

**2011
PEREGRINE FALCON MIGRATION STUDIES AT
SOUTH PADRE ISLAND, TEXAS**



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EXECUTIVE SUMMARY

As part of a continuing research program of migration studies of Nearctic migratory peregrine falcons (*Falco peregrinus*), we conducted the 33rd annual spring and 35th annual autumn Padre Island Peregrine Falcon Surveys (PIPFS) on South Padre Island, (SPI) Texas. This report is focused on these 2011 efforts. We monitor population trends, migratory characteristics, contaminant loads and infectious diseases that pose human health and conservation concern in peregrine falcons that migrate along the coastal corridor of South Padre Island.

During the spring survey period from 08-26 April, we conducted 178 survey hours in the field, recording 289 sightings and capturing 33 individual peregrines. Of those captured, 8 (24.24 %) were previously banded Padre Returns and 25 (75.76 %) were first banded during the survey. After second year (ASY) peregrines comprised 75.76 % of the captured sample. The seasonal sighting rate of 16.24 peregrines/10 survey hours is slightly below yet consistent with the 17 year mean of 17.43 (± 4.21). Not included in the totals above are 4 seasonal recaptures of peregrines, whose minimum average staging time on SPI is 2.75 days. Durations range from a few hours to 6 days.

In autumn, we surveyed the wind-tidal flats of SPI from 29 September to 24 October and the beachfront from 10-14 October. During this period we expended 371 survey hours in the field, recording 916 peregrine falcon observations and capturing 202 individuals. Of those captured; 3 (1.49 %) were previously banded and 199 (98.51 %) were first banded this season. Previously banded captures included one foreign falcon banded as a nestling on Baffin Island, Nunavut and 2 Padre Returns. Adults comprised 12.43 % of the age determined sightings (n=764) and 6.86 % of captured peregrines. The seasonal sighting rate of 24.69 birds/10 survey hours is the 2nd highest recorded in survey history, considerably above our 18 year mean of 18.62 (± 4.47) on SPI only. Not included in the above totals, we recorded 55 sightings of peregrines marked this season and recaptured 16. The minimum average staging time of recaptures on SPI was 5.38 days, ranging from a few hours to 20 days.

Biological samples (219 bloods, 170 feathers) were collected from captured peregrines for the DWH assessment, contaminants analyses, genetic studies and stable isotope research of Padre Migrants.

In collaboration with the Peregrine Fund and the Center for Environmental Sciences and Engineering at the University of Connecticut (CESE), we conducted the 2nd and 3rd sampling season to assess the scope of impacts of the 2010 BP Deepwater Horizon MC-252 oil spill (DWH) on migratory peregrines. Blood analyses of migrant peregrines collected during Earthspan's Assateague Island (MD) and Padre Island surveys seek to quantify exposure to polycyclic aromatic hydrocarbons (PAH), toxic components of the DWH oil. PAH analyses were conducted on Padre autumn 2010 and spring 2011 blood samples. Pre DWH control samples (Padre autumn 2009, Assateague 2010), were selected from our archive and analyzed at CESE this fall. Comparative analyses of pre and post DWH PAH burdens in peregrines are currently being conducted for publication. In November, Dr. Chris Perkins presented a poster (Perkins *et al.* 2011) of the novel PAH analyses techniques developed for this study at the Society of Environmental Toxicology and Chemistry North America 32nd Annual Meeting.

Our long-term PIPFS monitoring program and research on Nearctic peregrine migration ecology addresses present and future issues of concern to people, peregrines and other Neotropical migrants. Our data provide evidence of the Nearctic peregrine's recovery and the corresponding decline in organochlorine contaminant loads. The PIPFS monitoring program is an asset the U.S. Fish and Wildlife Service used in removing *F.p. tundrius* and *F.p. anatum* from the List of Endangered Species and in developing management strategies for a proposed harvest of migratory juvenile peregrines for falconry purposes. Collaborative genetic and stable isotope research to identify natal origins and breeding populations of Padre migrants are being conducted to further understanding of peregrine migration ecology and refine our biomonitoring efforts. Our research, while focused on peregrines, serves to benefit society and avian conservation.

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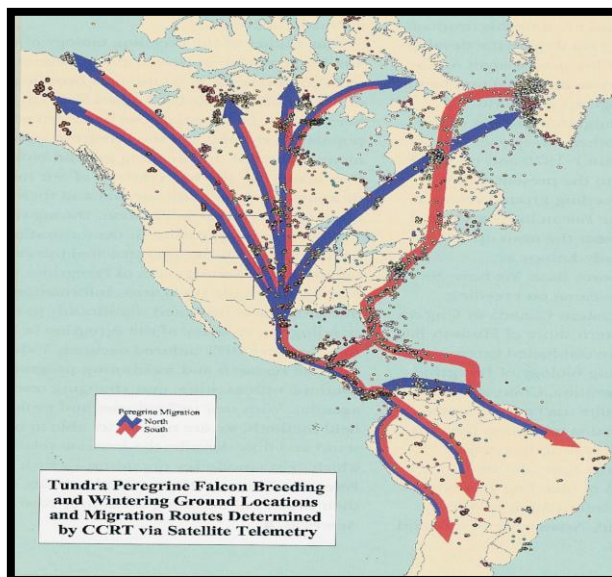
INTRODUCTION

Griscom and Crosby (1925) identified the Texas Gulf Coast as an autumnal focal point for Nearctic migratory peregrine falcons (*Falco peregrinus tundrius* and *F.p. anatum*) in 1890. During the era of DDT induced global population declines in peregrine populations, diverse efforts were undertaken to study, monitor and augment the species. Enderson (1969) advocated coastal surveys as population indices to monitor remote migratory peregrine populations. North and South Padre Islands have been a center for this monitoring activity and related migration research from falconers and scientists alike. As a result, studies of peregrine migration and staging ecology at Padre Island, contaminant and disease biomonitoring efforts and the importance of the Texas Gulf Coast as migratory and winter habitats of migratory peregrines are well documented and have been under investigation for decades.

Colonel R.L. Meredith conducted autumnal beachfront peregrine surveys on Padre Island from the 1940s through 1965. Surveys were further developed, in addition to studies of peregrine migration ecology by J.H. Enderson, W.G. Hunt and their colleagues in the early 1960s (Enderson 1963, Hunt 1966, Enderson 1969). F.P. Ward (1978) identified Padre Island as a spring migration concentration and staging area for northward migrants, the only known location of this type in the Western Hemisphere (Ward *et al.* 1978, Hunt *et al.* 1980). Ward and K. E. Riddle expanded surveys to incorporate both the spring and autumn migration periods (Riddle 1978-1985). Thus, the Padre Island Peregrine Falcon Survey was established. Earthspan principals, W.S. Seegar, T.L. Maechtle and M.A. Yates, with the addition of G. E. Doney in 2006, steer these spring and autumn migration surveys, biomonitoring efforts and related migratory peregrine research (Seegar *et al.* 2003).

