moving into a light southeasterly wind, taking them upwind slightly beyond the tower to the southeast, turning to be blown downwind to the northwest of the tower, stopping, and making way back upwind again. This pattern repeated itself, with the birds flying in a narrow elliptical path, issuing frequent flight calls, which Avery et al. (1976) stated, is generally characteristic of birds around a tower on overcast nights.

Taylor and Anderson (1973) reported unusual bird behavior during an incident on the night of September 28-29, 1970, when birds collided with the 1,484-foot tower at 11:00 p.m. following an extensive cold front. Collisions continued from 11:00 p.m. until dawn, with the greatest number of collisions occurred around 2:15 a.m. after heavy precipitation. Observers reported continuous "chirps and calls" from birds flying overhead, with individuals flying in rapid, erratic flights. Birds were seen to strike the lower part of the tower, two buildings, parked cars, and the ground. Almost 1,600 bird mortalities representing 37 species were recorded. The bird behavior and associated mortalities documented by Taylor and Anderson (1973) are some of the few direct observations of bird collisions at communication tower sites.

Larkin and Frase (1988) monitored nocturnal bird behavior and flights during migration near a 1,010-foot broadcasting tower using a portable tracking radar. This study reported that with a low cloud ceiling surrounding the tower, birds flew in nonlinear arcs and circles around the tower, but during clear conditions or a high ceiling, this behavior was not observed. According to Larkin and Frase, the slow circling speed recorded using this radar during low cloud cover was "remarkably precise" and inferred some sort of change in flight behavior relative to the tower location.

Gauthreaux and Belser (2000) also recorded flight behavior of nocturnal migrants in response to different tower lighting regimes. The study results showed a greater degree of nonlinear flight (i.e., pause-hover, curved, or circling) near towers with red lights than those with white lights or at a control site. These observations are discussed in greater detail for tower lighting in Section 3.3.6.2.

Cochran and Graber (1958) recorded bird behavior in response to lighting at a 984-foot tower in Illinois by monitoring bird vocalizations. This study was only completed on one night during the spring migration (May 29-30, 1957) and one night during fall migration (November 5, 1957). Through both acoustical monitoring and direct observations, Cochran and Graber (1958) were able to detect that the migrants were not evenly distributed. In the vicinity of the tower on nights with a low ceiling, migrants also appeared disoriented or confused, flying through the tower framework, circling, and passing through the tower again. However, on clear nights (unpublished manuscript), the auditory records show a number of migrants passing the tower with no apparent confusion or disorientation.

One interesting behavioral observation by Stoddard (1962) was the repeated presence of large numbers of exhausted and sleeping birds on the ground within 50 to 100 yards of the Florida tower following nights with low visibility and typically large numbers of mortalities and crippled birds. He assumed that the birds when circling the tower either fell to the ground exhausted or had been stunned by a strike. These birds were relatively unhurt, and remained on the ground until morning. These individuals would often fly off when approached upon waking the next morning. No sleeping birds were ever observed larger than "tanager-sized." Taylor and Anderson (1973) report a similar observation following nights with a large number of collisions, although the majority of the live birds recorded on the ground were injured.

Although records of bird behavior near communication towers are limited and few in-depth studies have been completed to date, a number of observations have been recorded by researchers that provide insight into attraction or avoidance of tower sites under varying environmental conditions. Different family or species migration patterns (e.g., flying altitudes, routes, social behavior) also may result in certain species being at a greater risk to collisions than others (Nehring and Bivens, 1999). As with other factors, several questions remain pertaining to bird behavior in the proximity to tower sites.

3.3.3.3 NOI Questions

The NOI did not specifically request comments on bird behavior near communication towers. However, a few comments on this topic were received.

3.3.3.4 General Responses and Summaries

Records of bird behavior near communication towers are limited. As stated above few in-depth studies have been completed to date. However, a number of observations have been recorded by researchers (Avery et al. 1976; Taylor and Anderson 1973; Larkin and Frase 1988; Gauthreaux and Belser 2000; Cochran and Graber 1958; Stoddard 1962; and Nehring and Bivens 1999), providing insight into birds' possible attraction or avoidance of tower sites under varying environmental conditions. As with other factors, questions remain pertaining to specific conditions that affect bird behavior in the proximity to tower sites. Little information was reported on the behavior of birds approaching towers during the day, specifically behavioral avoidance. The applicable studies provide information on bird behavior under lighted conditions but not under unlighted conditions.

3.3.3.5 Specific Respondent Comments

This topic was not specifically addressed by respondents except for the reference of a few studies that characterized bird behavior at lighted towers., e.g., the USFWS and Woodlot's reference to Avery (1976), and the USFWS reference to Gauthreaux and Belser (2000).

Woodlot discussed a few studies supporting the conclusion that seasonal differences in birds (assumed to be young versus adult) are reflected in mortality implying behavioral differences because of age.The American Bird Conservancy, Forest Conservation Council, and Friends of the Earth mentioned bird behavior relative to mortality effects from lighting and possibly attraction but no specific references to data were provided.

