**Perdido Key Beach Mouse**
**(*Peromyscus polionotus trissyllepsis*)**

**Photo by: USFWS**

# 5-Year Review:
# Summary and Evaluation

**U.S. Fish and Wildlife Service**
**Southeast Region**
**Panama City Field Office**
**Panama City, Florida**

**5-Year Review**
**Perdido Key Beach Mouse (*Peromyscus polionotus trissyllepsis*)**

## I. GENERAL INFORMATION

**A. Methodology used to complete the review:** This review was completed by the Service's lead recovery biologist for the Perdido Key beach mouse (PKBM) located at the Panama City Field Office. Information sources include the Recovery Plan for the Choctawhatchee Beach Mouse, PKBM, and Alabama Beach Mouse (1987), peer-reviewed scientific publications, unpublished reports, ongoing field survey results and information from qualified Service and State biologists, the final rule listing the subspecies, revised critical habitat (2006), and peer review comments (Appendix A). All literature and documents used in this review are on file at the Panama City Field Office. All recommendations resulting from this review are the result of thoroughly reviewing the best available information on the PKBM. No part of the review was contracted to an outside party. The public notice for this review was published on March 25, 2014, with a 60-day public comment period (79 FR 16366).

**B. Reviewers**

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## C. Background

**1. Federal Register Notice citation announcing initiation of this review:** 79 FR 16366 (March 25, 2014).

**2. Species status:** Increasing. We believe based on track tube data and limited field surveys that PKBM are increasing since the last review. Genetics data shows PKBM moving along the frontal berm and dunes to reach each of the three public lands containing the most contiguous and suitable habitat (FWC 2013a, FWC 2013b, Austin et al in review)

**3. Recovery achieved:** 2 – 26 -50% Recovery actions completed based on Recovery On-Line Activity Reporting (ROAR). Many smaller recovery action items were completed or initiated with our partners to reach this current achievement.

**4. Listing history**

Original Listing
FR notice: 50 FR 23872
Date listed: June 6, 1985
Entity listed: Subspecies
Classification: Endangered

**5. Associated rulemakings**

Critical habitat was designated at the time of listing (1985), and revised October 12, 2006 (71 FR 60238).

**6. Review History**

Recovery Plan, August 12, 1987

Status Review, 1991: In this review (56 FR 56882), different subspecies were simultaneously evaluated with no species-specific, in-depth assessment of the five factors and threats as they pertained to the different subspecies' recovery. The notices summarily listed these subspecies and stated that no changes in their designation were warranted at that time. In particular, no changes were proposed for the status of the PKBM in the review.

Status Review, 2007: In this review (71 FR 56545), we determined that no change was required to the endangered classification for the PKBM.

Recovery Data Calls: 2000 (declining); 2001 (improving); 2002 (improving); 2003 (improving); 2004 (unknown); 2005 (unknown); 2006 (declining); 2007 (declining); 2008 (declining); 2009 (unknown); 2010 (unknown); 2011 (improving).

FWC Beach Mouse Track Tube Monitoring in Northwest Florida: 2012 (improving); 2013 (improving).

**7. Species' Recovery Priority Number at start of review (48 FR 43098):** 3c

The PKBM is assigned a recovery priority of 3c because the degree of threat to its persistence is high, it is a subspecies and its potential for recovery is great if threats can be eliminated or minimized. The category "c" has been assigned to PKBM to indicate conflict with economic activities.

**8. Recovery Plan**

Name of plan: Choctawhatchee Beach Mouse, Perdido Key Beach Mouse, and Alabama Beach Mouse Recovery Plan
Date issued: August 12, 1987

## II REVIEW ANALYSIS

### A. Application of the 1996 Distinct Population Segment (DPS) policy

**1. Is the species under review listed as a DPS?** No.

**2. Is there relevant new information that would lead you to consider listing this species as a DPS in accordance with the 1996 policy?** No.

### B. Recovery Criteria

**1. Does the species have a final, approved recovery plan containing objective, measurable criteria?** Yes.

**2. Adequacy of recovery criteria.**

**a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?**

No, the approved recovery plan for the Perdido Key beach mouse (1987) is not up-to-date in regards to subspecies' status, threats, and critical habitat. The status does not reflect the PKBM populations occupying each of the three public lands. The criteria do not address specific threats to the subspecies, or their particular vulnerability to stochastic events. Since PKBM critical habitat has been revised, the criterion involving a percentage of occupied and protected critical habitat may also warrant modification.