Through the decades, studies of Padre Migrants have addressed aspects of migratory peregrine natural history. These include migratory and foraging behavior (Hunt 1966, Hunt *et al.* 1975), spring passage behavior (Hunt *et al.* 1980) and habitat selection of spring migrants (Hunt and Ward 1988). Recent investigations have also documented the importance of Padre Island as a peregrine falcon winter habitats (Enderson *et al.* 1995, Juergens 2003). Building on the Yates *et al.* (1988) band return analyses, our role in the development and application of satellite telemetry has greatly advanced the study of migratory peregrines (Fuller *et al.* 1998, Seegar *et al.* 2003, Fuller *et al.* 2006).

Tundra peregrines are proven sentinels of environmental conditions due to their high trophic standing, extensive migration and utilization of numerous prey species. The Padre Survey permits broad-scale, range wide sampling of this remote nesting sentinel to monitor environmental contaminants and the spread of infectious diseases that pose human health and conservation concern in the Western Hemisphere. Biomonitoring at Padre by Henny *et al.* (1988, 1996, and 2009) illustrated broad scale declines of organochlorine (OC) contaminant burdens during the corresponding recovery of arctic peregrine populations. Dusek *et al.* (2005) documented increases in West Nile virus (WNV) seroprevalance from 2001-2004, following its introduction and spread across North America. Present biomonitoring targets of the survey include; Avian Influenza (AI), WNV, OCs, polychlorinated biphenyls (PCBs) and most recently polycyclic aromatic hydrocarbons (PAHs). The newly initiated collaboration with the Peregrine Fund and the Center for Environmental Sciences and Engineering at the



University of Connecticut, examining the scope of impacts from the BP Deepwater Horizon oil spill on migratory peregrines is summarized in the Collaborative Studies Section (see pg. 6).

As Enderson envisioned in 1969, the ability to quantitatively link migration monitoring with wintering and breeding season population dynamics is still developing. A critical step is partitioning of Padre migrants into their regional breeding populations (Longmire 1988, Morizot 1988, Parrish *et al.* 1983). Known origin (breeding/natal) of migrants will permit investigations of the dynamics of the migratory population structure change over time, regional migration strategies, and the influence of continental weather patterns on migration. Genetics and stable isotope techniques hold the most promise for advances in these topics, though exploratory research and technique development is required. These are all relevant topics of interest to migration monitoring and refining our biomonitoring capabilities.

While the peregrine is one of the most studied avian species in the world (White *et al.* 2003), much remains to be learned about peregrine migration and winter ecology, their roles as infectious disease and environmental contaminant sentinels, and population dynamics. For all these topics of interest, Padre Island and our survey are important for the wealth of knowledge we have been able to amass on Nearctic peregrines that frequent our study area during migration.

OBJECTIVES

To monitor the overall health and further understanding of the migration ecology of tundra peregrines, the Padre Island Peregrine Falcon Survey addresses both short and long-term objectives. Short-term objectives include: 1) monitoring contaminant loads to assess population health and the general habitat conditions of the geographically broad areas they utilize; and 2) monitoring the spread of infectious diseases that pose human health and conservation concern (AI and WNV). Long-term objectives include: 1) monitoring population trends and migration phenology through band returns and sightings; 2) maintaining a banded population to continue this monitoring; 3) sampling blood from captured individuals for DNA level genetic analyses to identify the regional make-up of the Padre migrants; and 4) identifying migratory pathways, breeding areas and critical wintering areas for the migrant Padre population through band returns and locations of radio marked falcons tracked by satellite.

STUDY AREA AND METHODS

The study area includes the northern 40 km of undeveloped land on South Padre Island, from the north end of Highway 100 to the Mansfield Channel (Figure 1). Much of this property is currently administered by Laguna Atascosa National Wildlife Refuge. Hunt and Ward (1988) describe the study area. Spring and autumn survey efforts concentrate on the island's wind tidal flats, west of the dune barrier. Due to inundation, the landmass or amount of exposed and accessible wind tidal flats available to survey and as peregrine habitat can vary daily with tides, wind direction and rainfall. During autumn, we also monitor the beach front and hurricane washes due to seasonal peregrine habitat use of these areas.

The Padre Survey is conducted during the peak of each spring and autumn migration. A team of 2-3 researchers surveys the study area using all-terrain vehicles (ATVs) from dawn to dusk, as weather conditions permit. Peregrine sightings are noted according to time, species, age, sex, location and activity.

A capture attempt is made when peregrines are found in areas conducive to trapping and are not identified by color marking as duplicates. Ward and Berry (1972) describe capture methods. Captured peregrines are processed and released at the capture site, usually within five minutes. Processing includes: 1) marking of unbanded individuals with U.S. Geological Survey (USGS) bands or recording band information for previously banded falcons; 2) collection of a 2ml blood sample from the brachiocephalic vein for contaminants monitoring, infectious disease monitoring, and genetic analyses; 3) collecting naked eye and UV observations of falcon body oiling; 4) collection of an axillary feather from juvenile falcons for stable-isotope analysis of natal origins; 5) collecting morphologic measurements; and 6) color marking juvenile falcons' head and breast feathers with Rhodamine B in the fall, to subsequently identify previously captured falcons and accrue information on staging time they spend on the Island.



Figure 1. South Padre Island Study Area

When the study plan and funding so dictate, we also outfit a few individuals with satellite-received transmitters. The backpack attachment of Teflon ribbon or neoprene is individually fitted on each falcon, and the package weight conforms to USGS Bird Banding Laboratory (BBL) guidelines.

Samples collected are processed for storage daily at the base station. Sighting and banding data are entered in a database for analyses, reporting and access to recapture information. Therein, we have adopted the BBL methods of describing age and sex among sighted and captured peregrines, as well as subsequent encounters with those individuals. All banding information is reported to the BBL after each season. Band retrap, return and recovery data are accrued throughout the year from the BBL and compiled in our database.

The spring survey was conducted by Chris DeSorbo, Bruce Haak, Bill Seegar and Mike Yates. The autumn survey was conducted by Joe Barnes, Gregg Doney, Bart DuPont, Steve Flochs, Alastair Franke, Willard Heck, Pete, Barbara and Jacques Jenny, Brian Latta, Tish McDaniel, Matt Reidy, Jimmy Rutledge, Nick Todd, Holly Walton and Catherine Wightman.

RESULTS AND DISCUSSION

During the spring survey period from 08-26 April, we conducted 178 survey hours in the field, recording 289 sightings and capturing 33 individual peregrines. Of those captured, 8 (24.24 %) were previously banded Padre Returns and 25 (75.76 %) were first banded during the survey. After second year (ASY) peregrines comprised 75.76 % of the captured sample. The seasonal sighting rate of 16.24 peregrines/10 survey hours is slightly below yet consistent with the 17 year mean of 17.43 (± 4.21). Not included in the totals above are 4 seasonal recaptures of peregrines, whose minimum average staging time on SPI is 2.75 days. Durations range from a few hours to 6 days.

