

KENNEDY SPACE CENTER (KSC) LAUNCH PAD AVIAN ABATEMENT EFFORTS INCLUDING RELATED KSC ROAD KILL REDUCTION EFFORT

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ABSTRACT

While birds might seem harmless, there's a good reason for the concern. During the July 2005 launch of Discovery on mission STS-114, a vulture soaring around the launch pad impacted the shuttle's external tank just after liftoff. With a vulture's average weight ranging from 3 to 5 pounds, a strike at a critical point on the Shuttle -- like the nose or wing leading thermal protection panels -- could cause catastrophic damage to the vehicle. The foam chunk that fatefully struck Columbia's wing in 2003 weighed only 1.7 pounds. (Cheryl L. Mansfield "Bye Bye Birdies" 2006) To address this issue, NASA formed an "Avian Abatement Team". The team goal is to have safer Shuttle missions by reducing the vulture population at KSC near the pad area thereby reducing the probability of another vulture strike during a Shuttle launch. (Linda Herridge "It's a Jungle Out There" 2006, Photo Courtesy of NASA)



One key strategy is to monitor and understand bird activity at KSC. Existing KSC bird monitoring programs were studied and enhanced by adding biologist bird observations near the launch pads. New radar and video imaging systems were added to electronically monitor and track birds at the pads. These new systems now help the KSC Shuttle launch director determine if it is safe to launch based on bird count and location.

Another key strategy is to reduce the bird population at the launch pads. New sound deterrent systems were evaluated and tested for potential installation at the pads to scare large flying birds away from the pads just before launch. Since it was a vulture that the shuttle struck back in 2005 and since the KSC vulture population is unusually high, a special emphasis was placed on reducing the KSC vulture population. A vulture trap and release program was tested, but results were inconclusive. Vulture experts considered this trapping to be potentially detrimental because the related baiting could attract even more vultures to KSC. NASA abandoned this part of the vulture reduction effort. Other efforts like the use of effigies and chemical repellants also failed. The team consulted with experts at Walt Disney World and the Avon Park Air Force Range, and focused on why the vulture population was so high at KSC in the first place. The answer appears to be an excess road kill food supply.

KSC is overlaid with 140,000 acres of the Merritt Island National Wildlife Refuge. This is a good arrangement because both organizations need a lot of remote land. However, this land overlay has significantly contributed to refuge loss of wildlife. Vehicle collisions are the number one killer of Florida's wildlife and over 12,000 KSC employees must drive through the wildlife refuge to get to work. In the summer of 2006, KSC found that this generates an incredible amount of road kill and excess vulture food supply averaging over 100 dead animals at over 1000 pounds every month. KSC began an effort to prevent and quickly remove road kill. Through attrition, KSC plans to bring their vulture population back to normal levels. KSC began educating their workforce about this problem via e-mails, bulletins, posters, stickers, call-in badge cards, educational/entertaining videos, meetings, road signs, educational outreaches, and a central web site (<http://environmental.ksc.nasa.gov/projects/roadkill.htm>). The workforce appears to be responding strongly because KSC road kill numbers declined sharply in July, but other unknown environmental factors may be contributing. The workforce is also calling in road kill for rapid pickup. For the remainder of the Shuttle Program, a KSC contractor picks up road kill within 2 hours of each call-in during first shift five days a week. The contractor also patrols the roads and picks up road kill for 2 hours every morning independent of call-ins. The contractor marks each road kill with GPS for future analysis and potential roadway wildlife mitigations like dry culverts, wildlife over passes, fencing, or wildlife crossing sign positioning. Wildlife crossing signs have already been specially designed and in April 2007 were strategically placed based on KSC road kill "hot spot" GPS data.

Road kill is something that the Refuge has wanted to reduce for over 40 years. NASA is now clearly on board to help achieve that goal, but NASA ultimately cares about avoiding future Shuttle bird strikes. It will be hard to measure vulture reduction at KSC and overall bird reduction at the pads. However, we have very positive early anecdotal results. Some employees have reported seeing fewer vultures at KSC and seeing more vultures in their neighborhoods. Employees that clean bird mess off the launch pads report it takes them 75% less time to clean the mess, indicating there are likely fewer birds at the pads. The Shuttle has not hit any birds

during subsequent launches. The avian abatement team effort appears to be making some long lasting differences toward both Merritt Island National Wildlife Refuge mission success and NASA mission success, but only time will tell.

AUTHOR & PROJECT BACKGROUND

I have always had a strong passion for nature and the great outdoors, so during my 20 years with NASA at the Kennedy Space Center (KSC) I have always enjoyed and been keenly aware of the KSC overlay of land with the Merritt Island National Wildlife Refuge (MINWR). Every morning as part of my daily commute to work, my favorite part is the drive across the Banana River from Cape Canaveral Air Force Station to the Kennedy Space Center. This is also one of the four entrances to the MINWR where our work force gets a daily spectacular view of the launch pads, Vehicle Assembly Building (VAB) with it's large American Flag and NASA emblem painted on its side, and all of our abundant wildlife like alligators, manatees, dolphin, otter, fish, ducks, ospreys, hawks, bald eagles, wild hogs, and deer on both sides of the NASA Parkway as far as the eye can see. As part of the NASA Leadership Development Program (LDP) Class of 2005/2006, I had the unique opportunity, as a NASA engineer and project manager, to work outside of my own agency in a completely different field. Understandably, I was ecstatic when Mr. Ron Hight, Refuge Manager of the US Fish & Wildlife Service (US FWS) Merritt Island National Wildlife Refuge (MINWR), agreed to take me under his wing in partnership with the NASA LDP Program. I was finally on the other side of the fence, so to speak, in the long standing NASA/US FWS MINWR partnership. My diverse assignment was to be the US-FWS representative to NASA for the STS-121 "Avian Abatement Team" which sought to reduce the probability of another Shuttle vulture strike which had occurred on the previous STS-114 Shuttle mission.

AVIAN ABATEMENT TEAM & RELATED TASKS

Our multi-agency/multi-company team was led by Steve Payne, a NASA test director in the Shuttle Processing directorate. Concerning our team, Steve has been quoted in NASA articles as saying "We don't want the vehicle to get damaged in any way and while this program does have some 'chuckle factor' to it, we do take it seriously." Our team included Space Gateway Support, Yang Enterprises, InDyne Inc., United Space Alliance, ASRC Aerospace, Dynamac Corp., and the U.S. Fish and Wildlife Service. Even a veterinary pathologist, Dr. Scott Terrell, from Disney's Animal Kingdom in Florida, which has a bird control program, was invited to the center to share wildlife management expertise. Air Force Avon Park experts were also consulted on how they moved vulture roosts. This team assessed, developed, and implemented new radar systems that can now track birds at the pad, new software for bird tracking based on camera images from remote cameras that have been placed around the launch pads to track the vultures, and new non-lethal sound systems that scare flying birds away just before launch. Our team also tested a new effigy program, chemical deterrent program, and new vulture trap and release program all of which were eventually found to be ineffective and were abandoned. Many people have asked us why we just don't shoot the vultures near the pad. Well first of all shooting vultures close to launch time would not be a good idea because of all of the explosive propellants in the area at that time. But ultimately, vultures are protected under the Migratory Bird Treaty Act. It is illegal to harass, or in any way harm vultures without a permit from the Fish and

