Baccharis* sp. Native pathogens can also be a problem such as Raccoon Roundworm (*Baylisascaris procyonis*) crossing the species boundary to infect the Eastern Woodrat, an SGCN in South Carolina. White-tailed Deer, if overabundant, can over-browse the understory, reducing nesting

habitat for birds and decreasing floristic diversity. Clemson Regulatory Services keeps a list of invasive plants, insects, diseases, mollusks, and nematodes.

Current and Emerging Diseases

Wildlife health is a complex, dynamic topic that can be difficult to define and measure. It is more than just the presence or absence of disease caused by pathogens or contaminants; rather it can be defined by a population's ability to withstand challenges, which may include climate change, habitat loss, or the introduction of a disease-causing agent. Thus, health is the result of interacting biological, social, and environmental determinants (Stephen 2014). Diseases can have significant impacts on wildlife populations. The development of disease depends on factors related to the host organism, its environment, and the disease-causing agent. Pathogens (e.g. bacteria, viruses, parasites, and prions) and contaminants are normally present in wildlife populations, with disease typically occurring at low levels, but becoming more prevalent when hosts are stressed. An emerging disease is defined as "one that has recently been discovered; has recently increased in incidence, geography, or host range; or is newly evolved" (Rachowicz et al. 2005). Two hypotheses can apply to an emerging disease: the novel pathogen hypothesis states that the disease has recently spread into new geographic areas, whereas the endemic pathogen hypothesis suggests that it has been present in the environment but recently has affected new hosts or increased in its ability to cause disease (Rachowicz et al. 2005). For example, in North America, Chytridiomycosis, caused by the fungus *Batrachochytrium dendrobatidis*, and White-nose Syndrome, caused by the fungus *Pseudogymnoascus destructans*, (Figure 5-2) have emerged following pathogen introduction and have had devastating impacts on amphibian and bat populations, respectively.

Disease can have direct impacts, such as mortality, or can have indirect impacts, such as reproductive failure; both types of impacts can lead to population declines. As some species disappear from the landscape, others can proliferate, causing an imbalance in predator-prey relationships or overuse of resources. Sometimes these diseases are zoonotic and threaten human health as well. According to the World Health Organization, 70-80% of emerging infectious diseases are zoonotic in origin. Wildlife health is a critical component of One Heath, which is the intersection of human health, animal health, and environmental health. Therefore, discussions of wildlife health must consider connections with humans, domestic animals, and ecosystems. Such connections may include game species as a food source for humans, pathogens that can be transmitted between wildlife and humans or domestic animals, and the habitats needed to support wildlife populations. In addition, healthy ecosystems provide a variety of ecosystem services for humans, including agricultural production and recreation.

A Tricolored Bat (SWAP highest) showing the tale-tell signs of White-nose Syndrome on the muzzle. Photo by Jennifer Kindel, SCDNR.

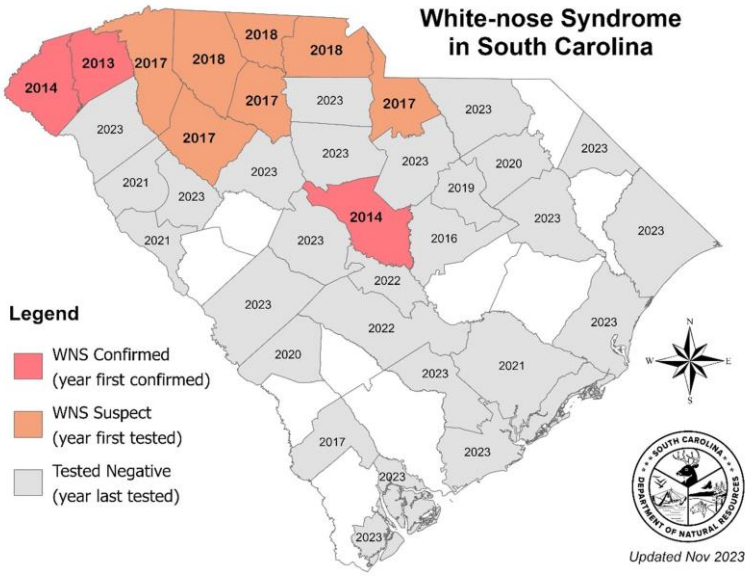


FIGURE 5-2: White-nose Syndrome status in bats in SC from 2013-2023.