3.3.4 Tower Height and Configuration

3.3.4.1 Current State of Knowledge – General

Tower height appears to be a potential factor in the rate of bird collisions with towers, although there is considerable discussion regarding the importance of tower height to the risk of collision. Towers taller than 500 feet tend to be implicated in more of the mass kills reported for communication tower sites. However, there have been few mortality studies and monitoring programs for the "shorter towers" (500 ft and less). It may be premature, then, to assume that shorter towers present a lower collision risk and result in fewer bird mortalities. The following studies discuss these factors and how to define "tall" versus "short" towers, which can be interpreted differently.

3.3.4.2 Discussion of Specific Studies

Tower Height. One of the more long-term bird-monitoring projects on communication towers in the U.S. was conducted by a physician in Eau Claire, Wisconsin from 1957-1995. From 1949 to 1955, a 500-foot high television tower site was surveyed without any notable findings of bird mortalities. However, in 1957, a 1,000-foot-high tower was erected adjacent to the original tower, and on August 29, 1957, the first mass bird kill at this site was recorded (Kemper 1996). The 500-foot tower was ultimately removed in about 1960, but the 1,000-foot Eau Claire tower continued to be monitored with records of significant bird kills, reporting 121,560 birds of 123 species over a 38-year period (Kemper 1996).

A second long-term study that has provided valuable data on species' composition, bird behavior, predator/scavenger effects, and inferences to the effects to birds from tower height is the 29-year study at a northern Florida tower at the Tall Timbers Research Station (Stoddard 1962; Crawford and Engstrom 2001; Crawford 1971, 1978, and 1981). In October 1955, Stoddard (1962) initiated site surveys at a new 669-foot television tower. Almost daily, surveys were conducted at this site continuing from 1955 through 1983. In early 1960, the original 669-foot tower was replaced with a 1,010-foot tower. Subsequently in 1989, the tower was shortened to 295 feet. This long-term study of three tower heights at the same location provided a unique opportunity to compare avian kills

with tower heights, while controlling for other variables (Crawford and Engstrom 2001). During the 29-year period, 44,007 birds of 186 species were collected and recorded for the three tower heights. Comparative mortality estimates were not provided for each tower height over time, however, Crawford and Engstrom's (2001) study summary showed that there was not a "significant difference" when comparing the mortality numbers attributed to the 669-foot tower and the 1,010-foot tower, even when controlling for weather conditions and cloud ceiling height. However, the data showed a "significant decrease" in mortality of nearly two orders of magnitude at a tower height of 295 feet. Based on these data, the authors further suggest that towers 300 feet and less pose little "significant threats" to migrating birds. However, this inference has yet to be proven and is currently being examined in an Arizona study, as discussed in Section 3.4.3.

Another example of tower height effects included a tower study in Indiana where minimal bird mortalities were reported for three television towers ranging from 350 to 450 feet high and that were oriented in a north-south direction. In July 1962, a 1,074-foot-high tower was erected nearby. After the taller tower was erected, Manuwal (1963) reported "significantly higher" bird mortalities for this site starting in the fall of 1962.

Although the critical threshold for tower height has not been definitively determined (Seets and Bohlen 1977; Crawford and Engstrom 2001), Kemper (1996) hypothesized this threshold to be approximately 400 feet.

Guy Wires vs. Self-supporting. Intuitively, one would assume that towers with an array of guyed wires would present a greater collision hazard or risk to migrating birds than self-supporting structures. . No specific studies comparing avian collisions with guyed towers to self-supporting structures were found as part of this review. Additionally, it would be difficult to differentiate causal factors between guyed structures and tower height, as tall towers require guy wires. Nevertheless, should the presence of guy wires represent an increased probability of bird strikes (i.e. larger collision potential), the development of a demonstration study and the collection of associated data would be valuable.

In summary, a number of studies and incidental mortality reports have been completed on the "taller" towers. However, existing data are not sufficient to draw direct conclusions between tower height and migratory bird collisions. The critical threshold for tower height has not been definitively determined relative to bird collision risks. Although some assumptions are made on tower height effects, additional information is warranted. Tower configuration, guyed versus self-supporting structures, appears to be more defined in that a greater number of mass kills of birds are associated with the taller, guyed structures. However, no specific studies comparing avian collisions between guyed and self-supporting structures are known to occur. Studies on shorter, self-supporting towers have been recently initiated, as discussed in Section 3.4.

3.3.4.3 NOI Questions

The following discussion is associated with the request by FCC in its NOI to provide specific information regarding the quantity and quality of existing data documenting the impact of tower height and tower configuration on migratory bird collisions with communication towers.

- *21. We seek comment on the role of tower height as a cause of collisions by migratory birds with communications towers.*
- *Are there reliable scientific studies that compare the impacts on migratory birds of towers of different heights, and do they control for other variables such as geographic location, proximity to bird movement corridors, and prevailing weather conditions?*
- *Do studies examine whether short towers have less impact on migratory birds than tall towers, and do they identify the heights of the towers that were studied?*
- *We also ask that comments address the relationship, if any, of tower height with other factors, such as lighting, and whether there are situations where tower height could be limited to deter collisions by birds with towers yet still allow the provision of reliable communications services.*
- *We seek comment on what impact, if any, different tower structures may have on migratory birds.*
- *Are there factors that may make a particular type of tower structure more or less of a risk to migratory birds?*

- *We also seek comment on whether particular tower designs or potential deterrent devices such as visual markers may deter migratory birds from towers.*

3.3.4.4 General Responses and Summaries

The respondents expressed opinions on the varying risks posed by different tower heights to migratory birds. However, no new research or data were provided in the NOI comments. There appears to be a consensus among the respondents that comparative studies of different tower heights are limited. However, a few studies discussed in Section 3.3.4.2 (Kemper 1996; Stoddard 1962; Manuwal 1963) infer that tower height likely influences migratory bird mortality under certain conditions. Although there also appears to be the consensus that other variables such as geographic location, proximity to bird movement corridors, and prevailing weather conditions are influential, the combined impact of these factors with tower height have not been specifically studied.