Wildlife Conservation Commission. For this reason, only non-lethal deterrents were attempted. Several failed, some are in use, but their effectiveness is still under evaluation. As a side note for those who would argue to kill all the vultures, we must remember that vultures are a critical part of our environment. Robert Koenig wrote a very interesting and alarming article for Science Magazine where he describes “a catastrophic die-off of vultures in South Asia and recent sharp declines in some populations in Africa which have focused research on this often reviled but majestic bird”. He also describes what continents around the globe like Europe are doing to save certain species of these critical birds “by establishing sanctuaries, ‘vulture restaurants’, and monitoring campaigns”. (Koenig, Robert “ORNITHOLOGY: Vulture Research Soars as the Scavengers' Numbers Decline” 2006)

Monitoring and Understanding KSC Bird Activity

After forming our team, an important first step was to monitor and understand the bird activity at KSC. Existing KSC bird monitoring programs were studied and enhanced by adding biologist bird observations near the launch pads. New radar systems were added to electronically monitor and track birds at the pads. These new radar systems now help the KSC Shuttle launch director determine if it is safe to launch based on bird count and location.

Detecting Birds Using New Radar Capability

By far the best final line of defense is bird detection radar, already proven effective for aviation, where the threats posed by bird strikes have long been a problem.

The image at the right is the avian radar in position at Launch Complex 39. It offers the ability to monitor either of the two shuttle launch pads during a countdown.

Technicians adjust the system's two customized marine radars that provide both horizontal and vertical scanning. (Photo Courtesy of NASA of test unit used during STS-121 and STS-115, permanent unit is larger and was used for STS-116)

The vultures are more active during the day as they search for food and circle high into the bright blue Florida sky, soaring on the thermal gradients. To mitigate the danger, an avian radar system known as "Aircraft Birdstrike Avoidance Radar" is in position to track their movement around the launch area and relay the data to launch control experts. The system was developed by a company called DeTect of Panama City, Fla., which



primarily has served the commercial aviation industry and the military.

The image at the right was taken inside the Launch Control Center at the Kennedy Space Center. Data relayed from the avian radar aided by camera images will help controllers recognize when any large birds are in dangerously close proximity to the vehicle and hold the countdown when necessary. (Photo Courtesy of NASA, The left laptop shows the tracking camera display and the right laptop is for the horizontal radar display)

The goal is to provide the launch team with real-time detection for on-the-spot launch decisions up to one minute before liftoff. To do that, the system uses two customized marine radars -- one for horizontal scanning and one for vertical scanning. While vultures have been identified as the main threat, the radar system has enough power to detect even small birds.

After 3 separate standalone tests, the STS-121, STS-115, and STS-116 missions provided the first successful uses for the technology during actual shuttle launches. The unit's location will allow it to monitor either of the launch pads at Launch Complex 39 during future space shuttle launches, providing a new margin of safety for astronaut crews. (Cheryl L. Mansfield "Bye Bye Birdies" 2006)

Detecting and Tracking Birds Using New Video Imaging Software Capability

Using existing video cameras at the pad, a novel system was developed that captures video, processes the images, identifies birds, combines together the data from all video sources, and presents the 3D positions of the birds in real time to allow birds to be monitored and tracked within the pad perimeter. This system is complementary to the new radar system described above. Using cameras, the new software can distinguish pad structure from moving objects like large birds. The new system is able to provide azimuth, elevation, distance, and direction in real time. The resultant trajectory data are presented in a variety of formats, including a 2D overhead view (similar to radar) and 3D view with pan and zoom capabilities similar in style to that of Google Earth. The system has capability to record the time-tagged 3D positions of birds for subsequent analysis or playback. The system can easily be scaled up by including additional camera views. This project development was led for our team by John Lane and Chris Immer who work for ASRC Aerospace, one of our on-site contractors.

Monitoring to Measure the Baseline Problem and to Measure the Effectiveness of our Mitigation Efforts

Rebecca Bolt, DYNAMAC Wildlife Ecologist, is leading our team effort to measure our vulture activity at our two shuttle launch pads. Her group counted vultures sitting and flying in the pad perimeter for approximately the past year. I asked her if we could make any conclusions yet on bird reduction at the pad, but as is often the case with animal activity, the jury is still out. It often takes years to find any conclusive results in wildlife activity. The data will continue to be collected and only time will tell.

Educational Awareness

I volunteered to lead our team's educational awareness effort to the KSC workforce and local visitors concerning the existence of the wildlife refuge overlay of land with KSC property, related road kill prevention, and road kill call-in to help reduce our excess vulture population and avoid another Shuttle bird strike. I collected and analyzed road kill data, designed and installed new strategically placed wildlife crossing signs, and designed and distributed road kill prevention & call-in stickers, posters, & badge cards. (See the NASA designed call-in poster/sticker image on the right and the raccoon road kill prevention poster/sticker image & call-in badge card design below)



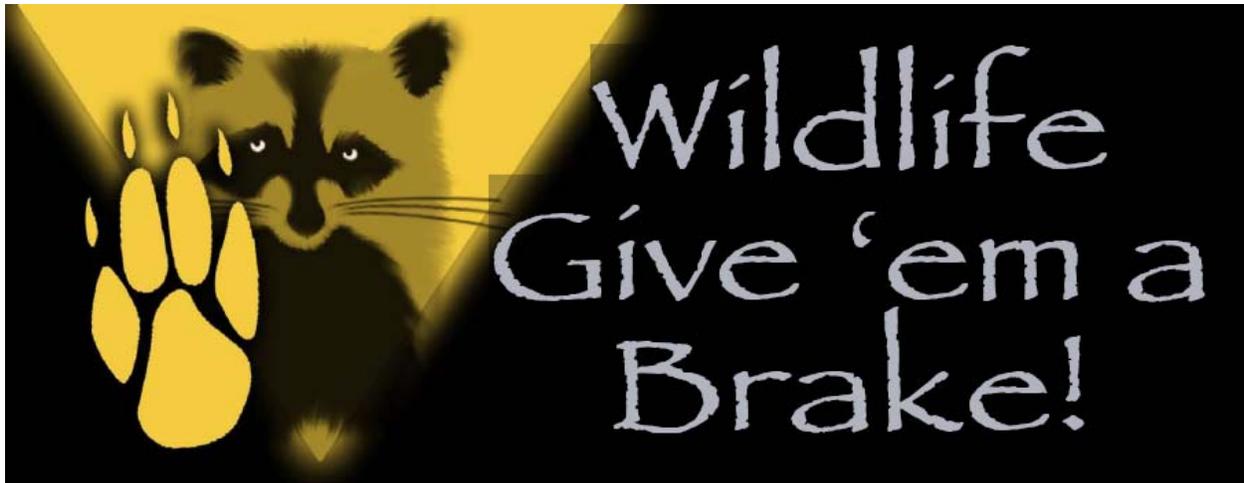
Get Your Leaders Trained Properly First!