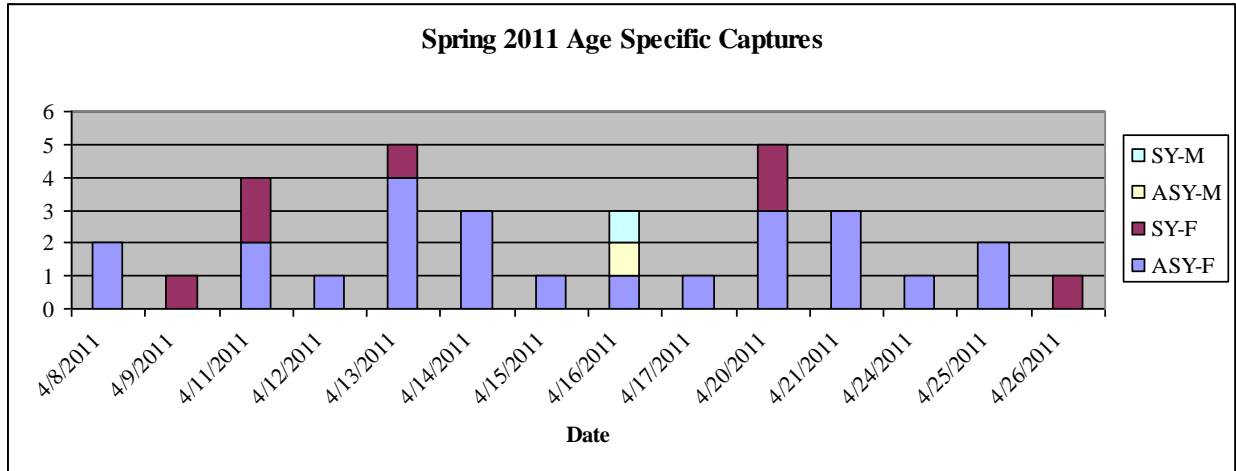


Figure 2. Age specific daily captures of the spring survey

The spring survey was plagued by the most consistently high winds in memory. Usually from the southeast, they blew almost daily from 20 to 30 knots with higher gusts. We could not safely conduct survey operations on some days or parts of days, and capture effectiveness was reduced when we could. Laguna waters were often high as well, requiring us to access the area north of Deer Island via a rugged beach detour and reducing the available survey area. During these times the algal mat was submerged and wind-blown sand often met the water edge, leaving few places falcons would sit. A trailer wheel bearing failure took two days to remedy, but those were days of extreme wind. One ATV transmission failed, but no productivity was lost as a result.

In autumn, we surveyed the wind-tidal flats of SPI from 29 September to 24 October and the beachfront from 10-14 October. During this period we expended 371 survey hours in the field, recording 916 peregrine falcon observations and capturing 202 individuals. Of those captured; 3 (1.49 %) were previously banded and 199 (98.51 %) were first banded this season. Previously banded captures included one foreign falcon banded as a nestling on Baffin Island, Nunavut and 2 Padre Returns. Adults comprised 12.43 % of the age determined sightings ($n=764$) and 6.86 % of captured peregrines. The seasonal sighting rate of 24.69 birds/10 survey hours is the 2nd highest recorded in survey history, considerably above our 18 year mean of 18.62 (± 4.47) on SPI only. Not included in the above totals, we recorded 55 sightings of peregrines marked this season and recaptured 16. The minimum average staging time of recaptures on SPI was 5.38 days, ranging from a few hours to 20 days.

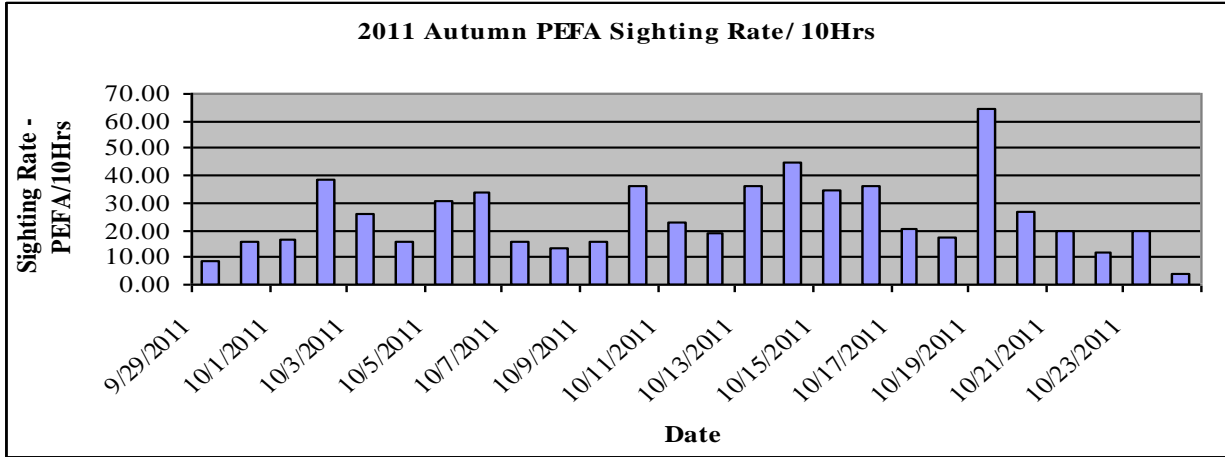


Figure 3. Daily sighting rate of autumn survey

It was an exceptional fall migration season. The extreme drought in Texas, devastating in many areas, permitted easy travel on the island with dry and extensive wind-tidal flats. A series of four relatively dry northern cold fronts in October pushed the bulk of migrants in waves as seen in figure 3, with few lulls in the flight throughout the season. The high seasonal sighting rate was composed mostly of young of the year with the percentage of adults considerably lower than seen in recent years. The adult peregrine flight peaked relatively late on 09 October. Building southeast winds during the last survey week blew sand over the wind-tidal flats intermittently and cleared the Island of peregrines. Again, late season recaptures, with minimum staging times of up to 20 days in the vicinity, illustrate the importance of Padre Island to tundra peregrines.

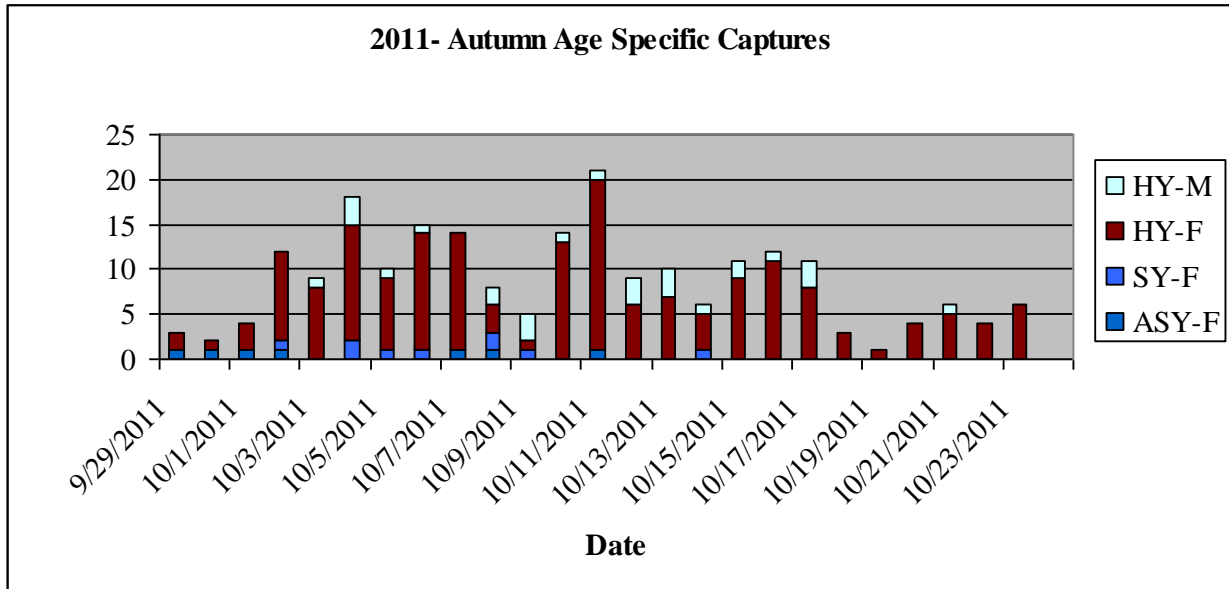


Figure 4. Age specific daily captures of the autumn survey

Banding Information

Sixteen Padre Migrants were reencountered during 2011, either as Padre returns, recaptured during the surveys (n=10) or as foreign encounters (n=6). These encounters illustrate the tundra peregrine's long-term fidelity to migratory stopover/staging on Padre Island, the hemispheric importance of Padre Island habitats and further the knowledge of peregrine migratory habits.