Additionally, no recent information or research was provided whether particular tower designs or potential deterrent devices, such as visual markers, might reduce the migratory bird collision risk with communication towers.

Existing data are not sufficient to draw direct conclusions between tower height and migratory bird collisions. As discussed above, the critical threshold for tower height has not been definitively determined relative to bird collision risks. Although some assumptions are made on tower height effects, additional information is needed. Tower configuration, guyed versus self-supporting structures, appears to be more defined in that a greater number of mass kills of birds are associated with the taller, guyed structures. However, no specific studies comparing avian collisions between guyed and self-supporting structures are known to occur. Studies on shorter, self-supporting towers have been recently initiated, as discussed below and in Section 3.4.

3.3.4.5 Specific Respondent Comments

No new research or data were provided in the individual comments.

CTIA, PCIA, and NAB generalized that because of the lack of studies, conclusions cannot be drawn on tower designs affecting mortality. Woodlot stated that few studies

exist to draw conclusions on geographical, topographical, and elevation factors affecting mortality.

Woodlot further discussed that little information exists to draw conclusions on tower heights affecting mortality. However, they did report that when looking at towers with mass kills of 100 mortalities or more, the tallest towers appear to have the greatest impact. They cautioned that large biases may be involved with these data, and information on geographic and topographic locations may be important, missing components. Woodlot also commented that no observable trend could be presented on guy wires as a factor. This is because the literature had limited information on the presence of guy wires although it is likely that most tall towers reporting mortality were guyed.

NAB specifically stated that encouraging more towers of a shorter design is simply not feasible due to distance separation rules (FCC Parts 73.207 and 73.610), costs, and local jurisdictions. In addition, NAB speculated that installing a greater number of shorter towers (less than 200 feet tall) could actually contribute to increased mortality. No specific information was presented, however, to support this conclusion.

PCIA specifically referenced the Woodlot report in questioning USFWS' guidelines on lighting of towers <199 feet. As discussed in Section 3.3.1.3, PCIA conducted a survey of their members, which included information on bird collision mortality and its relationship to tower type along with other factors. PCIA indicated that two respondents stated certain tower types (monopoles or lattice) are more likely to be struck by birds. The respondents were split over whether birds are more likely to collide with guyed or self-supporting towers. No information is provided on the number of towers these data represent.

The American Bird Conservancy, Forest Conservation Council, and Friends of the Earth raised the issue of tower configuration but drew no conclusions. They cited one study in which bird mortality was observed at a 100-foot tower located on 2,600-foot ridge.

According to the USFWS, because so few studies have been conducted at both short and tall towers, it is premature to debate the impact and mortality caused by communication towers on birds until systematic research is conducted nationwide. There are no methodical studies analyzing the role of tower height and there is no established threshold effect reported in the literature. While short (<200 feet above ground level), unguyed, and unlit towers may be the least problematic, the USFWS further states that no systematic research has been conducted on impacts of short towers on birds. As discussed in Section 3.4.3, the U.S. Forest Service and WEST (2004) began a 3-year study April 2004 on six cell phone towers (less than 200 feet in height) on the Coconino and Prescott National Forests in Arizona to assess bird mortality for short towers in the western U.S.

Cingular Wireless and SBC Communications stated without documentation that the vast majority of cellular and PCS towers pose no danger to migratory birds because they are <200 feet in height, further stating available research fails to demonstrate significant risk. The authors indicated that there is no support for a 199-foot limit on tower height in the scientific literature and that based on the limited information available, it does not appear that migratory bird mortality would justify restrictions on towers < 400 feet tall. They also noted that the USFWS' guidelines recommending collocation of towers and tower height limitation to less than 200 feet may be unattainable in certain areas; stating that it is difficult to collocate multiple carriers while minimizing tower height. Finally, they stated that keeping towers less than 200 feet will likely require a greater number of towers, which is in opposition to USFWS' Guideline 10, which recommends minimizing the number of towers.

Cingular Wireless and SBC Communications reported tower height, rather than the type of antenna structure, seems to be implicated in migratory bird strikes, although no supporting information was provided. Additionally, it is unknown why 400 feet was selected as the tower height threshold by Cingular Wireless and SBC Communications in this discussion, unless it was in response to Kemper (1996) projecting a critical threshold of around 400 feet for tower height.