Early in my assignment I received some critical training at the USFWS National Conservation Training Center in Shepherdstown West Virginia. It was a 3 day course entitled "Innovative Approaches to Wildlife/Highway Interactions" put on by Glenn Gravatt and instructed by Sandra Jacobson, Wildlife Biologist, and Terry Brennan, Forest Engineer. A valuable part of the training was having instructors simultaneously providing insights from both the biological sciences/human behavior and civil engineering perspectives along with having fellow classmates from all over the country providing their own positive and negative experiences. Some of this training was directly applied for our road kill monitoring and wildlife crossing efforts in the short term. Any potential long term mitigations like dry culverts, overpasses, or underpasses will require more data to ensure effectiveness and funding. Two very helpful websites provided during this training. The first website was the "Wildlife Crossings Toolkit" found at <http://www.wildlifecrossings.info/>. This site was designed for professional wildlife biologists and engineers faced with integrating our highway infrastructure and wildlife resources. The second website was the "Critter Crossings" website found at <http://www.fhwa.dot.gov/environment/wildlifecrossings/index.htm>. This site was built for anyone interested in protecting wildlife along highways and the habitats that sustain them. Another source of inspiration for me and the potential of our new effort was an article on the success Canada has had in some of their Road Kill reduction efforts as described by Lawrence Herzog in "Road kill: cars and animals don't mix" in Canadian Driver dated April 7, 2005. (Ref. <http://www.canadiandriver.com/articles/lh/roadkill.htm>)

Use of Humor, Shock, and a Tug at the Heart

It helps to have great creative people. Early in our educational awareness program, we asked Lynda Brammer, KSC Contractor from InDyne Inc., to help us design our related posters,

stickers, and call-in cards. In “Shuttle/Vulture” cartoon-like sticker/poster design above our team used humor to inspire our target audience to call in road kills at KSC for rapid pickup. In the “Raccoon” design to the right (Image provided by NASA), we tugged at the heart to inspire our drivers to be more careful not to “impact” our imperiled wildlife. In February 2007, our “Raccoon” design that declares "Wildlife Give 'em a brake!" won the local Gold ADDY® Award and is moving on to compete at the regional and National level. The ADDY® Awards are sponsored by the American Advertising Federation (AAF) and honor excellence in advertising and cultivate the highest creative standards in the industry.

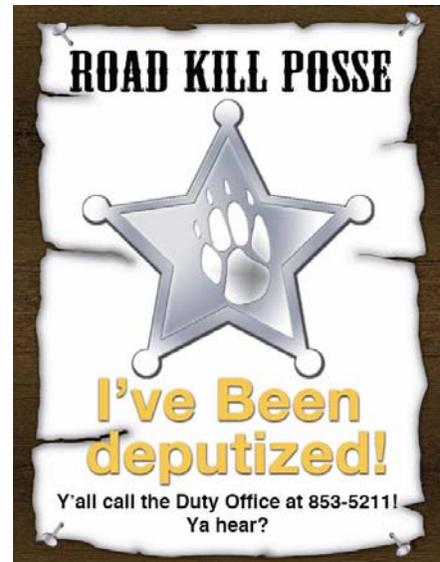


We used humor as our team became affectionately called “The Road Kill Posse” as we daily “Deputized” our workforce into action. When folks teased me about sending the road kill to the cafeteria, I just let them peruse my copy of “The Original Road Kill Cook Book” by D.R. “Buck” Peterson published in 1985 that I picked up during a hike on the Appalachian Trail. A link to a short French humorous video was shown to our workforce during our educational outreach activities. It shows an innovative way to help wildlife cross the highway and can be found at

<http://www.floridahabitat.org/wiki/pdf/transportation-infrastructure-and-wildlife-conservation/ecoalternatief.asf/view>.

The popular GEICO Squirrel commercial was also referenced and can be found at

<http://video.google.com/videoplay?docid=-149271128122026657>.



During my “Highway/Wildlife Interactions” training, our class viewed a video where an artist, fed up with excess road kill, used actual road kill to cast his artwork. Many visitors to his gallery were shocked. We also tried some shock tactics. I think many of us can become complacent about road kill and just accept it as a part of life in the modern world, but the cumulative effect can be staggering once measured and put out in the open. We sent e-mails and posted data in our main building lobbies and our web site concerning our cumulative road kill at KSC. We

sometimes averaged killing over 100 animals a month weighing over 1000 pounds. This information often shocked some of our target audience. Hopefully we shocked some of them out of complacency and into action such as responsible driving and recruitment of other drivers to do the same. Road kill will never be zero in our modern society, but it can certainly be reduced through educational awareness, change of driving habits, and changes in our roadways.

Multi-Media Approach

One key strategy that I learned during my “Wildlife/Highway Interactions” training was to create a consistent image and message and to promote it in many different ways. I created and presented a humorous educational multi-media slide show on the subject. I designed & led an educational interpretive 3 table display and brought it to all of the major KSC building lobbies via our “Road Show”. During our “Road Shows”, we distributed Merritt Island National wildlife refuge fliers found at <http://www.fws.gov/merrittisland/publications/mrtcon.pdf> . We distributed Refuge fliers & and displayed taxidermy animals like otters, alligators, and turtles. We provided information on the nearby overlaid US Park Service National Seashore and provided their web link found at <http://www.nps.gov/cana> . We displayed and discussed our road kill map & statistics (See Appendix A) and overlaid them on an area map using the GPS data. We also displayed and promoted our new wildlife crossing sign design and positioning. With the recruitment and help of fellow NASA employees and Merritt Island Wildlife Association volunteers like Ed Ronco, Al Brayton, and Jim Stahl, we talked to over 1000 people throughout the area on this important Shuttle safety issue and how we can improve safety by driving carefully to reduce road kill and to report any road kill that we see. These same volunteers also distributed our stickers at the MINWR Visitor Center so that the general public who had access to drive on the public portion of the Refuge and KSC would also be aware of and support our effort. With the help of our graphics department, we designed and distributed in total over 2000 of each sticker, over 2000 badge cards, and over 500 of each poster. Enlarged posters were created and displayed in the building lobbies. Our web site was visited over 5000 times. These visits are not entirely from within our gates. Our web site has generated e-mails and requests for stickers from several teachers in classrooms from around the country and even some international activity.

I wrote 2 local articles on the subject. The first article was for the KSC Spaceport News entitled “National Wildlife Refuge, KSC peacefully coexist and it can be found at http://www.nasa.gov/centers/kennedy/pdf/156371main_sep1color.pdf. The second article was for the “Habi-Chat” Newsletter of the Merritt Island Wildlife Association entitled “To Kill or Not to Kill, That is the Question” and it can be found at <http://www.nbbd.com/npr/miwa/Habi-Chat/06summer-habichat.pdf>. KSC also has a weekly bulletin and daily news e-mail that were used regularly to continue sending our message to our workforce drivers. There was also a related interview of my US FWS mentor, Marc Epstein, and myself conducted by Lyn Millner that aired for the National Public Radio program “Weekend America”. There were also several local news programs and related interview with our Team Members by local newscasters. Most of these are ways to “push out” information. In order to provide a means for our workforce drivers to “pull out” information, we also created a dedicated web site. A graphic of our web site can be found in Appendix B and at (<http://environmental.ksc.nasa.gov/projects/roadkill.htm>). At this web site be promoted our main message of “You’ve Been Deputized!” Visitors to this site

could view our video, go to related links, order stickers, posters, and badge cards, and study our latest road kill data & see our wildlife crossing sign design

Collecting Road Kill and Road Kill Data at KSC

All KSC and Cape Canaveral Air Force Station (CCAFS) road kills are now being picked up, double-bagged, disposed of, and the road kill site is logged in a database using Global Positioning System (GPS) information so that animal/driver interactions can be even better understood. These way even more effective mitigations can be implemented and measured over time. I came to learn about these latest tools and methods of map marking and overlaying GPS waypoints by working with the brave firefighters of the MINWR who use a similar system to track and more effectively fight fires.