During 2011 surveys, 10 previously banded Padre Returns (8-spring, 2-autumn) were recaptured. Half of which, span both southward and northward migrations. Please see Appendix IV for details. Age classes of Padre returns range from >8 to 1 year-old falcons [8+ (1), 6 (1), 5 (1), 4 (1), 3+ (2), 2 (1), 1 (3)].

In 2011, we received reports of 6 foreign encounters with Padre migrants. These include; 4 foreign breeding area recaptures/bandings in the eastern Canadian Arctic, 1 falcon captured in Texas during fall migration and 1 winter band recovery from central Mexico.

An adult falcon originally banded at SPI by Joe Snyder on 15 October 2009 was captured at her breeding cliff on the Melville Peninsula, Nunavut by Mark Prostor in 2010. Outfitted with satellite telemetry, this falcon's 2010 southward migration was tracked off Florida to a wintering area in Columbia. After a stopover at Padre Island during her 2011 spring migration (May 2011), the transmitter failed before reaching her breeding area. Mark trapped her again (05-Aug. 2011) at her breeding cliff with young and in good condition to remove the transmitter. Two Padre migrants known to be breeding in the Rankin Inlet study area were re-identified in 2011. A hatch year (HY) falcon originally banded at SPI by Ruth Mutch on 17 Oct. 1999 has been confirmed at a breeding cliff from 2006-2009 and in 2011. The second year (SY) falcon originally banded by Bill Seegar on 17 Apr. 2000 was also confirmed at a breeding cliff on 26 May 2011 by Alastair Franke. During the fall survey, on 20 October Brian Latta captured a hatch year falcon banded by Alexandre Anctil as a nestling on Baffin Island, NU on 12 August 2011. The peregrine research efforts in Nunavut are combined under Arctic Raptors.ca.

A male peregrine banded as a hatch year by Nick Todd on 30 September 2010, was found dead, hit by an airplane, in Distrito Federal, south-central Mexico in December of 2010. Lastly, a falcon, banded as a hatch year on 15 October 2010 by Gregg Doney was recaptured in Bastrop, Texas due to an injury during fall migration on 06 October 2011.

We collected biological samples (n=389) from captured falcons for collaborative studies of contaminants monitoring, infectious disease monitoring, genetic analyses and stable isotope research. These efforts are outlined in the following section. In total, during our 35-year survey effort on Padre Island (1977–2011), we have conducted 29,826 hours of survey observations, recorded 42,105 peregrine falcon sightings, and captured/ marked/sampled 8,709 peregrines.

COLLABORATIVE STUDIES AND RECENT PUBLICATIONS

Contaminants Monitoring

In collaboration with the Peregrine Fund (TPF) and the Center for Environmental Sciences and Engineering at the University of Connecticut (CESE), we conducted our 2nd and 3rd sampling seasons of blood collection to assess the scope of impacts of the 2010 BP Deepwater Horizon MC-252 oil spill (DWH) on migratory peregrines. Blood analyses of migrant peregrines collected during Earthspan's Assateague Island (MD) and Padre Island surveys seek to quantify exposure to polycyclic aromatic hydrocarbons (PAHs), toxic

components of the DWH oil. Our long-term data sets and archived samples provide an unparalleled baseline to detect change in blood contaminant levels resulting from the spill and predict if effects on survival and reproduction in tundra peregrines can be expected. PAH analyses were conducted on Padre autumn 2010 and spring 2011 blood samples. Pre DWH control samples (Padre autumn 2009, Assateague 2010), were selected from our archive and analyzed at CESE this fall. Comparative analyses of pre and post DWH PAH burdens in peregrines are currently being conducted for publication. In November, Dr. Chris Perkins presented a poster (Perkins *et al.* 2011) of the novel PAH analyses techniques developed for this study at the Society of Environmental Toxicology and Chemistry North America 32nd Annual Meeting.

Polycyclic aromatic hydrocarbons are known to cause a variety of adverse eco-toxicological impacts in peregrines and avian species, including acute toxicity, reproductive failures, DNA adducts, and heritable mutagenesis in offspring (Zuberogoitia *et al* 2006). Long term PAH exposure, either direct or within the food chain, is suggested to have stronger impacts on population dynamics than direct mortality (Alonzo-Alvarez *et al* 2007). Earthspan researchers have determined that > 80% of tundra peregrines pass through (or stage in) Gulf Coast habitats during fall and/or spring migration. Some winter along the Gulf Coast. PAH exposure in peregrines could occur through direct contact with oil, preening of oiled feathers, and/or ingestion of oil when falcons capture and consume contaminated prey. Comparative analyses to detect change from baseline PAH levels will identify exposure and corresponding contaminant burdens in tundra peregrines resulting from the DWH spill. Deviation in the broad scale migration survey metrics of sex and age structure, migration phenology, mass and body condition will provide additional inference to the extent of adverse toxicological impacts. This monitoring will be helpful in assessing if further study is warranted. Biomonitoring of this top predator will also provide inference to potential contaminant burdens in avian prey species (shorebirds, passerines, and waterfowl).

Henny *et al.* (1996) reported that organochlorine (OC) residues in plasma of peregrine falcons decreased significantly in spring migrants at Padre Island between collections obtained during 1978-80 and those collected in 1994. Henny noted that decreases in OC pesticide residues coincided with increased peregrine populations throughout the Arctic and other regions of North America. The update of this study conducted with 2004 samples (Henny *et al.* 2009) reported further dramatic declines (96-97%) in tundra peregrine OC contaminant loads at Padre Island during the later sampling period. This is a significant conservation milestone of the past century, though Henny suggests vigilance since the indoor use of DDT has been reauthorized in Africa. While the decreased use of persistent OCs has been an important factor in restoring peregrine populations, it heralds a change in agricultural processes that may now employ less persistent but more toxic chemicals. Henny (2009) also elucidates the large scale utility of Padre Survey biomonitoring for emergent persistent organic pollutants (POPs) in the Americas. Polybrominated diphenyl ether (PBDE) flame retardants have dramatically increased in wildlife and humans and are of developing concern worldwide. By utilizing our sample archive and future sampling, a future broad scale inquiry of PBDE contaminant burdens in Padre migrants is warranted.