Natural Processes

Even natural processes can be a threat or at least a stressor. The changing of the seasons (e.g. frosts, algal blooms/red tide events), weather patterns, food supplies, competition, and predation are all examples. In the case of predation, coyotes and wild hogs are a constant threat to sea turtle nests while crows have had devastating effects on some Least Tern nesting colonies (Mary-Catherine Martin, pers. comm). Even as communities undergo natural successional stages, there is displacement at each step. For example, a grassland may slowly fill with shrubs and trees and then climax as a forest. Species that require different stages will occupy the landscape at different times depending on the habitat present.

> "Harmony with land is like harmony with a friend; you cannot cherish his right hand and chop off his left. That is to say, you cannot love game and hate predators... The land is one organism."
>
> – **Aldo Leopold**

Natural Disasters

Like natural processes, natural disasters can stress species. Examples of natural disasters include hurricanes, tornados, ice storms, droughts, wildfires, and flood events. The severity of the event, how widespread it is, and how long it lasts are all factors contributing to stress on species. Disasters can be especially harsh on rare or declining species that are already in small refuges and thus greatly impacted by even the most localized events. During natural disasters, animals and plants can experience direct mortality, displacement, habitat destruction, or a disruption in their life cycle (e.g. a storm that destroys bird nests and thus reproductive success for that breeding season).

Ice storm damage in Williamsburg County, SC. Photo provided by the SCFC.

Tornado damage in Allendale County, SC. Photo provided by the SCFC.

Climate Change

Climate change is a vast topic that affects a multitude of ecological and biological systems. Our ability to predict the consequences of climate change is limited by uncertainty in climate predictions compounded by complexity in ecological system behavior. Our climate is being impacted not only by natural warming cycles but also by a 40% increase in greenhouse gas emissions into the atmosphere by humans since the 1700s (EPA 2016). The six primary gases defined by the Kyoto Protocol are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

As the climate warms and moisture regimes change, there can be an array of changes ranging from changes in weather patterns to the resulting habitat changes. Examples of climate change-induced changes include the uncoupling of phenologies (e.g. Vasiliev and Greenwood 2021, Thackeray et al. 2016, Robertson et al. 2024) such as plant bloom windows versus insect emergence, range shifts (expansions and contractions), hybridizations, and changes in food webs/pyramid bases. As sea level rises and ocean waters experience thermal expansion, habitats can become inundated with salt water. According to the National Sea Level Explorer (2024), two locations in South Carolina have been assessed for sea level rise (SLR) changes since 1993; Charleston Harbor (Charleston County) has experienced a 8.2 inch rise while Springmaid Pier (Horry County) has had a 8.3 inch rise. Charleston peninsula will experience even more flooding in the future (Sweet et al. 2022). Salt-sensitive plants species die back in favor of migrating marshes and mangroves. Salinity intrusion into once fresh water sources changes entire communities. Ocean acidification can disrupt the calcium deposition in corals, univalves, and bivalves, leading to collapses in diversity as species die out. As precipitation changes, so do hydrologic regimes (flows). Increased temperatures likewise affect snowmelt patterns and frost-free days as well as land and water temperatures. Heat stress can affect survivability of some species. The severity and timing of weather events may produce droughts, rain bombs, floods, and severe storms. As the climate changes, ecosystems will naturally encroach into new areas with unpredictable consequences. One example of this is mangroves, which are advancing northward through Georgia while simultaneously retreating in Florida, and how their presence will affect salt marshes (Adno 2024). Habitats will migrate, with species experiencing range expansions or contractions. Habitat loss and degradation will occur.

Skeletonized trees in “the boneyard” at Cape Romain National Wildlife Refuge bear witness to rising sea levels. Photo by Keith Bradley, SCDNR.

Chapter 10 provides a regional perspective of climate change impacts in the Southeast. Other documents that address climate changes in South Carolina are the South Carolina Comprehensive Climate Action Plan (CCAP) (2024) and the South Carolina Strategic Statewide Resilience and Risk Reduction Plan (2023). An older document, Climate Change Impacts to Natural Resources in South Carolina (2013), is outdated but provides interesting predictions and case studies for comparison with more recent models.