3.3.5 Tower Siting

3.3.5.1 Current State of Knowledge – General

Most researchers agree that tower siting can be key in minimizing the risk of future bird collisions with the tower and its ancillary facilities. Relative collision risk can be attributed to a number of variables, such as topography, land features, elevation, habitats, urban and suburban interface, degree of existing development, and climatic conditions (localized and regional). As discussed in Section 3.1, the USFWS has developed voluntary siting guidelines for communication towers. These guidelines incorporate siting variables with tower configuration options to provide direction, based on existing knowledge and developed theories regarding bird collisions with communication towers.

3.3.5.2 Discussion of Specific Studies

No studies specifically examining tower siting and associated variables or comparing tower site features were found as part of this review. Siting criteria are mentioned in tower studies in combination with other factors, such as tower lighting and height. Tower siting is important in some areas to reduce the collision risk to birds, although insufficient information is available to draw conclusions as to the specific importance of these factors.

3.3.5.3 NOI Questions

The following discussion is associated with the request by FCC in its NOI to provide specific information regarding the quantity and quality of existing data documenting the effect of communication tower siting on migratory bird collisions.

- *23. We seek comment on research or other data relating to any other matters within the scope of this inquiry.*
- *Do towers on ridges, mountains, or other high ground have a differential impact on migratory bird populations and, if so, are there scientifically rigorous studies that address such effects and their causes?*

- *We seek comment on the impact on migratory birds, if any, of locating towers in areas with a high incidence of fog, low clouds, or similar obscuration, in proximity to coastlines and major bird movement corridors, or either clustered near or dispersed from other towers. Comments on the role of any of these factors should consider the extent of any such impact during migration seasons.*
- *We also seek comment on any other factors that may influence the impact of communications towers on migratory birds.*
- *24. Consistent with that commitment, we specifically seek comments from the Tribes and other parties on whether any of the questions raised in this inquiry will significantly impact Tribal governments, their land, and resources.*

3.3.5.4 General Responses and Summaries

The effect of the siting of communication towers was not explicitly addressed by the respondents but was frequently referenced in the discussions of location towers in migration flyways and proximity to certain specific habitats. The respondents did not address differential mortality associated with tower siting, including topographical features, regional weather patterns, land ownership, or land use.

No specific studies on communication tower siting were cited by the respondents. As stated above, siting criteria are mentioned in tower studies in combination with other factors, such as tower lighting and height, which are addressed specifically for those study aspects. Tower siting is important in some areas to reduce the collision risk to birds, although insufficient information is available to draw conclusions as to the specific factors associated with siting towers.

3.3.5.5 Specific Respondent Comments

NAB stated that the USFWS' (2000) voluntary guidelines recommending against siting towers in areas that historically exhibit conditions with storm events or frontal systems, especially during spring and fall migrations, is unworkable because this suggested criteria could characterize a vast majority of territory. No specific information was provided.

The USFWS observed that because of their extensive use by avian populations, wetlands are some of the least desirable locations to site towers; however, they stated that information is still needed to support a minimum distance from wetlands to construct

towers. The agency indicated that ongoing studies on Michigan State Police towers (see Section 3.4.1), as well as U.S. Coast Guard's (USCG) proposed "Rescue 21" project (see Section 3.4.6) next to the Great Lakes and along the U.S. coastline hopefully will provide the additional information needed to support guidance on where to site towers in, around, or near water or wetlands. They also acknowledged that impacts from communication towers situated on ridges, mountains, and other high ground are not well known. The USFWS stated that studies on cell towers in the National Forests in Arizona (see Section 3.4.3) also should begin to provide some useful data regarding this issue.

3.3.6 Tower Lighting

3.3.6.1 Current State of Knowledge – General

For aviation safety, tower lighting is required for towers exceeding 199 feet in height. Lighting specified by the FAA has traditionally included steady red lights, pulsating/flashing red lights, and/or white strobe lights. Historically, both lights and radio signals were implicated as potential factors for disorienting birds and thus contributing to the increased mortality rates reported for communication tower sites. However, the behavioral effects of radio signals on birds are poorly understood and are not usually identified as the major cause of tower kills. Limited studies suggest that bird behavior around communication towers is similar whether or not the tower is transmitting.

More compelling is the growing body of evidence that birds may be attracted to tower lights, and certain colors and flash patterns may have disorienting effects, especially during inclement weather conditions where the tower illumination bounces and refracts off a myriad of water droplets suspended in the air to create an aura of light and a greater illuminated space around the tower (Avery et al. 1976). Historically, birds have appeared to be "attracted" to artificial light sources from lighthouses and buildings (Ogden 1996). However, it is unclear whether birds are actually attracted to a light source and move toward it or whether the birds are "trapped" by the light during their nocturnal flights (Ogden 1996).

One prominent theory of the incidence of bird collisions with communication towers is that as birds enter this lighted area during foggy or inclement weather, they become disoriented, lose or change some of their nocturnal navigational cues, and are reluctant to leave the lighted sphere (Avery et al. 1976). As the birds begin to circle or flutter in the lighted space, individuals begin to strike guy wires, the tower, or each other often resulting in direct mortalities or crippling effects. Others fall to the ground exhausted. However, records of nocturnally migrating birds becoming confused by artificial lights also have been recorded during clear, calm nights (Ogden 1996).