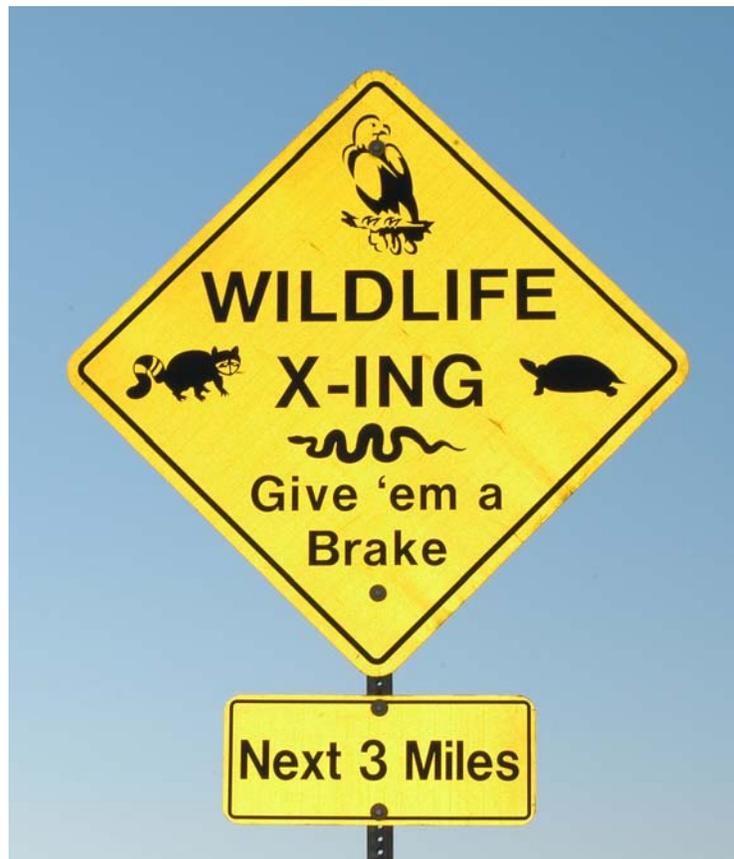
Since May 2006, the workforce has been calling in road kill for rapid pickup. For the remainder of the Shuttle Program, our KSC contractor now picks up road kill within 2 hours of each call-in, during first shift, five days a week. The contractor also patrols the roads and picks up road kill for 2 hours every morning independent of call-ins. The contractor marks each road kill with GPS for future analysis and potential roadway wildlife mitigations like dry culverts, wildlife over passes, fencing, or wildlife crossing sign positioning. Wildlife crossing signs have already been specially designed and will be strategically placed based on KSC road kill “hot spot” GPS data.

This portion of the effort is being led by Yang Enterprises entomologist Glenn Willis on KSC, Derick Fowler on Cape Canaveral Air Force Station, and Space Gateway Support Manager Brad Missimer. This portion of our team is affectionately called “The Road Kill Posse” and ideally includes every driver on the refuge as we encourage them to drive carefully to avoid road kill, but to call it in if they see any. A road kill reporting call-in number was put into effect and displayed at our KSC gate entrance marquees. One of our drivers even captured and distributed via e-mail a photo taken of several vultures sitting on our marquee sign, as if they were protesting our efforts to pick up their breakfast. This image is displayed on our web site. Business cards were also designed and handed out with our logo design and call in number. (See image to the right provided by NASA) In April 2007, we completed our 1st complete year of this program and the related data is summarized below. Upon sending me this latest report covering our first year, Glenn noted that “As you can tell from the data, (See Appendix A) we have picked up a substantial quantity of carrion during our first year and our success has benefited greatly from the daily calls by KSC drivers. We have calls every day that help us to pinpoint vulture activity and dead animals that could contribute to an increased vulture population. Callers have really helped us locate and prioritize high profile incidents before vultures have an opportunity to locate them. I recall one instance when an unfortunate otter generated over 5 calls before we could get out and remove it. We even received calls later in the

day after it had been picked up!” I personally remember that day because I received over 20 calls that day because so many people knew that I was leading the overall effort. Otters must really have a special place in the hearts of our workforce! Glenn also said that “The wildlife awareness program has generated generous support of this Shuttle flight safety program and I fully expect that it will continue.”

Strategically Designing and Placing Wildlife Crossing Signs

During my “Wildlife/Highway Interactions” training, I learned that the effectiveness of wildlife crossing signs is marginal. The placement of a single deer crossing sign at the site of 1 accident is not likely to take care of a major wildlife crossing problem. I learned that it is critical that the design and placement of the signs are targeted for the specific wildlife crossing situation and even then it is hard to achieve significant results. It was obvious that the couple of deer crossing signs sprinkled throughout our Center/Refuge was not going to influence our drivers significantly for our “Avian Abatement Team” effort. Based on the road kill data above I designed a custom wildlife crossing sign. (See NASA provided image to the right taken by Rodney Ostoski of United Space Alliance [USA])



At the top of our wildlife crossing sign is the image of a bald eagle. Our Center/Refuge employees are very aware and proud of the fact that we have always had several eagle nests in our area. Gladly, no bald eagles are believed to have been killed by vehicles on the MINWR recently. However, while working at the Refuge, I read a report that said “At least 5 adults and 1 fledgling have been recovered in the past 27 years in the vicinity of Merritt Island (MINWR Annual Narrative Reports [1963-1990]) that were known or thought to have died of injuries resulting from vehicle collision; all occurred during the nesting season. (Hardesty/Callopy “History, demography, distribution, habitat use, and management of the Southern Bald Eagle on Merritt Island National Wildlife Refuge, Florida, 1990) This is probably somewhat due to the fact that bald eagles have been seen sometimes feeding on carrion while holding a circle of vultures at bay. I witnessed this myself my first week working on the Refuge. (Reference image below taken and provided by Rodney Ostoski of United Space Alliance [USA] with permission)

On the left side of our sign is the image of a raccoon. Since we started collecting and tracking our carrion, we collected 281 dead Raccoons and discovered that Raccoons account for 26% of our road kill.



On the right side of our sign is the image of a turtle. During my assignment at the

Refuge, I met Richard A. Seigel, Ph.D. He has been studying reptiles at the MINWR for years. He informed me that the MINWR also has one of the highest national populations of the nearly threatened Gopher tortoise. Gopher tortoise is a State listed species of special concern. We have an estimated 2000 of them here. Their population density is the highest near the launch pads, so we designed and installed 3 special “Tortoise Crossing” signs in that area. For this reason, and because other turtles are impacted throughout the area a turtle image was also used on our more general “Wildlife Crossing” sign.

Dr. Seigel also informed me that some people actually try to run over snakes. Since our Center/Refuge also hosts many threatened eastern indigo snakes, the image of a snake was placed at the bottom of our “Wildlife Crossing” sign.