Avian Disease Monitoring

In collaboration with Dr. Pat Redig of the Raptor Center at the University of Minnesota, peregrine tissue samples have been analyzed to detect exposure to Highly Pathogenic Avian Influenza H5N1. No samples were sent in 2011, though future monitoring is warranted as a potential limiting factor in peregrines.

To date and consistent with wild bird monitoring throughout North America, the test results for the presence of Avian Influenza (H5N1) in all our samples to date have been negative. Dr. Redig related in February 2009 that they have "... tested all cloacal swabs with a matrix pcr (m-PCR) and all of the blood samples with a competitive ELISA for influenza - neither test has yielded evidence of virus parts (m-pcr) or antibodies (ELISA) in these samples." To date H5N1 has not been detected in North America. This

particularly virulent strain of Avian Influenza emerged in Asia in 2003 and outbreaks in wild and domestic birds in the Eastern Hemisphere are becoming more frequent. While there are no cases of humans becoming infected from migratory birds, humans have become infected through contact with domestic poultry. If (many scientists say “when”) it mutates to allow human to human contact, we will be facing the next global pandemic.

Genetic Analyses

In collaboration with Drs. Sandra Talbot (USGS), David Mindell (California Academy of Sciences) and Jeff Johnson (University of North Texas) tissues have been sent for genetic analyses of Padre migrants. Talbot will utilize samples collected from past surveys and investigate methods that will help us: 1) describe the composition of the migratory population using a molecular probe that will identify birds to population of natal origin; 2) assess the relative contribution of various breeding populations to the migratory populations at Padre; 3) examine how changes in weather patterns and migratory patterns influence the size of the migratory populations; and 4) possibly draw conclusions about changes in the size of breeding populations.

Johnson and Mindell (2007) presented a poster (abstract in appendix II) assessing the temporal genetic stability of migrant peregrine falcons sampled at Padre Island, Texas between the years 1985-2007. Further analyses were published in Johnson *et al.* (2010), see appendix II for the abstract.

Stable Isotope Research

We collected 160 feather samples from juvenile falcons at Padre for future stable isotope analyses to continue research initiated by Dr. Nancy Clum of the Wildlife Conservation Society. Dr. Clum’s research assesses the feasibility of using stable isotopes as a means of identifying natal origins of migrant birds. If successful, this technique may allow us to: 1) evaluate the relative importance of different breeding habitats to populations of arctic peregrines; 2) identify the dominant trophic position of arctic peregrines; and 3) identify any temporal patterns of migration related to breeding habitat. Isotope data will be combined with data on plumage and morphological variation, which have also been suggested to vary geographically among peregrine populations. In addition, future comparative analyses of isotopic signatures of Gulf and East Coast HY falcons have potential to reveal the effects of continental weather patterns on juvenile tundra peregrines.

Population Monitoring

We are collaborating with Dr. Mark Fuller (USGS and Boise State University, Raptor Research Center) to report peregrine trend analyses for the period 1985-2000. Dr. William Gould, New Mexico State University, has conducted the statistical analyses. Gould’s analyses will be incorporated into a broader investigation of peregrine migration that also will include data from the Assateague Island Survey, conducted by Seegar and Yates.

We provided the chapter on migration studies (Seegar *et al.* 2003) in Return of the Peregrine, the Peregrine Fund book documenting the species’ recovery. Our studies at Padre and Assateague Islands formed the basis of that chapter.

Satellite Telemetry

Advances in the miniaturization of satellite-received transmitters have only recently allowed the tracking of medium sized raptors such as peregrine falcons. Dr. W. Seegar first equipped migrating peregrines with 30-

gram Platform Transmitter Terminals (PTTs) at Assateague Island, MD/VA in 1993. After the successful deployment and tracking of these first two individuals, we radio marked seven adult female peregrine falcons at Padre Island in the spring of 1994. In the spring of 1996 we radio marked the first migrant male peregrines at Padre Island with 20-gram PTTs. To date 20 peregrine falcons (two males, 18 females) have been radio marked with PTTs at Padre Island. No peregrines were outfitted with satellite-received telemetry in 2011.

Dr. Michael McGrady is analyzing data collected from these instrumented birds. Building on the Yates *et al.* (1988) collation of band return data, this information has identified important areas in the Western Hemisphere for the conservation of peregrines and their prey. Please refer to Appendix III for a map of the satellite derived migratory routes of peregrines outfitted on Padre Island in the spring of 2005.

Dr. Mark Fuller presented analyses of our satellite tracking results, including peregrines tagged on Padre Island, during the Raptor Migration, Ecology and Conservation in the New World Symposium, held in conjunction with the North American Ornithological Conference, Veracruz, Mexico, in October 2006. This analysis examined peregrine migration strategies, migratory corridors, wintering areas, staging areas and the influence of weather patterns on peregrine migration. Please refer to the Fuller *et al.* (2006) abstract in Appendix II. We will further describe aspects of our satellite tracking results in a forthcoming journal publication, "Timing of migration and location of wintering areas of Nearctic Peregrine Falcons" (Yates *et al.*, in press).

Satellite telemetry has spurred many of the recent advances in migration research. An applied example of its value was demonstrated in Swainson's hawks (*Buteo swainsoni*). From concerns generated by declining demographics in nest monitoring surveys, Earthspan was part of a multi-agency effort to monitor Swainson's hawk populations throughout the year using satellite-received telemetry. Use of this technology led researchers to areas in Argentina, where large numbers of Swainson's hawks were found dead. Subsequent investigations determined that secondary poisoning due to contact with the insecticide Monochrotophos caused the mortalities. This chemical was used to protect crops from grasshoppers, a primary food source for Swainson's hawks wintering in Argentina. Winter use areas were delimited through the satellite tracking of radiomarked Swainson's hawks. Once the cause of mortality was discovered, researchers working with government representatives and environmental groups were able to convince the products manufacturer to voluntarily withdraw its use from the region. They replaced farmers' stocks with a reportedly less toxic product for controlling insect pests. This case demonstrates the utility of tracking migrants with the aid of satellite telemetry to monitor environmental health. Field evaluations would have been more difficult and costly without the location estimates for Swainson's hawk wintering areas provided by satellite tracking. Most significantly, the needless mortality of Swainson's hawks was quickly curtailed. Besides conserving Swainson's hawks, this proactive management saved an untold amount of multi-agency resources.

The situation described above indicates the need for continued and more extensive field evaluations of highly toxic, but less persistent (therefore more difficult to detect) chemicals. It also illustrates the advantages of proactive monitoring, as embodied by our PIPFS efforts. The threat of poisoning for Neotropical migrants continues to be a problem in Latin America, where organophosphates appear to have largely replaced the use of persistent organochlorines.