Two aspects of tower lighting have been identified as possibly attracting birds and include color (white lights, ultraviolet, or specific wavelengths) and the light duration (strobes, flashing, or steady). Unfortunately, of the approximate 10,000 species of birds, we know the photo or visual pigments for only 11 of those species. Of those 11 species, only two are nocturnal migrants in the Western Hemisphere (Beason 2000). Although some studies and several anecdotal reports suggest that white strobe lights may be less attractive to birds, this has not been proven to date. To complicate policy implementation and local planning, white strobe lighting often is not favored by residents located within sight of the tower; therefore, this becomes an aesthetic issue as well.

3.3.6.2 Discussion of Specific Studies

One of the more dramatic examples of apparent light attraction by migrating birds was exhibited during the period of October 5-8, 1954, where 25 reported bird kills (over 100,000 total mortalities) occurred at airport ceilometers (devices used to measure the height of cloud cover), communication towers, and tall buildings from New York to the South Atlantic states following an advancing cold front (Johnston and Haines 1957). Of these 25 reports, an estimated 50,000 birds (53 species) were killed at one location in one night (October 7-8) at Warner Robins Air Force Base near Macon, Georgia. Birds were observed flying vertically down into the ceilometer beam, colliding with the ground. Of the other 24 incidents, 8 cases involved birds colliding with communication towers from 200 to 1,062 feet tall.

Avery et al. (1976) observed a 1,200-foot communication tower in North Dakota on overcast nights during the migratory periods. They found that the number of migrant birds observed directly at the tower was "significantly greater" than the number recorded 1,000 feet northeast of the tower at a control site. This study further suggests that migrants may not be attracted specifically to lit structures themselves on overcast nights simply because celestial navigational cues are not available, but rather because of the refraction of the light in the dense moisture droplets, which greatly increases the sphere of illumination around the tower. Birds that pass nearby the tower enter the illuminated area and are reluctant to leave. As they fly back toward the tower into the illuminated zone, it is more likely that individuals may strike the tower, guy wires, each other, resulting in mortalities or crippling effects.

As stated in Section 3.3.3.2, Gauthreaux and Belser (2000) recorded flight behavior of nocturnal migrants in proximity to different types of tower lighting during spring and fall migration in 1999 to better understand why birds appear to be attracted to lights and to determine the relative influences of different lighting regimes on migratory birds. During spring migration, they monitored migrant flight behavior, using an image intensifier, during nine evenings near a white strobe light FM broadcasting tower and over a control area. During the fall migration, Gauthreaux and Belser monitored migrant flight behavior on 14 evenings near a television tower with red lights, near a television tower with white strobe lights, and over a control area with no tower. They coded the flight behavior of the migrating birds into two categories: 1) linear flight (i.e., straight) and nonlinear flight (i.e., pause-hover, curved, or circling).

These unpublished results available in a report abstract compare the number of birds exhibiting nonlinear flight among sites and the total number of birds among sites:

- During the spring surveys, the number of birds exhibiting nonlinear flight near the tower with white strobe lights was significantly greater than at the control site, but the number of birds recorded at each site was not significantly different.

- During the fall surveys, the number of birds exhibiting nonlinear flight near the tower with red lighting was "significantly greater" than those flying near the tower with white strobe lighting. Similarly, the number of birds recorded in nonlinear flight near the tower with white strobes was "significantly greater" than the number of birds recorded flying over the control site.

- Parallel to the flight behavior observations, the number of birds recorded flying near the tower with the red lights was "significantly greater" than those recorded flying near the tower with the white strobes and over the control site. Interestingly, the number of birds detected flying near the tower with the white strobe lights did not "differ significantly" from the number observed over the control site.

Gauthreaux and Belser (2000) further suggest that the greater number of birds recorded for the tower with red lighting is likely the result of the "attraction" to constantly illuminated red lights on the tower and the proportion of the birds exhibiting nonlinear flight behavior (i.e., the individual birds pausing, hovering, or circling the tower) spending more time at the tower site than those in linear flight. Although these study results have not been published to date and the study has not been duplicated, the results provide evidence to suggest migrant attraction to red lights over the white strobes.

Another phenomenon reported at lighted towers relative to migrant bird behavior involves the species' individual flight calls. Migratory bird calls given while circling a lighted tower during low visibility and inclement weather have been acoustically recorded at tower sites (Evans 2000). Two representative studies temporarily extinguished the lights at two tower sites. Upon turning the lights off, the migrant calls then ceased and the birds left the circle of light (Avery et al. 1976; Cochran and Graber 1958). Cochran and Graber (1958) specifically reported that immediately after the tower lights were extinguished, the birds began to leave the tower vicinity, based on the diminishing volume of call notes and in less than 2 minutes all of the birds were out of hearing. After turning the tower lights back on, the first auditory calls from birds could

be heard within 1 to 2 minutes, with the number of call notes increasing considerably thereafter.

Historically, observations have documented that birds appear to be "attracted" to certain light sources under certain environmental conditions. However, no clear conclusions can be drawn, based on the existing literature, regarding the importance and effects of lighting color, duration, intensity, and type (e.g., incandescent, strobe, neon, or laser) and bird attraction. Additional research is needed on the types of lights in conjunction with other factors that increase or decrease the risk of bird collisions with communication towers.

3.3.6.3 NOI Questions

The following subsections are associated with the request by FCC in its NOI to provide specific information regarding the quantity and quality of existing data documenting the effect of communication tower lighting on migratory bird collisions.