During my “Wildlife/Highway Interactions” training, I also learned that it is better to bound the wildlife crossing area with a mileage indication if the data supports it. Wildlife has been killed in many areas of the Center/Refuge, but our early data indicated several “Hot Spots”. One by the Visitor Center, one in the Industrial Area, one by Launch Complex 39, and some others, so our signs were placed strategically and marked with mileage based on this early data.

Investigating Other Non-Lethal Deterrents & Methods for Moving Vultures and Other Large Birds

Besides the carrion reduction and removal program, our team also explored other options for moving vultures and other large birds away from our launch pads for flight safety. Charles Stevenson of NASA and Tracy Gibson and Rubiela Vinje of ASRC led several efforts to determine the effectiveness of other non-lethal deterrents.



Standard bird sound deterrents (bird X system), chemical deterrents, & effigies were tested and found to be ineffective on vultures. The potential use of falcons was also considered as one of the deterrents however it was determined to be a lower priority and is awaiting funding and testing. Other areas that were evaluated with some degree of success were a large bird cannon and a long range acoustic device (LRAD).

The large bird cannon is an acetylene operated device that produces a strong pressure and sound wave. The unit is 18 ft. tall and 3 ft. in diameter. It is mounted on a trailer and can be operated manually and remotely. Early indications are that this device may be useful for moving birds that are at rest or on the ground. The LRAD is a sound projection device that produces a very focused parabolic sound wave. Pre-recorded sounds were loaded into the system and projected towards the vultures. Our team hopes that this device proves to be useful at deterring large birds that are in flight. These two devices are still under evaluation for potential use at the pads during the Shuttle Launch.

Trapping & Releasing Vultures was Deemed Ineffective and Too Risky

NASA wanted to test a vulture trap and release program. The FWCC did not think that a test and release program would be effective and was concerned that baiting a trap might even attract more vultures to the area of concern. A depredation permit was issued to NASA from FWCC for 1 test. The test results were inconclusive and there were other concerns such as what would be done if a bald eagle got into the trap or what if we had trapped some vultures



and then the launch begins to delay and scrub day by day. As concerns mounted, the trap and release program was abandoned.

Moving Roosts Away From the Launch Pad was deemed Too Risky

There are at least 4 vulture roosts within a few miles of the Shuttle launch pads each containing hundreds of vultures. Our team consulted with Vicki Davis and Troy Hershberger, Wildlife Biologists at the Avon Park Air Force Range, on the potential of moving these KSC vulture roosts farther away from the Shuttle launch pads. We found out that the Air Force has successfully accomplished this at Avon Park with some difficulty using various loud sound and bright light techniques consistently at their roosts in the evenings as the vultures come to try and settle in for the night. The movement of roosts at KSC carries significant risk and is still under evaluation.

AVIAN ABATEMENT TEAM RESULTS

It is very hard to measure our ongoing and final effectiveness on workforce and visitor driving and on our vulture population at the launch pads. We only have 1 year of road kill information (See Appendix A) and most experts say that at least 2 years of data is needed when assessing wildlife related changes like this. For example our Road Kill posse thinks our numbers may be higher when it rains, but we have not proven that potential correlation. The grounds are being mowed less often allowing the grass to grow taller closer to the roadways. Our wildlife crossing signs just recently were erected. Most of what we have is anecdotal information, but the initial word back is compelling. The crew that cleans the pads before launch usually needs 2 days to clean up the mess left by birds. Since our efforts it only took ½ day and the launch pad was the cleanest they have ever seen it. Long time MINWR Refuge Biologists like my mentor, Marc Epstein, said they used to see 60 vultures flying around the Vehicle Assembly Building (VAB) and now they say they only see 20 or 30. Employees to the north, west, and south of KSC have reported new colonies of vultures in their neighborhoods. This is a good indication that the vultures are starting to diffuse and disperse in order to get back to normal levels at KSC. Most importantly to NASA, the shuttle has not hit another vulture or large bird since the earlier incident. Besides this obvious NASA benefit, preserving wildlife through road kill prevention strongly supports the US FWS mission to all Americans. Every Scrub Jay, Gopher Tortoise, Otter, Bobcat, or other animal that is not run over, is one more that can ensure that species is around for the next generation of earth and space explorers to enjoy. Our team feels that our Center wide/Refuge wide program which includes awareness training, carrion removal, bird monitoring, and potential sound deterrents will be effective in the long run, but only time will tell. We also hope that by making our effort, data, results, and points of contact more available, that others may provide us additional ideas to try or potentially be able to apply our efforts to their own situations.

MERRITT ISLAND NATIONAL WILDLIFE REFUGE (MINWR) OVERVIEW

Refuge Facts and Natural History

Dorn Whitmore, MINWR Visitor Services Manager, describes this area as “an island in a sea of urban development”. The MINWR was established: 1963. The land is owned by NASA, but the overlaid Refuge is managed by Ron Hight with a 27-person US FWS staff. Its headquarters is located five miles east of Titusville on State Road 402. The MINWR also administers the Lake Wales Ridge NWR and the St. Johns NWR as part of the complex. The Refuge has approximately 500,000 visitors annually excluding visits to the FWS exhibit at NASA’s Visitor Center. The Refuge operated on a \$1.9 million budget in FY05. Approximately one-half of the refuge’s 140,000 acres consists of brackish estuaries and marshes. The remaining lands consist of coastal dunes, scrub oaks, pine forests and flatwoods, and palm and oak hammocks. The coastal location of MINWR, seven distinct habitat types, and position between the subtropic and temperate climatic zones, contribute to the refuge’s importance as a major wintering area for migratory birds. Over 500 species of wildlife inhabit the refuge with 10 being listed as federally threatened or endangered. Several wading bird rookeries, 11 active bald eagle nests, numerous osprey nests, up to 400 manatees during spring months, and an estimated 2,500 Florida scrub jays can be found on the refuge. Richard A. Seigel, Ph.D., has been studying reptiles at the MINWR for years. He says that the MINWR also has one of the highest national populations of the nearly threatened Gopher tortoise. Gopher tortoise is a State listed species of special concern. We have an estimated 2000 of them here. For more information on Dr. Seigel’s and others work can be found in “Amphibians and Reptiles of the John F. Kennedy Space Center, Florida: A long-term assessment of large protected habitat (1975-200)” (Seigel 2002)

Refuge Objectives

The Refuge objectives are to provide habitat for migratory birds, provide habitat and protection for endangered and threatened species, provide habitat for natural wildlife diversity, provide opportunities for environmental education and interpretation, and wildlife oriented recreation.

Refuge Public Use Opportunities

The MINWR has a Visitor Information Center. It has five hiking trails ranging from 1/4-mile to 5 miles in length. There is a Manatee observation deck. There is also a 7-mile auto tour route (Black Point Wildlife Drive) with observation towers for wildlife observation and photography. The Refuge also provides environmental education, guided tours, fishing, waterfowl hunting, boating, and canoeing. The Refuge also contains sections of “The Great Florida Birding Trail”. Details of this statewide trail can be found at <http://www.floridabirdingtrail.com/> .

Refuge Management Tools

The Refuge uses several management tools to achieve these objectives. MINWR staff manages water levels within the refuge’s 76 impoundments for migratory birds, wading birds, shorebirds, and other native species of plants and wildlife. Staff firefighters use prescribed fire to maintain fire dependent/fire influenced communities.