CONCLUSIONS AND RECOMMENDATIONS

Data from the Padre survey continue to suggest full recovery of Arctic populations of peregrine falcons. This conclusion is supported by reports of researchers observing increased production in most Arctic

regions of North America (Cade *et al.* 1988, Cade and Burnham 2003). With an overall increasing trend in our sighting rate (Fig. 5), the variability in this rate and other survey metrics may be due to the effects of continental weather patterns on migration and warrants further study. The recovery of the peregrine is one of the few success stories for an Endangered Species. Continued monitoring furthers our understanding of peregrine population dynamics. While we supported delisting the Arctic subspecies from the List of Threatened and Endangered Species in 1994, we continue to recognize its importance as a sentinel species of environmental conditions that affect a myriad of other avian species, as exemplified in our current DWH oil spill monitoring. Through the integration of several technologies, (e. g., tracking of peregrines by satellite, analyses of genetic make-up and investigation of contaminant burdens) the Padre Island Peregrine Falcon Survey can be used to monitor the environmental health of a large geographic area. This includes diverse habitats used by peregrines, as revealed by satellite derived location estimates and band returns. These habitats are shared by a wide variety of avian species and can serve to identify areas where further local monitoring is warranted (particularly in Latin America).

We recommend that the Padre Island Peregrine Falcon Survey continue, as data from our research will: 1) provide information on evolving population dynamics and migration; 2) provide samples to monitor for present and future infectious diseases, contaminant levels and define genetic composition of the Padre population; and 3) help identify key migration and over-wintering habitat of Neotropical migrants in the Gulf coast region, Central and South America.

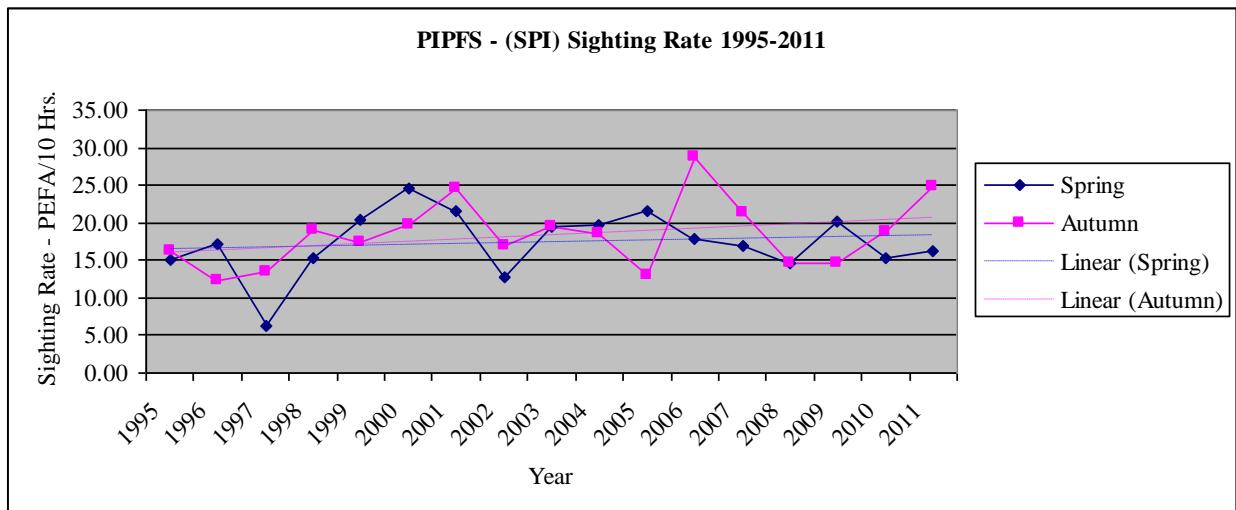


Figure 5. PIPFS sighting rate trends for SPI

Additionally, we recommend that winter use areas revealed by band returns and satellite received location estimates be investigated to evaluate their importance to peregrine falcons, other Neotropical migrants and resident species. Pending sufficient funding, we plan to continue autumn and spring surveys. Our surveys will be conducted using similar methods and number of personnel as deployed throughout the survey's history, incorporating new protocols to deal with developing concerns; these include emergent persistent organic pollutants, zoonotic diseases and the impacts of climate change on this Neotropical migrant.

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APPENDIX – I

Padre Island Peregrine Falcon Survey Totals 1977-2011

Year	Season	Survey Hours	Sighting Rate # s./10h	Peregrines Sighted	Peregrines Captured	Vehicles used
1977	Autumn	467	2.59	121	31	Trucks/beachfront
1978	Autumn	384	0.31	118	33	t/b(12) & PTS (21)
1979	Spring	154	3.77	58	8	t/b (8) & PTS (0)
1979	Autumn	420	8.98	377	89	t/b (41) PTS (24) ATC (24)
1980	Spring	542	8.73	473	54	t/b-PTS-ATC
1980	Autumn	0	0.00	0	0	Hurricane Allen
1981	Spring	448	6.05	271	32	t/b ATC
1981	Autumn	602	9.95	599	152	t/b ATC
1982	Spring	950	8.22	781	92	t/b ATC
1982	Autumn	734	11.10	815	155	t/b ATC
1983	Spring	1150	11.86	1364	149	t/b ATC
1983	Autumn	986	11.08	1092	283	t/b ATC
1984	Spring	1240	7.31	906	88	t/b ATC
1984	Autumn	809	14.47	1171	196	t/b ATC PTS
1985	Spring	895	10.06	900	152	t/b ATC
1985	Autumn	409	11.02	451	128	ATC
1986	Spring	597	15.63	933	102	ATC
1986	Autumn	632	13.29	840	216	ATC
1987	Spring	828	12.75	1056	140	ATC
1987	Autumn	433	15.98	692	188	ATC
1988	Spring	770	19.44	1497	209	ATC
1988	Autumn	656	14.53	953	296	ATC/begin using dye in fall.
1989	Spring	864	14.51	1,254	127	ATC
1989	Autumn	701	11.10	778	248	ATC
1990	Spring	817	13.61	1112	129	ATC
1990	Autumn	735	18.24	1341	298	ATC t/b
1991	Spring	670	13.64	914	114	ATC
1991	Autumn	580	13.45	780	250	ATC t/b
1992	Spring	578	10.80	624	89	ATC
1992	Autumn	114	18.42	210	64	ATC t/b
1993	Spring	618	13.06	807	127	ATC
1993	Autumn	995	24.28	2,416	694	ATC t/b
1994	Spring	319	12.23	390	83	ATC/hovercraft
1994	Autumn	276	22.32	616	118	ATC t/b-SPI only
1995	Spring	139	15.04	209	43	ATC/SPI only
1995	Autumn	192	16.30	313	84	ATC t/b-SPI only/hurricanes
1996	Spring	54	17.04	92	19	ATC/SPI only
1996	Autumn	397	12.19	484	198	ATC t/b-SPI only
1997	Spring	87	6.21	54	16	ATC/SPI only
1997	Autumn	328	13.41	440	183	ATC t/b-SPI only

APPENDIX – I (cont.)