- *18. We seek comment on whether and why lighted towers attract birds, and whether different lighting systems increase the potential for migratory bird collisions with communications towers.*
- *We seek information on whether studies document any difference in risk posed by lighting systems that use lights of different color or different rates of flash, pulse, or strobe (including red or white strobe).*
- *Comments also should address the effects of lighting color, duration, intensity, and type (e.g., incandescent, strobed, neon, or laser) on bird attraction, especially at night during inclement weather and during spring and fall migrations.*
- *In addition, we ask that respondents take into consideration, where appropriate, the impact of different tower lighting systems on human communities. Further, are particular lighting systems or colors more or less attractive to migratory birds based on differing tower heights?*
- *We also ask that respondents recommend specific lighting systems to minimize migratory bird collisions with towers, to the extent supported by scientific findings.*

3.3.6.4 General Responses and Summaries

Comments were received on the varied risks posed by different lighting systems. Credible studies were cited on avian attraction to lights. Hovering and circling behavior has been observed near tower lights. Radar studies have shown that birds will circle towers on overcast nights. It also has been documented that the frequency of call notes decreases when tower lights are turned off on nights with low cloud ceilings. It can be concluded from the respondents' comments that certain types of lights appear to attract birds more than other types of lights, but there still is debate. No firm conclusions could be drawn based on the existing literature regarding the importance and effects of lighting color, duration, intensity, and type (e.g., incandescent, strobe, neon, or laser) on bird attraction, although as discussed earlier in this section, inferences can be drawn on different lighting regimes. Additional research is needed on the types of lights in conjunction with other factors that increase or decrease the risk of bird collisions with communication towers.

3.3.6.5 Specific Respondent Comments

No recent research or data were provided by the respondents.

NAB stated that because the lighting effects of towers on avian attraction are not well known, it may be later determined that more species are attracted to the lighting configurations set forth in the USFWS' interim guidelines than are attracted to currently set lighting configurations. The USFWS guidelines recommend using only white (preferable) or red strobe lights with the minimum number, minimum intensity, and minimum number of flashes per minute (longest duration between flashes) allowable by the FAA. The use of solid red or pulsating red warning lights at night should be avoided. These guidelines are available at:

http://migratorybirds.fws.gov/issues/towers/comtow.html

Woodlot outlined scientific studies that infer that lights attract birds and that resulting mortality may be related to certain types of weather events. They further stated that

insufficient published information exists on different lighting regimes to draw comparisons or clear conclusions.

PCIA referenced its member survey report (not provided) and the Woodlot report. Specifically, PCIA's member survey requested information on bird collision mortality and its relationship to lighting along with other factors. The reported 74% response rate is based upon receiving responses from an unspecified number of representatives owning or managing 37,000 towers. Only one survey response indicated a correlation between lighting and bird collisions. The number of survey respondents and the type of lighting were not provided. Also the number of towers represented in this single response is unknown. Interpreting the survey results is problematic without more information or a compilation of the survey data.

The American Bird Conservancy, Forest Conservation Council, and Friends of the Earth discussed the issue of lighting and bird mortality and drew conclusions based on cited studies that "lights on towers (especially solid red lights) disrupt neotropical migratory birds' celestial navigation system and perhaps the magnetic navigation system" resulting in disorientation and increasing the risk of collisions with the towers or their support structures.

The USFWS cited scientific literature that infers that bird collisions and consequent mortality may result from the combination of a lighting system in association with poor weather conditions. The USFWS further acknowledged that current lighting recommendations in their voluntary interim guidelines (USFWS 2000) are based on limited research. There is presently only a single study demonstrating a greater proportion of bird attraction to red flashing incandescent lights than to white strobes (Gauthreaux and Belser 2000). In this study, white strobe lights attracted birds as compared to unlit control sites that attracted none. Although there is strong evidence to support light as an attractant during inclement weather, there is still much speculation regarding light type, color, intensity, and duration. This is universally acknowledged as being a key research need. The impact of different lighting schemes on migratory birds is

presently being investigated and preliminary results are expected after the 2005 fall migration season.

Cingular Wireless and SBC Communications iterated that an optimum balance must be sought between aircraft safety and avian mortality. In reference to this statement, however, the USFWS' comment letter clearly states they have no intention of requesting modifications that would negatively impact air safety. Cingular Wireless and SBC Communications also challenge the USFWS' voluntary guidelines that recommend white lights, citing an unpublished work by L.K. Raynor, et al. in which white-throated sparrows were shown to be attracted to white lights. These contradictory findings further support the need for additional information on avian vision because certain species may be more affected by certain spectral bands than others.

3.3.7 Weather

3.3.7.1 Current State of Knowledge – General

Stoddard (1962) states that furthering our knowledge of nocturnal bird migration is intricately connected with the study of weather factors and how they relate to migratory movements. The majority of tower studies and incidental mortality observations report the greater the frequency of inclement weather events at a tower site during bird migration the greater the likelihood of increased avian collisions and associated mortalities. Most researchers and tower operators agree that most bird mortalities have occurred during or after weather events, including precipitation, increased frontal system winds (particularly tail-winds), low cloud ceilings and visibility, and foggy conditions. However, the degree of association between climatic factors and bird kills is not completely known or understood.