They perform Chemical and mechanical control of exotic plants and thinning of pine stands to improve bald eagle nesting habitat. Public education and outreach is provided to help instill conservation ethics. Active law enforcement patrols protect wildlife, habitat and the visiting public. They also maintain productive partnerships with NASA, state agencies, other Federal and local agencies to further refuge goals and objectives.

Note: Most of this “Merritt Island National Wildlife Refuge (MINWR)” section text was taken from the MINWR Fact Sheet which can be found at <http://www.fws.gov/southeast/pubs/facts/mrtcon.pdf>.

NASA & MINWR CONTINUED PARTNERING FOR MISSION SUCCESS

A large part of the Avian Abatement Team success is due to the ongoing partnership of personnel, technologies, and funding between NASA/KSC and the USFWS/MINWR and other entities. Without this partnership much of our task would not have been achievable. In my KSC Spaceport News article titled “Can Space Centers and Wildlife Refuges peacefully coexist?”, I asserted that most people would agree that a wildlife refuge and a space center can share the same property. After all, both require a lot of land and minimal urban development. But the good longstanding partnership between NASA and the US Fish & Wildlife Service does not come without constant concerns for both agencies. So who exactly are these Refuge employees, what are they doing at KSC, and how does their mission affect and integrate with the KSC mission.

Well first, how many of you can remember when Florida went up in flames in 1998? In some ways, recent draught conditions in 2006 were even worse than in 1998. But changes in fire suppression and fire management have begun to make a difference in restoring the landscape and preventing catastrophic fires. Refuge employees are coordinating and performing more controlled burns so that wildfire smoke does not contaminate KSC sensitive space flight hardware. Other past joint efforts include KSC reduction of shoreline lighting for endangered sea turtles; boat motor modifications for threatened manatees, and Shuttle Landing Facility modifications to deter birds from impacting the Shuttle during landing. Migrating bird patterns have recently been evaluated to determine if new power generating wind turbines could be built and operated within the KSC Exploration Park development. The Refuge did not concur with that plan and it is currently on hold. But how can everyday people who might live near a National Wildlife Refuge, or who may occasionally visit one, or who, like me, may even physically work on one, better support a peaceful coexistence and partnership with that Refuge? If you ask Refuge employees, two BIG ideas are usually expressed: Don’t Speed & Don’t Feed!

Don’t Feed!

Jim Lyon, a biological science technician at the Refuge, gets nuisance wildlife calls from KSC employees routinely. One day during my 3 month assignment with US FWS, I was called out with Jim to the Shuttle launch pad to rescue trapped mottled ducklings from certain death. On another day, Jim told me how he finds himself smacking his head on the beams in the Vehicle Assembly Building (VAB) while helping disoriented birds get back outside. On another day he showed me a dead Starling that a NASA employee found inside the Shuttle. So one day as I was

preparing to perform some Refuge educational awareness outreach activities, I asked Jim, “What do you think is the most important thing that I should be sure to tell people about visiting and working on a Wildlife Refuge. Jim told me, “Don’t feed the wildlife. It’s illegal and you’re not doing them any favors.” Jim sees the KSC workforce feeding the Refuge wildlife donuts and such. Wildlife that is fed loses its natural ability to feed itself and loses its fear of people. Because of this, many of these wild animals die or must be destroyed. Just remember, fed wildlife is dead wildlife.

Don’t Speed!

Vehicle collisions are the number 1 killer of Florida’s imperiled wildlife. Dr. Seigel, who also studies our threatened eastern indigo snakes, says that snake researchers in Louisiana have found that 30% of drivers will change lanes to deliberately kill a snake and 10% will back up over the snake to ensure that it is dead. This is a serious driver education concern. Threatened Florida scrub-jays have been picked up by the KSC “Road Kill



Posse” and employee vehicles have been severely damaged by larger animals like alligators, hogs, and deer. In the last 10 years there have been over 400 reported accidents with animals on the Refuge. Each reported accident averaged \$884 in vehicle damage and together they total over \$350,000! With over 12,000 employees driving to KSC every day, it’s a tough mix. In the first 9 months since we started keeping track, over 800 dead animals have been picked up weighing over 11,000 pounds! Refuge Biologist Marc Epstein said that “it is like the NASA 500 out here.” But when the vultures are added to the equation, all of a sudden, NASA mission success and Refuge mission success once again become tightly aligned. After all, the shuttle hit that vulture in 2005 and the new joint “Avian Abatement Team” is still working hard on the related issues. I was recently driving home late at night from KSC, under the speed limit, and still was not able to avoid an Armadillo. Road kill prevention is a tough local, state, and national problem and speed is a huge factor! The KSC “Road Kill Posse” team hopes that our continuing road kill reduction effort and related road kill data will help us and others get smarter on this very tough issue.