Overharvesting, Illegal Collecting, and the Exotic Pet Trade

Some species of wildlife are managed through hunting or fishing regulations, but illegal overharvesting or overexploitation can and does occur, negatively affecting populations. Direct mortality can result from humans harassing species in an attempting to capture, transport, and confine South Carolina's native species as "pets". Both animals and plants fall victim to the illegal pet trade as they are collected from their native habitats which often results in degradation of the biological community from their removal. If too many of a species are removed, the depopulation can threaten the continued survival of the species on the landscape. Often humans cannot provide the best accommodations for species so that they suffer from malnutrition, behavioral and physical abnormalities resulting from stress, and loss of vital survival instincts. As humans search for these species across the landscape, the intrusion can spread pathogens and diseases as well as result in habitat destruction. If a pet owner no longer wishes to keep the animal or plant, they are often released back onto the landscape in inappropriate habitats where they are likely to perish. Sometimes they simply escape captivity.

In 2021, poachers at Lewis Ocean Bay Heritage Preserve were caught digging up Yellow Pitcher Plants and issued citations by SCDNR Law Enforcement. The plants were returned to their extraction sites. Photo by SCDNR.

Illegal collecting and poaching of wildlife and plants are threats to SGCN in South Carolina, often requiring intervention by law enforcement. Photo by Joey Frazier, SCDNR.

Non-native species are also kept as pets. Currently, there are over 1,000 species in the exotic pet trade, with the United States being the largest global market for the trade (Scheffers 2024). High-volume, low-cost species are often easy to obtain but naïve buyers, tired of their care or when the animal overgrows its living quarters, release them into native systems. This can alter ecosystems if these released species are able to survive and thrive in these new environments. Climate change is causing temperate systems of the Southeast to transition to tropical environments, making it easier for once cold-sensitive species to survive the winters,

reproduce, and disrupt native food webs (Scheffers 2024). South Carolina falls within a high-risk area for such invasions as it has an overlap in both a high pet ownership culture (popularity) and pet store locations (industry) on top of climate suitability (Scheffers 2024).

Eastern Box Turtles (SGCN High) confiscated from a poacher. Photo by Andrew Grosse, SCDNR.

As an example of the magnitude of the problem, since 2013, SCDNR has compiled over 2,400 reports of nonnative reptile and amphibian species observed and reported throughout South Carolina. Over that time, biologists have visually confirmed, in person or through photographs, 873 reports of over 30 nonnative species. The most frequently reported species include Mediterranean House Geckos, Brown Anoles, Red-eared Sliders, Cuban Tree Frogs, Argentine Black-and-White Tegus, African Spurred Tortoises, and Ball Pythons. SCDNR has also confirmed Burmese Pythons, Green Iguanas, various tortoise and monitor lizard species, and two crocodilian species. The Argentine Black-and-White Tegu, which is prohibited in South Carolina, has been confirmed from 17 counties statewide as of 2024. To date, 18 tegus have been removed from the wild in South Carolina. Releasing nonnative reptiles and amphibians is illegal in South Carolina. The public can report sightings of non-native species on the SCDNR Non-native Animal EDDMapS reporting page.

Broken bottles, campfires, and graffiti spraypainted on the granitic dome at Bald Rock Heritage Preserve has damaged rare plants like Blue Ridge Ragwort (*Packera millefolia*). Photo by SCW staff.

Exploitation can also occur on the habitat level such as when sand is mined or river rocks are removed for landscaping, changing the characteristics and suitability of the habitat. Human activities can completely destroy or seriously degrade habitat properties relied on by species for some stage of their life cycle. In the case of removal of aquatic river stones for landscaping, salamanders, fish, crayfish, and aquatic insect larvae that

utilize this substrate for shade, protection from swift currents, nesting, or hiding are negatively impacted. Even if features or structures are not removed directly, they can be rendered obsolete if degraded. An example would be when reptile collectors cleave rock outcrops and overturn boulder fields in the search for snakes hidden in winter denning sites (Andrew Grosse, SCDNR, pers. comm.). Sometimes outright vandalism affects sensitive habitats like spray-painting on granitic domes.