3.3.7.2 Discussion of Specific Studies

The correlation between bird kills and advancing cold fronts with lower cloud ceilings, increased winds, and lower visibility appears to be strong, particularly during autumn (Avery et al. 1977; Brewer and Ellis (1958); Eaton 1967; Kemper 1996; Mollhoff 1983; Nicholson 1984; Norwoods 1960). Some of the larger bird kills recorded at tower sites

have occurred as the birds move into weather frontal systems from an area that was clear upon leaving that night or as weather systems overtake birds already migrating, forcing the birds to lower altitudes (Kemper 1996; Stoddard 1962; Welles 1978). Tail winds also are a factor for increasing the avian collision risk with communication towers (Kemper 1996), even on clear nights (Stoddard 1962).

An example of how changing weather patterns may affect the rate of bird collisions with communication towers includes an observation by Kemper (1996). During an overcast night at the Wisconsin tower site, birds were recorded falling steadily at a rate of two to three birds per minute at a lighted structure. When the overcast conditions broke and the sky became clear, the collisions ceased (Kemper 1996).

Both Kemper (1996) and Stoddard (1962) state that it is typically clear weather when migrants begin their nightly movement. As weather fronts move in or visibility decreases with reduced cloud ceilings or increased precipitation or fog, migrating birds are forced down in altitude, increasing the collision risk with tall man-made structures. Stoddard (1962) observed that families, such as warblers, vireos, and thrushes do not migrate on nights with heavy precipitation in the early evening hours, particularly during fall migration. However, finches (Fringillidae) were found to initiate migration despite early evening precipitation. Therefore, on nights where clear, dry conditions existed early in the evening followed by later storm events, warblers, vireos, and thrushes typically comprised approximately 75% of the mortalities recorded at the Tall Timbers Research Station tower site. However, on those nights when rainfall occurred early in the evening, mortality was dominated by finches and waterbird species (Stoddard, 1962).

Vocalizations by nocturnal migrants near towers have provided researchers additional information on the duration of a species' presence, flight behavior, composition, and relative bird density (Kale et al. 1969). Surveyors using acoustic monitoring have observed that rapid weather changes from overcast to clear conditions have resulted in the cessation of bird collisions (Kemper 1996; Avery et al. 1976). This phenomenon parallels the behavior reported in Section 3.3.6 where migratory birds calls given while circling a lighted tower during low visibility and inclement weather cease and the birds

leave the circle of light once the lights have been temporarily extinguished at the tower site (Avery et al. 1976; Cochran and Graber 1958).

The North Dakota tower study by Avery et al. (1976) examined nocturnal bird behavior and movements. Weather patterns appeared to influence the number and distribution of birds around the tower's lights. On overcast nights, "significantly greater" numbers of birds were documented at the tower than during clear nights, and many individual birds appeared to be disoriented during these inclement weather periods. This study also suggested that some birds may actively avoid towers on clear nights (Avery et al. 1976). However, another study completed by Avery et al. (1977) recorded incidents of bird mortalities during migration, particularly in the spring, when skies were clear. Although bird losses during the fall period were associated with overcast skies and advancing cold fronts, 58% of the mortalities recorded during the spring occurred on non-overcast skies typically with southeasterly (i.e., favorable) winds. Another interesting note recorded during these North Dakota studies was related to the location of the bird mortalities. The birds killed during fall migration were generally found close to the tower as birds continued to circle the tower and area of illumination. However, the spring mortalities were documented farther from the tower than those on overcast nights, as the birds were assumed to be colliding with the outlying guy wires and transmitting cables. The differences in mortality between overcast and clear nights within certain distances from the tower base were determined to be "statistically significant", indicating that the distance of bird losses from the tower was influenced by the cloud cover (Avery et al. 1976).

Crawford (1981) compared recorded bird mortalities at a Florida tower site to the moon phases. Verheijen (1981) initially hypothesized that bright moonlight mitigated the disorienting effects on birds from the artificial lights located on communication tower structures. Crawford (1981) tested this hypothesis, using a "fraction illuminated" lunar value compared with mortality records. Crawford found that although there was some evidence that the moon phase may indirectly influence the number of bird mortalities at tower sites, since the volume of migrating birds appeared to be less during a full moon,

there did not appear to be a direct association between the moon phase, tower lights, and bird orientation during migration. Crawford (1981) further states that weather at tower sites and the magnitude of migrating birds during a certain period are more significant factors for determining tower kills.

Based on these studies and incidental mortality reports comparing the number of bird kills to environmental conditions, most of the moderate to large bird kills at tower sites have occurred during or following a storm event or frontal system, particularly during the migration periods. Many of these studies suggest a direct correlation between bird collision risk and weather events. However, the extent or degree of this association and how other factors may influence mortality rates are essentially unknown. Additional information is needed on weather patterns relative to bird movement and other conditions that may contribute to increasing or decreasing risk of bird collisions.

3.3.7.3 NOI Questions

The NOI did not specifically request comments on the effects of weather conditions on bird mortalities with communication towers. However, based on a review of the literature, there appears to be a correlation between certain weather conditions and avian collisions , and a few comments on this topic were received.