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APPENDIX A – ROAD KILL DATA

Sample Road Kill Data Entry Form

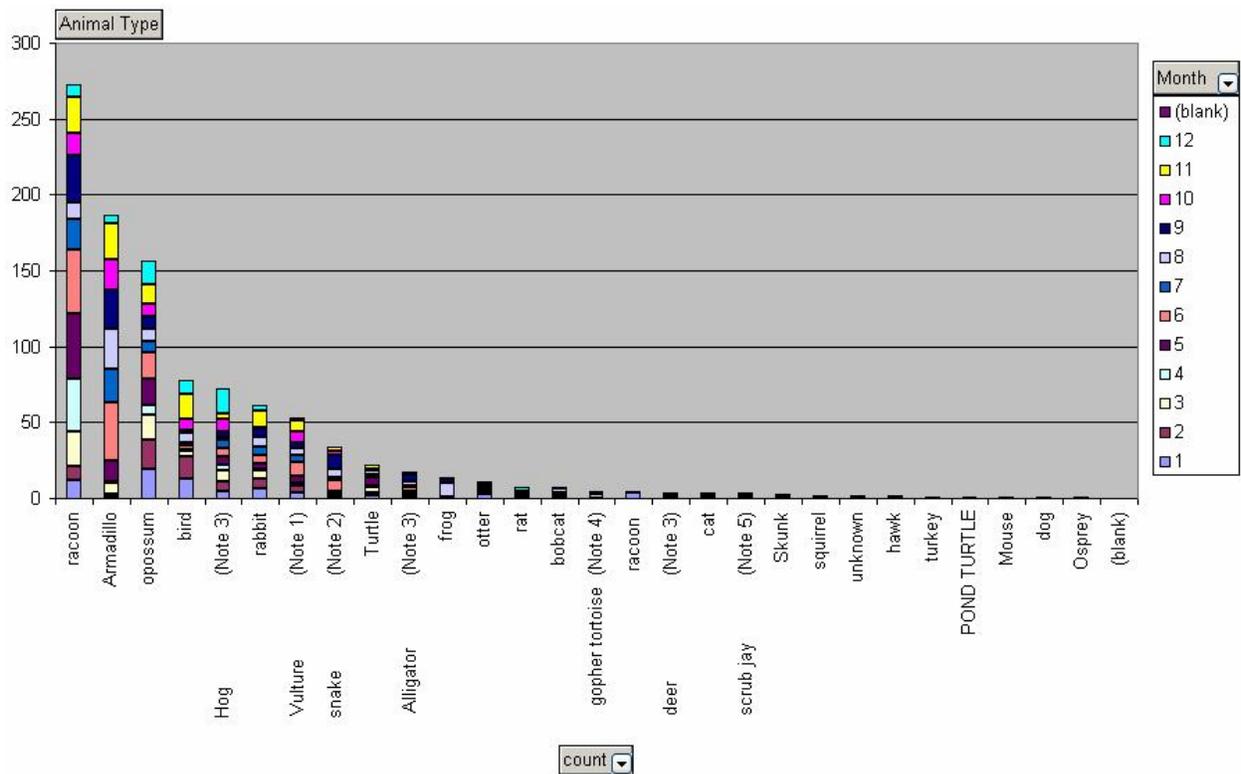
Date / Time	Date	Lat / Long	Month		Type of Animal	Weight	Responder
02-APR-07 8:23:07AM	02-APR-07	N28.49974 W80.59080	4	2007	opossum	5	Francisco
02-APR-07 8:38:02AM	02-APR-07	N28.54071 W80.61722	4	2007	bird	4	Francisco
03-APR-07 8:17:09AM	03-APR-07	N28.52606 W80.71383	4	2007	hog	75	Francisco
03-APR-07 9:20:01AM	03-APR-07	N28.48533 W80.67732	4	2007	raccoon	8	Francisco
03-APR-07 10:02:35AM	03-APR-07	N28.52693 W80.77904	4	2007	ARMADILLO	4	Francisco
03-APR-07 10:02:35AM	03-APR-07	N28.52693 W80.77904	4	2007	raccoon	8	Francisco
04-APR-07 9:20:12AM	04-APR-07	N28.60227 W80.60383	4	2007	raccoon	5	Francisco
04-APR-07 10:01:17AM	04-APR-07	N28.51211 W80.66858	4	2007	opossum	5	Francisco
04-APR-07 10:36:26AM	04-APR-07	N28.70427 W80.72638	4	2007	hog	215	Francisco
05-APR-07 7:15:20AM	05-APR-07	N28.53925 W80.61780	4	2007	rabbit	4	Francisco
05-APR-07 8:50:26AM	05-APR-07	N28.52624 W80.71587	4	2007	opossum	5	Francisco
05-APR-07 7:20:16AM	05-APR-07	N28.64825 W80.70003	4	2007	bird	0.3	Shaw
02-APR-07 7:21:33AM	02-APR-07	N28.57710 W80.65595	4	2007	opossum	3	Shaw
02-APR-07 7:27:33AM	02-APR-07	N28.58961 W80.65916	4	2007	bird	2	Shaw
02-APR-07 8:21:58AM	02-APR-07	N28.71170 W80.73230	4	2007	opossum	1	Shaw
02-APR-07 9:08:09AM	02-APR-07	N28.70062 W80.72418	4	2007	opossum	3	Shaw
02-APR-07 9:27:39AM	02-APR-07	N28.64043 W80.77399	4	2007	raccoon	10	Shaw
03-APR-07 7:41:59AM	03-APR-07	N28.56722 W80.65378	4	2007	opossum	5	Shaw
03-APR-07 8:58:20AM	03-APR-07	N28.71210 W80.73288	4	2007	bird	0.1	Shaw
03-APR-07 9:13:31AM	03-APR-07	N28.62885 W80.78706	4	2007	bird	0.5	Shaw
03-APR-07 9:18:01AM	03-APR-07	N28.64298 W80.76256	4	2007	snake	0.1	Shaw
03-APR-07 9:27:33AM	03-APR-07	N28.64333 W80.75454	4	2007	snake	0.2	Shaw
03-APR-07 9:48:07AM	03-APR-07	N28.58824 W80.65881	4	2007	fish	0.2	Shaw
03-APR-07 9:51:23AM	03-APR-07	N28.57837 W80.65595	4	2007	Alligator	15	Shaw
03-APR-07 9:55:58AM	03-APR-07	N28.56317 W80.65590	4	2007	bird	0.1	Shaw
05-APR-07 7:20:17AM	05-APR-07	N28.64825 W80.70003	4	2007	rabbit	1	Shaw
05-APR-07 7:37:21AM	05-APR-07	N28.66825 W80.71265	4	2007	hog	176	Shaw
05-APR-07 8:02:53AM	05-APR-07	N28.67738 W80.71807	4	2007	raccoon	1	Shaw
05-APR-07 8:50:52AM	05-APR-07	N28.64298 W80.76591	4	2007	raccoon	5	Shaw
05-APR-07 8:50:52AM	05-APR-07	N28.48160 W80.68054	4	2007	coyote	36	Shaw
06-APR-07 7:46:08AM	06-APR-07	N28.63821 W80.69353	4	2007	opossum	5	Shaw
06-APR-07 7:56:44AM	06-APR-07	N28.66390 W80.70987	4	2007	ARMADILLO	1	Shaw
06-APR-07 8:05:28AM	06-APR-07	N28.69484 W80.72171	4	2007	opossum	3	Shaw
06-APR-07 8:08:32AM	06-APR-07	N28.70236 W80.72518	4	2007	raccoon	4	Shaw
06-APR-07 10:35:31AM	06-APR-07	N28.52278 W80.65738	4	2007	raccoon	5	Shaw



(Images above courtesy of NASA thru Brad Missimer, SGS)

First 12 Months of KSC/Refuge & CCAFS Road Kill Data (Sorted by Animal Count)

Animal Count	months 1-3 are 2007 months 4-12 are 2006													
Year	(All)													
	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07		
Animal Type														
count													Grand Total	
raccoon	35	43	42	20	11	31	15	23	9	12	9	23	273	
Armadillo	1	14	38	22	27	25	20	24	6	1	2	7	187	
opossum	6	18	17	7	9	8	8	13	15	19	19	17	156	
bird		1	3	2	6	2	7	17	9	13	14	4	78	
Hog (Note 3)	4	5	6	5	2	4	8	4	16	5	6	7	72	
rabbit	1	4	5	6	6	6	1	11	3	6	7	5	61	
Vulture (Note 1)		5	9	4	5	4	7	7	2	4	4	2	53	
snake (Note 2)	1	1	7	2	5	9	3	3		1		2	34	
Turtle	1	6	2	2	2	1		3		2	2	3	22	
Alligator (Note 3)	2	2	2	1	3	5			1		1		17	
frog				1	9	3		1					14	
otter	1				1		1	2	1	3	1	1	11	
rat		1				2	1	1	2				7	
bobcat			2		2		1			1		1	7	
gopher tortoise (Note 4)					3	1	1						5	
raccoon										4	1		5	
deer (Note 3)			1			1	2						4	
cat		1			1	2							4	
scrub jay (Note 5)		1	1		1	1							4	
Skunk						1	1				1		3	
squirrel				1								1	2	
unknown		2											2	
hawk					1			1					2	
turkey												1	1	
POND TURTLE									1				1	
Mouse						1							1	
dog					1								1	
Osprey	1												1	
(blank)														
Grand Total	53	104	136	71	95	107	76	110	65	71	67	74	1028	





Note 1: These vultures were likely killed while feeding on other road kill. Sometimes a bald eagle will join in on the feast. 6 bald eagles have been documented as killed at KSC by vehicles, probably while feeding on other road kill. Vehicle collisions are the greatest known source of adult eagle mortality usually while feeding on road kill in the middle of a circle of vultures. Our goal is to reduce our road kill in order to move our vultures away from our roadways and away from our launch pads, and back to a normal distribution across the state.