Persecution by Humans

Snakes are often killed when misidentified as venomous. This Southern (Banded) Watersnake was presumed to be a "cottonmouth." Photo provided by Andrew Grosse, SCDNR

Persecution involves the intentional killing of a species (e.g. snakes) or harassment (e.g. chasing shorebirds and hatchling sea turtles). Indirect persecution may come from the disruption of the equilibrium between predators and their prey. This is best demonstrated through misguided predator removal programs that end up removing top carnivores or mesocarnivores, upsetting the biological balance. Over-browsing by herbivores may occur, resulting in habitat deterioration and food web disruptions. Other indirect impacts on wildlife come from the willful destruction of nests, roosts, dens, or other places of refuge or young-rearing sites. Although some destruction is necessary for human health (e.g. bats in the attic), safety (e.g. geese on airport runways), and sanitation (e.g. vulture roosts on houses) or to prevent infrastructure complications (e.g. nests on cell towers), other destructive behaviors have no basis in sound management and are thus categorized as persecution.

Recreation

Managing agencies face competing demands for access by users whose interests are not always compatible. Impacts of recreational uses on the resource base vary by intensity and type, posing challenges to meeting resource-based management objectives.

Disturbance of seabirds by walking, jogging, or biking through them causes stress. Allowing pets to run through or chase shorebirds is also a stressor. Photo by Janet Thibault, SCDNR.

Perhaps the most unintended threat or stressor is that caused by humans acting benevolently toward or simply independently of wildlife and their habitat needs. The simple presence of a human in a sensitive area (e.g. Wood Stork rookery) may disrupt natural behaviors and lead to abandonment of a site or reduced survivorship. Human traffic can trample nestlings or rare plant species while pets allowed to roam off leash or in restricted areas can directly kill, injure, or harass wildlife. Nest attempts by shorebirds and sea turtles may be aborted when humans disturb a site (Mary Catherine Martin, pers. comm.). Studies have also shown that the sound of human recreating in an area can elicit predator avoidance behavior in wildlife and hypervigilance, a stress reaction (Zeller et al. 2024). Even though nature tourism is an important contributor to local economies, photographers and wildlife watchers that descend on sensitive habitats can disrupt species behavior in the quest for the perfect picture (i.e. use of call playbacks, baiting, drones, and handling) (Davis et al. 2024). Their online posting to social media accounts can bring unwanted attention to rare and declining species by advertising species locations to poachers as well as increasing visitation which can spread disease and a higher risk of predation (Davis et al. 2024).

A game camera captures an unnatural gathering of deer and raccoons around an artificial food source, a corn feeder. Photo by Anna Smith, SCDNR.

Humans also like to feed wildlife under the mistaken belief that they need to supplement the wild diet. Sometimes these additional foods are not as nutritious as the wild variety the species would typically feed upon or can result in health problems for the wildlife through digestive complications. As animals congregate at food sources like feeders or corn piles, unnaturally high concentrations of a species (e.g. deer herds) or assemblages of species (e.g. deer, squirrels, and raccoons) may co-mingle at the same site, increasing the likelihood of disease transmission and altering behavior. Sadly, some humans think that by relocating a species (which is often illegal), they are both ridding themselves of a nuisance but letting it live. However, many species are often placed outside of their territory where they knew where to find food, in inappropriate habitats, or outside of their natural range. This often leads to stress or direct mortality of the animal.

> "Ethical behavior is doing the right thing when no one else is watching– even when doing the wrong thing is legal."
> – Aldo Leopold

TABLE 5-1: Primary Threats, Stressors, and Associated Impacts			
Primary Threats and Stressors		**Associated Impacts**	
1	Lack of Species Data	1.1	taxonomic uncertainty
		1.2	population size unknown
		1.3	distribution unknown
		1.4	life history unknown
2	Development & Infrastructure	2.1	direct mortality during construction phase
		2.2	habitat destruction
		2.3	habitat fragmentation (from engineered structures or loss of corridors for dispersal through appropriate habitats)
		2.4	habitat alterations / degradation (including altered sediment regimes)
		2.5	non-point source pollution (chemicals, fertilizers, pathogens); sedimentation
		2.6	point source pollution (effluents, sewage, chemicals, thermal discharges)
		2.7	unnatural species concentrations and interactions
3	Transportation and Service Corridors	3.1	direct mortality or injury from collisions
		3.2	habitat degradation / fragmentation (from engineered structures, the removal of natural structures, and the transmission of invasive species)
		3.3	habitat destruction (through vegetation management regimes or through the use of impervious surfaces)
4	Beach Nourishment/Shoreline Stabilization/ Shoreline Modification	4.1	direct mortality
		4.2	loss of habitat or food resources
		4.3	alterations to sediment regimes and wave action
5	Agriculture (row crops and livestock)	5.1	loss of diversity
		5.2	habitat fragmentation and interrupted gene flow
		5.3	groundwater withdrawals impacts on hydrology
		5.4	habitat destruction / alterations (including loss of food resources)
		5.5	runoff pollution (herbicides, fungicides, insecticides, rodenticides, fertilizers, fecal coliform, sediment)
6	Mining Operations	6.1	direct mortality
		6.2	habitat destruction
		6.3	hydrologic alterations
		6.4	pollution (chemicals, heavy metals, sediments)
7	Solar Farms	7.1	direct mortality
8	Wind Energy Facilities (mainland [A] and offshore [B])	8.1	habitat destruction or alterations (including productivity and temperature regimes)
		8.2	displacement
		8.3	maladaptive behavioral changes
9	Silviculture	9.1	direct mortality from timber operations