Padre Island Peregrine Falcon Survey Totals 1977-2011

Year	Season	Survey Hours	Sighting Rate # s./10h	Peregrines Sighted	Peregrines Captured	Vehicles used
1998	Spring	164	15.37	252	44	ATC/SPI only
1998	Autumn	605	19.04	1152	309	ATC/SPI only
1999	Spring	160	20.38	326	78	ATC/SPI only
1999	Autumn	512	17.40	891	275	ATC/SPI only
2000	Spring	195	24.62	480	80	ATC/SPI only
2000	Autumn	400	19.75	790	151	ATC/SPI only
2001	Spring	251	21.67	544	105	ATC/SPI only
2001	Autumn	290	24.66	715	186	ATC/SPI only
2002	Spring	309	12.82	396	49	ATC/SPI only
2002	Autumn	197	16.95	334	68	ATC/SPI only
2003	Spring	162	19.44	315	37	ATC/SPI only
2003	Autumn	302	19.50	589	171	ATC/SPI only
2004	Spring	159	19.81	315	52	ATC/SPI only
2004	Autumn	263	18.48	486	103	ATC/SPI only
2005	Spring	106	21.51	228	34	ATC/SPI only
2005	Autumn	262	12.98	340	117	ATC/SPI only
2006	Spring	111	17.75	197	17	ATC/SPI only
2006	Autumn	359	28.66	1029	200	ATC/SPI only
2007	Spring	112	16.88	189	30	ATC/SPI only
2007	Autumn	258	21.32	550	92	ATC/SPI only
2008	Spring	154	14.68	226	40	ATC/SPI only
2008	Autumn	318	14.65	466	133	ATC/SPI only
2009	Spring	166	20.18	335	60	ATC/SPI only
2009	Autumn	387	14.60	565	144	ATC/SPI only
2010	Spring	104	15.19	158	42	ATC/SPI only
2010	Autumn	401	18.20	730	180	ATC t/b SPI only
2011	Spring	178	16.24	289	33	ATC/SPI only
2011	Autumn	371	24.69	916	202	ATC t/b SPI only
Totals		29,826		42,105	8,709	

Codes

ATC = all terrain cycle

SPI = South Padre Island

t/b = trucks on beachfront

PTS = permanent trapping station

Unit hours = 1 person hour w/ATC

APPENDIX – II

Abstracts of Recent Publications and Presentations

Perkins, C., A. Provas, W. Seegar, M. Yates, D. Evers, and P. Jenny. 2011. Analysis of PAHs 9500 from MC-252 in whole blood and RBCs from live-captured birds using ultra performance liquid chromatography (UPLC): Method development and assessment. SETAC North America 32nd Annual Meeting in Boston, MA., Nov. 15, 2011.

The explosion of the Deepwater Horizon oil platform on April 20, 2010 resulted in an unprecedented release of crude oil in the Gulf of Mexico. Much of the oil and the dispersants used impacted salt marshes and beaches around the Gulf, with numerous species of birds documented as being exposed. While the use of dispersants in an oil spill response involves tradeoffs between effects to the shoreline and effects to pelagic and deep-sea environments, relatively little is known on the effects that the oil-associated polycyclic aromatic hydrocarbons (PAHs) have upon the health of avian populations. Circulating blood-borne, parent PAHs can provide a direct link for exposure assessment and reconstruction since they are not as affected by differences in metabolism and excretion. There are a couple of challenges in analyzing whole blood and red blood cells (RBCs) from live-captured birds that make quantitation more difficult; minimal sample volume (0.1- 0.5 ml) can be obtained without being detrimental and the target analytes are less abundant by volume in circulating RBCs in contrast to whole blood. We developed a novel method for the analysis of 16 PAHs utilizing ultra-performance liquid chromatography coupled to photodiode array, fluorescence, and tandem mass spectrometry detectors. This rigorous method obtained good recoveries of standard reference material (60-95%), matrix spikes (60-95%), calibration verifications (90-95%), and surrogates (85%) while obtaining good sensitivity of at least 5ng/g for PAHs and for Dispersants. This method was developed in support of an ongoing study examining uptake and exposure in migrating peregrine falcons and other birds.

Johnson, J.A., S.L. Talbot, G.K. Sage, K.K. Burnham, J.W. Brown, T.L. Maechtle, W.S. Seegar, M.A. Yates, B. Anderson, D.P. Mindell. 2010. The Use of Genetics for the Management of a Recovering Population: Temporal Assessment of Migratory Peregrine Falcons in North America. PLoS ONE 5(11): e14042. doi:10.1371/journal.pone.0014042

Background: Our ability to monitor populations or species that were once threatened or endangered and in the process of recovery is enhanced by using genetic methods to assess overall population stability and size over time. This can be accomplished most directly by obtaining genetic measures from temporally-spaced samples that reflect the overall stability of the population as given by changes in genetic diversity levels (allelic richness and heterozygosity), degree of population differentiation (F_{ST} and D_{EST}), and effective population size (N_e). The primary goal of any recovery effort is to produce a long-term self-sustaining population, and these genetic measures provide a metric by which we can gauge our progress and help make important management decisions.

Methodology/Principal Findings: The peregrine falcon in North America (*Falco peregrinus tundrius* and *anatum*) was delisted in 1994 and 1999, respectively, and its abundance will be monitored by the species Recovery Team every three years until 2015. Although the United States Fish and Wildlife Service makes a distinction between *tundrius* and *anatum* subspecies, our genetic results based on eleven microsatellite loci suggest limited differentiation that can be attributed to an isolation by distance relationship and warrant no delineation of these two subspecies in its northern latitudinal distribution from Alaska through Canada into Greenland. Using temporal samples collected at Padre Island, Texas during migration (seven temporal time

periods between 1985–2007), no significant differences in genetic diversity or significant population differentiation in allele frequencies between time periods were observed and were indistinguishable from those obtained from tundrus/anatum breeding locations throughout their northern distribution. Estimates of harmonic mean N_e were variable and imprecise, but always greater than 500 when employing multiple temporal genetic methods.

Conclusions/Significance: These results, including those from simulations to assess the power of each method to estimate N_e , suggest a stable or growing population, which is consistent with ongoing field-based monitoring surveys. Therefore, historic and continuing efforts to prevent the extinction of the peregrine falcon in North America appear successful with no indication of recent decline, at least from the northern latitude range-wide perspective. The results also further highlight the importance of archiving samples and their use for continual assessment of population recovery and long-term viability.

Henny, C.J., M.A. Yates, W.S. Seegar. 2009. Dramatic Declines of DDE and Other Organochlorines in Spring Migrant Peregrine Falcons from Padre Island, Texas, 1978–2004. *J. Raptor Res.* 43(1):37-42.

Peregrine Falcons (*Falco peregrinus*) captured in the spring at Padre Island, Texas, nest across the arctic and subarctic from Alaska to Greenland and winter throughout Latin America. Padre Island, located immediately north of the Mexican border, is the peregrines' first landfall in the U.S.A. after spending about 6 mo in Latin America. Blood plasma was collected from spring migrants at Padre Island between 1978 and 2004 to monitor trends in organochlorine (OC) pesticides and their metabolites.

Geometric mean concentrations of p,p'-DDE (mg/g, ww) decreased throughout the study: 1978–1979 (0.879), 1980 (0.617), 1984 (0.551), 1994 (0.406) and 2004 (0.013). Most other OC pesticides, with detection limits used during the earlier portion of this study, were no longer detected during the last two

sampling periods. The reduced concentrations of OC pesticides suggest that other pesticides (including carbamates, organophosphates and pyrethroids) are likely being used as replacements. These replacement compounds are not as persistent and cannot be readily evaluated at migration sites like Padre Island. However, concentrations of flame retardants (polybrominated diphenyl ethers; PBDEs) have recently increased in bird eggs in many regions and have been reported in blood plasma. Concentrations of PBDEs in peregrine plasma could be evaluated at Padre Island for assessment of trends in the Americas.