Note 2: A snake researcher in Louisiana found that 30% of drivers will deliberately change lanes to run over a snake. 10% will stop and back-up over it to ensure that it is dead. KSC is a refuge for threatened Indigo Snakes and we really need all of our snakes to help keep down our state rodent population and related disease.



Note 3: Animals like alligators, hogs, and deer can weigh in the 100s of pounds and total your vehicle! Since 1996, 400 reported animal collisions out here have averaged \$884 in vehicle damage and together have totaled to over \$350,000 in vehicle damage. We average 10 reported hog accidents a year and we had 56 hog related accidents reported in 1995. The 2006 KSC hog population is estimated as being as high as 12,000.



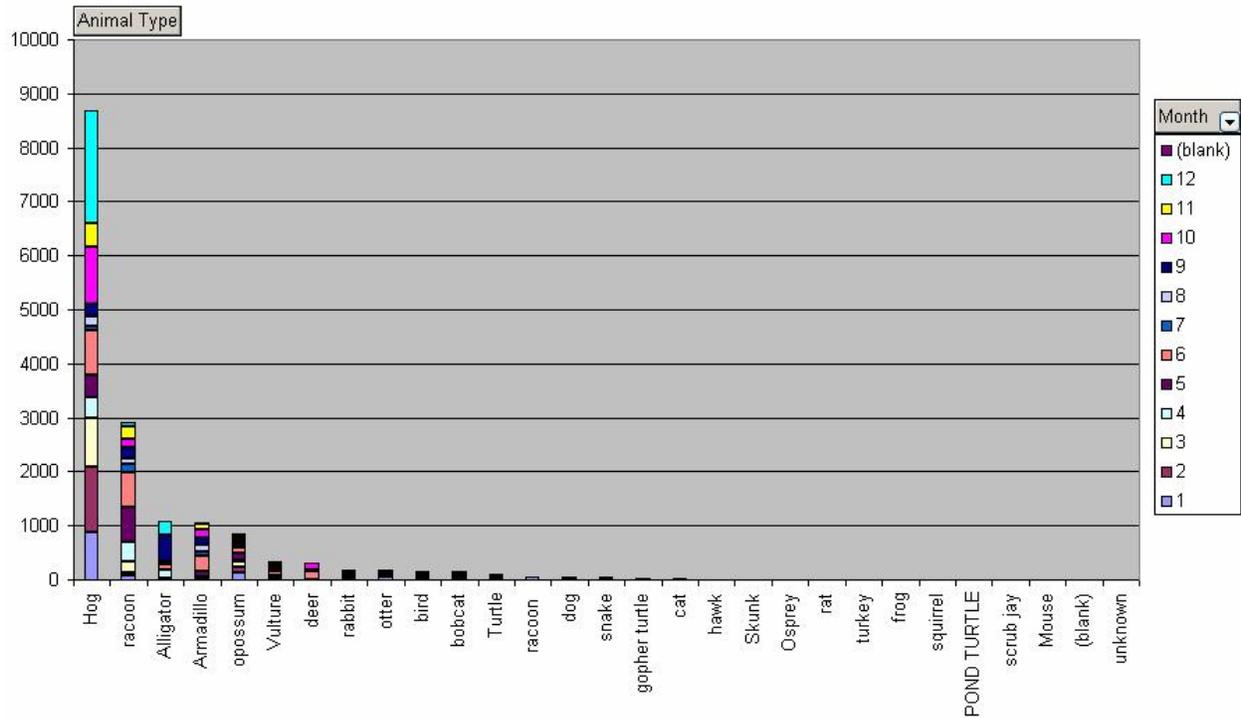
Note 4: We have one of the highest populations of the nearly threatened gopher tortoises near our launch pads. Tortoise crossing road signs are planned for that area, but they can be found throughout the refuge.



Note 5: Our threatened Florida Scrub-Jays can be easily seen flying across our roadways, so please keep an eye out for them and slow down for them.

First 12 Months of KSC/Refuge & CCAFS Road Kill Data (Sorted by Animal Weight in Pounds)

Animal Weight	months 1-3 are 2007 months 4-12 are 2006													
Year	(All)													
Animal Type	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07		
Sum	4	5	6	7	8	9	10	11	12	1	2	3 (blank)	Grand Total	
Hog	400	410	830	83	165	225	1060	455	2080	878	1204	898	8688.00	
raccoon	359.5	651	641	163	96	215	138	253	76	71	60	199	2922.50	
Alligator	140	13	90	3	50	511			250		30		1087.00	
Armadillo	10	97	293	71	137.5	138	131	125	17	1	13	24	1057.50	
opossum	23	133	106	29	33	43	35	49	64	127	113	99	854.00	
Vulture		24	77	26	21	20	33	30	32	33	21	10	327.00	
deer			160			20	140						320.00	
rabbit	0	8	25	21	16	21	5	41	9	13	19	15	193.00	
otter	32				15		10	40	10	44	10	15	176.00	
bird		2	5.25	4	9.6	4	24	51.3	17.2	17.4	16.2	4.2	155.15	
bobcat			55		40		10			10		40	155.00	
Turtle	5	36	6		7	3		8		10	11	23	109.00	
raccoon										47	15		62.00	
dog					60								60.00	
snake	0.5	1	7	2	1.2	17.1	9	3		1		0.2	42.00	
gopher turtle					27	4	2						33.00	
cat		2			5	8							15.00	
hawk					3			5					8.00	
Skunk						3	2				2		7.00	
Osprey	5												5.00	
rat		0.4				2	1	0.1	1.5				5.00	
turkey												5	5.00	
frog				0.1	0.9	1.5		0.1					2.60	
squirrel				1								1	2.00	
POND TURTLE									2				2.00	
scrub jay		0.5	0.5		0.1	0.5							1.60	
Mouse						0.1							0.10	
(blank)													0.00	
unknown		0											0.00	
Grand Total	975	1377.9	2295.75	403.1	687.3	1236.2	1600	1060.5	2558.7	1252.4	1514.2	1333.4	16294.45	



APPENDIX B – WEB PAGE - <http://environmental.ksc.nasa.gov/projects/roadkill.htm>



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WELCOME TO THE ROAD KILL POSSE WEBSITE



In July of 2005, the Space Shuttle Discovery hit a vulture during ascent. To address this issue, NASA formed the "Avian Abatement Team" which includes YOU! At this site, you can view an educational/entertaining video, order free related materials

like stickers/posters, and find the latest updated information on our efforts.



AVIAN ABATEMENT TEAM – ROAD KILL PREVENTION

- | | |
|--|---|
| Latest Road Kill Statistics | It's a Jungle Out There! (article) |
| Bye Bye, Birdies (article) | Canaveral National Seashore |
| Merritt Island National Wildlife Refuge | General Public Critter Crossing Information |
| Professional Wildlife Crossing Information | |
| Fox News Birds & the Shuttle Launch (video) | |
| National Wildlife Refuge, KSC Peacefully coexist (see pg 7 of 8) (article) | |

Please watch for these Wildlife Crossing signs - coming to a KSC intersection near YOU!



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