		9.2	fire suppression (resulting in plant & animal community changes)
		9.3	artificial habitat creation (inappropriate tree stocking rates or thin cycles; planting of off-site tee species; loss of diversity through monocultures)
		9.4	introduction of invasive plants / seeds
		9.5	runoff pollution from chemicals and/or fertilizers
		9.6	altered hydrologic and sedimentation regimes
10	Pollution (light [A], air [B], sound [C], water [D], soil [E], thermal [F])	10.1	direct mortality
		10.2	mutations /cellular damage
		10.3	disruption of life cycle
		10.4	disruption of behavior; vulnerability to predation
		10.5	habitat destruction / degradation
		10.6	aquatic habitat imbalances
		10.7	trophic cascade leading to food web impacts and disruptions host relationships
11	Litter	11.1	direct mortality or injury from entrapment
		11.2	direct mortality or impaired health from ingestion or absorption (toxicity)
		11.3	habitat degradation
12	Invasive Species (native or non-native/exotic)	12.1	direct mortality
		12.2	displacement and/or competition for resources
		12.3	introduced genetic material / hybridization
		12.4	new pathogens, parasites, diseases, etc.
		12.5	loss of biodiversity
		12.6	habitat degradation (including herbivory impacts from overpopulated native species)
13	Current & Emerging Diseases (pathogens, microbes, viruses, prions)	13.1	direct mortality
		13.2	decreased fitness
		13.3	ecosystem imbalances
		13.4	habitat degradation
14	Natural Processes	14.1	Competition for resources
		14.2	predation
		14.3	normal seasonal shifts in weather patterns and temperature / effects on habitats
		14.4	shifts in communities from natural ecosystem succession
15	Natural Disasters (hurricane, tornado, ice storm, wildfire, drought, flood)	15.1	direct mortality
		15.2	displacement
		15.3	habitat destruction
		15.4	disruption of life cycles
16	Climate Change	16.1	effects of uncoupled phenologies
		16.2	effects of ocean acidification

		16.4	effects on species' habitat utilization patterns and life cycles from changes in snowmelt patterns, frost-free days, precipitation, and flow regimes
		16.5	changes in food web / pyramid bases
		16.6	severity and timing of weather events on life cycles
		16.7	habitat chemical composition changes from increases in water temperatures
		16.8	range shifts and hybridizations
		16.9	direct habitat loss or degradation
		16.10	habitat changes to new steady states: ecosystem encroachment / habitat migration (expansions and contractions); other ecological transformations
17	Overharvesting and Illegal Collecting / Exotic Pet Trade	17.1	direct mortality
		17.2	harassment
		17.3	decreased fitness caused by the spread of pathogens and diseases
		17.4	habitat destruction through human intrusion or manipulation
		17.5	competition from non-native introductions (releases and escapes)
		17.6	depopulation
18	Persecution by Humans (intentional)	18.1	direct mortality through purposeful killing
		18.2	harassment
		18.3	ecological disequilibrium from predator removal
		18.4	indirect effects from willful destruction of nests, roosts, dens, etc.
19	Recreation (unintentional)	19.1	unintentional direct mortality or injury
		19.2	human intrusion / harassment negatively altering behavior
		19.3	negative health and behavior impacts from intentional or unintentional feeding
		19.4	human or pet disturbance / harassment or destruction of sensitive habitats
		19.5	uniformed relocation of species to inappropriate habitats or ranges resulting in mortality or decreased fitness

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