Johnson, J.A. and D. P. Mindell 2007. Temporal population genetic stability of Peregrine Falcons migrating through Padre Island, Texas. Poster presentation at the One Hundred and Twenty-Fifth Stated Meeting of the American Ornithologists' Union, University of Wyoming, Laramie, WY. August 2007.

Temporal samples were collected from Peregrine Falcons during both fall and spring migration at Padre Island, TX. Three temporal periods (1985 - 1986, 1988 - 1989, and 2006 - 2007) were analyzed using 11 microsatellite loci. No significant differences in genetic diversity (number of alleles and heterozygosity) were observed within a migration period or between years, and no significant differences in allele frequencies were identified across temporal periods. Estimates of variance effective population size (N_e) were also quite high. Assuming panmixia across breeding territories in North America for migrant Peregrine Falcons, these genetic results indicate that the population is doing well due to extensive efforts to prevent extinction following their precipitous decline in the mid-20th Century.

Fuller, M.R., W.S. Seegar, L. Schueck, G. Young., K. Thorup, A. Hedenstrom. Peregrine Falcon Migration in the Western Hemisphere. Presentation at the Raptor Migration, Ecology and Conservation in the New World Symposium, held in conjunction with the North American Ornithological Conference, Veracruz, Mexico. October 2006.

We radio marked adult female Arctic peregrine falcons (*Falco peregrinus tundrius*) at nests in West Greenland, the northern Ungava Peninsula and Rankin Inlet, Canada, and on Assateague and Padre Islands, USA. During southward migration, falcons leaving Greenland often paused before crossing the Davis Strait. Some individuals stopped for 4 or more days during migration, but we found no consistent stopover strategy. Analyses of meteorological data from Canada and the USA during sample southward migrations suggest that peregrines are affected more by the winds on the morning of migration than by winds the morning after, and that tailwinds affect the likelihood of migration and the migration distance. Some falcons migrated near coastlines, but others made water crossings of more than 1,000km. However, detours from direct routes occurred commonly. Generally, the movement patterns are described best by geographical courses, and in no cases do the tracks indicate the use of constant geomagnetic courses. At least five peregrine falcons made a loop migration, southward along the eastern seaboard to Central and South America, then north into southern Canada via the central USA. Average migration rates varied from 142 to 282 km per day among bands of latitude. The average southward migration was 162 km/day and northward was 149 km/day.

Dusek, R. J., E. K. Hofmeister, W. S. Seegar, M. A. Yates, T. L. Maechtle, and B. J. Dayton. 2005. Prevalence of West Nile Virus in Peregrine Falcons. Poster presentation, Proceedings of the Raptor Research Foundation annual meeting, Green Bay, WI.

Since West Nile Virus (WNV) was discovered in New York City, New York in 1999, it has quickly spread throughout the continental United States, much of Canada, central America and the Caribbean. Yearly outbreaks of this disease have continued into 2005 causing mortality in tens of thousands of wild birds and likely will never disappear from the western hemisphere. Morbidity and mortality from WNV has been reported quite commonly in raptors, especially in Ohio in 2002 and then again in Colorado in 2003, but little is known about the impact or prevalence of this disease in this group of birds. In 2001 we initiated a study to determine the prevalence of specific WNV neutralizing antibody in Peregrine Falcons during migration at Assateague Island, Maryland and Virginia (fall only), and South Padre Island, Texas (spring and fall). Peregrine Falcons have been monitored through observation and banding for 35 and 28 years respectively at these two locations. From fall of 2001 through the spring of 2005 more than 650 blood samples have been tested by PRNT for WNV antibody. Prevalence of antibody has increased from 2.0% in fall 2001 to 14.7% in spring of 2005. During 1999-2004 capture success and observations have declined when compared against the 10-yr average 1988-1998 at Assateague Island, however, this decline can not be directly attributed to WNV based on our data. Results from this study reflect the increasing prevalence of WNV throughout North America. Based on our data continued monitoring and research are warranted.

APPENDIX – III

Band Return Information - 2011

Previously Banded Padre Returns:

Band #	Date	Age	Sex	Captured By	First Banded By	Age	Date	Location	Status	Comments
1687-00647	11-Apr-2011	SY	F	M. Yates	G. Doney	HY	15-Oct-2010	SPI	RTRN	
1687-10137	13-Apr-2011	ASY	F	M. Yates	M. Yates	SY	22-Apr-2006	SPI	RTRN	RTRN-10/15/07-R. Mutch
1687-10478	14-Apr-2011	ASY	F	B. Seegar	M. Yates	SY	18-Apr-2010	SPI	RTRN	
1807-86651	14-Apr-2011	ASY	F	M. Yates	G. Doney	HY	20-Oct-2007	SPI	RTRN	
1807-86495	15-Apr-2011	ASY	F	B. Seegar	B. Latta	ASY	2-Oct-2003	SPI	RTRN	
1687-10476	17-Apr-2011	ASY	F	B. Seegar	M. Yates	ASY	18-Apr-2010	SPI	RTRN	
1687-03621	21-Apr-2011	ASY	F	M. Yates	C. Wightman	HY	10-Oct-2006	SPI	RTRN	
1687-03707	21-Apr-2011	ASY	F	M. Yates	G. Doney	HY	24-Oct-2008	SPI	RTRN	
1947-00740	5-Oct-2011	SY	F	A. Franke	R. Mutch	HY	8-Oct-2010	SPI	RTRN	RCAP-10/08/11-N. Todd
1947-00590	6-Oct-2011	SY	F	N. Todd	N. Todd	HY	6-Oct-2010	SPI	RTRN	

Foreign Captures & Recoveries:

Band #	Band Date	Age	Sex	First Banded	Location	Captured By	Date	Age	Location	Lat	Lon	Status	Comments
1807-51685	17-Oct-99	HY	F	R. Mutch	SPI	A. Franke	31-May-11	ASY	Nunavut	62 4	092 0	FCAP	Ranking Inlet NU, - Breeding '06-'09, 2011
1807-82531	17-Apr-00	SY	F	B. Seegar	SPI	A. Franke	26-May-11	ASY	Nunavut	62 4	092 0	FCAP	Ranking Inlet NU, - Breeding 2003- 2011
1947-00531	15-Oct-09	ASY	F	J. Snyder	SPI	M. Prostor	05-Aug-11	ASY	Nunavut	69 25	082 46	FCAP	Melville Peninsula, NU Breeding 2010-2011
0816-64077	30-Sep-10	HY	M	N. Todd	SPI	J. Fernandez	01-Dec-10	HY	Mexico	19 2	099 0	RCOV	Killed by airplane-Distro Federal, MX
1947-00794	15-Oct-10	HY	F	G. Doney	SPI	K. Bishop	06-Oct-11	SY	Texas	30 1	097 1	FRTR	Captured -injury-in captivity-Bastrop, Texas
1687-05117	12-Aug-11	HY	F	A. Antcil	NU	B. Latta	20-Oct-11	HY	SPI	70 21	078 34	FRTR	Nestling banded in Baffin Island, NU

Status Codes:

RTRN – Padre Returns, FCAP – Foreign capture of falcon banded at Padre, FRTR – Capture of a falcon banded elsewhere, RCOV – Band recovery – found dead