3.3.7.4 General Responses and Summaries

There is general consensus that most collision events, particularly during the fall period, occur in tandem with a weather system or inclement weather, including overcast, foggy, or low cloud ceiling conditions. Respondents also recognized that weather conditions resulting in poor visibility for birds increase collision risk. These conditions are especially important with increasing mortality around lighted towers.

As discussed previously in this section, there is general consensus that most of the moderate to large bird kills at tower sites have occurred during or following a storm event or frontal system, particularly during the migration periods. Many of the studies cited suggest a correlation or an association between bird collision risk and weather events. However, the extent or degree of this association is unknown, and additional information

is needed on the weather conditions that may contribute to increasing or decreasing risk of bird collisions.

3.3.7.5 Specific Respondent Comments

As discussed in Section 3.3.5.5, NAB commented that the USFWS (2000) voluntary guidelines recommending against siting towers in areas that historically exhibit conditions noted for severe storm events or frontal systems, especially during spring and fall migrations, is unworkable because this suggested criterion characterizes a vast majority of territory.

Woodlot cited studies stating that although sampling designs have varied, weather conditions have been shown to influence mortality rates. PCIA's member survey included information on bird collision mortality and its relationship to weather. PCIA stated the survey results indicate that isolated collision incidents usually occurred after inclement weather. However, no information was provided on either the number of respondents or the number of towers these data represent.

USFWS documented that weather factors are involved with some mortality events especially those associated with lighted towers.

NATE acknowledged they have not undertaken any scientific studies relative to birds and communication towers, but they asserted a great deal of reports from their members suggest that only in the most severe wind conditions have they ever found significant numbers of dead birds at or near the bases of telecommunications towers. It is not clear how these conclusions were derived or the extent of these storm events. No study designs or statistical review were presented.

3.3.8 Need For and Scope of Additional Studies

3.3.8.1 NOI Questions

- *25. In the event that parties believe that existing research is insufficient to permit the Commission to address fully the issue of migratory bird collisions with towers, we seek comment on what additional study or studies may be needed.*

- *We also seek comment on what types of procedures should be used to monitor birds that may be killed at communications towers during these studies.*
- *In addition, we request comment on whether studies can be structured specifically to research potential methods of reducing the potential for migratory bird collisions with towers.*
- *We seek comment on the factors that would impact the length of any study, including the number of towers that would be the subject of the research, and the particular testing procedures that would be used.*
- *We also seek comment on whether pilot studies followed by one or more larger studies are necessary, or whether one or more smaller studies could yield sufficient information, on which the Commission could base future actions respecting migratory bird issues.*
- *27. We also seek comment on the appropriate party or parties to design and conduct a study.*
- *We also seek comment on any ongoing or planned studies with which the Commission might coordinate in order to achieve synergies and avoid duplication of effort.*
- *28. Comments should address both the estimated cost of any studies and potential sources of funding.*
- *29. We seek comment on whether existing studies or research address the use of particular methods to minimize any impact of communications towers on migratory birds.*
- *31. We request comment on the scientific basis for these guidelines (i.e., USFWS Tower Siting Guidelines), the general use of the guidelines and the use of each of the specific guidelines, and any other potential measures to minimize impacts on migratory birds within the scope of our current rules.*
- *Further, does current scientific evidence support a finding that particular towers do not significantly pose a threat to migratory birds?*

3.3.8.2 General Responses and Summaries

NOI respondents who commented on the adequacy of the existing research generally agreed that for many specific issues (e.g., tower lighting, tower configuration, tower siting) the existing research is insufficient or inadequate. Based on the respondents'

comments, more information is needed to determine the importance of different factors on bird mortality before specific mitigative measures can be identified. Several respondents (see Sections 3.3.4.5 and 3.3.5.5) questioned the application of the USFWS' 2000 *Interim Guideline for Recommendations on Communication Tower Siting, Construction, Operations and Decommissioning* based on the limitations of the existing studies.

Section 4.1, *Going Forward and Data Needs,* discusses the identified data gaps relative to bird collision with communication towers and suggests recommended approaches to begin to answer some of these outstanding questions. These recommendations are based on previous study results, incidental mortality reporting at tower sites, researchers' input, and industry feedback

No new studies or recommended study designs were identified by the respondents. There was general agreement among the respondents for standardized mortality survey methods including adjusting for scavenger removal rates and observer bias.

3.3.8.3 Specific Respondent Comments

CITA, PCIA, and NAB provided comments that recognize scavenging as factors affecting mortality results. Woodlot discussed that duration, sampling frequency, and survey efforts vary between studies and, therefore, limit conclusions, except possibly, for the influence of inclement weather on fall migrants.

The USFWS provided comments on the need for standardized mortality sampling protocols including estimating and adjusting for scavenger removal rates and searcher bias. They referenced a recent recommended protocol for wind turbines (Anderson et al. 1999) that could be followed for mortality monitoring. The USFWS further suggested additional studies that are warranted, including a 3-year, 250-tower comparative study and monitoring program. For individual tower mortality monitoring, they recommended monitoring throughout the fall and spring migration periods. The USFSW acknowledged that a nationwide study is likely not feasible. The agency recommended utilizing information for several referenced pilot studies in Michigan, Arizona, and the Midwest to