The approved recovery plan for PKBM (1987) does contain recovery

criteria, though it is not up-to-date in regard to species' status and threats. Therefore, implementation of recovery should be based on the best available information and current knowledge of the subspecies and its needs until the recovery plan can be updated.

**b. Are all of the 5 listing factors that are relevant to the species? Addressed in the recovery criteria?**

All five listing factors are relevant to PKBM, but are not addressed in the current recovery plan. The five listing factors are: 1) Present or threatened destruction, modification or curtailment of its habitat or range; 2) Overutilization for commercial, recreational, scientific, or educational purposes; 3) Disease or predation; 4) Inadequacy of existing regulatory mechanism; and 5) Other natural or manmade factors affecting its continued existence.

**3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.**

"Each subspecies of beach mouse can be considered for downlisting to threatened when there are three distinct, self-sustaining populations in each of the critical habitat areas, and a minimum of 50% of the critical habitat is protected and occupied by mice."

Since the Recovery Plan was finalized (1987), all populations of PKBM at each of the three public lands (Gulf State Park (GSP), Perdido Key State Park (PKSP), and Gulf Islands National Seashore (GINS)) have been extirpated at some time. Through translocation efforts, at least one population has remained viable to present day (see II.C.1.b). Currently, PKBM are present on all public land areas, however, they are not self-sustaining as the threats have not been removed. The current plan does not define indictors of a self-sustaining population, indicate the length of time the population should be self-sustaining, or discuss the conditions that would be required to allow the PKBM population to naturally "boom and bust" as is typical of all beach mouse populations.

Current distribution and densities of PKBM on adjacent private lands are unknown. Many areas of private lands that are currently classified as critical habitat (revised 2006) were not addressed in the Recovery Plan. The second criterion ("minimum of 50% of the critical habitat is protected and occupied by mice") has not been met.

## C. Updated Information and Current Species Status

### 1. Biology and Habitat

**a. Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:**

*Abundance and population trends.*
Since its listing in 1985, PKBM population estimates never reached more than 400 to 500 individuals until 2003. Before Hurricane Ivan (2004), trapping survey data led to a population estimate of 500 to 800 which was divided between two populations - the Johnson Beach Unit of Gulf Islands National Seashore (GINS) and Perdido Key State Park (PKSP) (Service 2004). The population of PKBM at Gulf State Park – Florida Point (GSP) was likely extirpated in 1999 (Moyers et al 1999). In October 2005, following the active hurricane seasons of 2004 and 2005, a trapping effort of less than one-third of the habitat available on public lands yielded captures of fewer than 30 individuals. Tracking data from June 2006 indicated that about 25 and 32 percent of the available habitat was occupied at PKSP and GINS, respectively (FWC 2007). Trapping at PKSP in March 2007 was cancelled after two nights following the capture of only one mouse (a fatality) and very few sightings of beach mouse tracks or burrows (FWC 2007). Trapping conducted in April of 2008 was more encouraging with the capture of 35 mice at GINS (Sneckenberger 2008 pers. comm.). However, no mice were captured on PKSP (Loggins 2008). Tracking data from summer of 2009 suggested population abundance and distribution was increasing within GINS and PKSP (FWC 2010). Trapping at GINS and PKSP in spring 2010 generally confirmed this with PKBM widely distributed at both public lands. However, abundance at GINS was lower than anticipated.

Extensive monitoring efforts at GSP during 2009 and early 2010 failed to show any presence of PKBM. In the spring of 2010, captive-born PKBM from Brevard and Palm Beach zoos were released at GSP. A total of 48 PKBM were released in the southwestern portion of GSP and 28 were fitted with radio transmitters. Within a few days, 15 of the transmitters were found in a red fox den. By the time two adults and five red fox pups were removed by USDA employees, only 13 mice remained. Monitoring continued daily for the life of the transmitters (3 weeks) and monthly tracking and periodic trapping continued over the summer and fall. A 3-day trapping effort at the end of September 2010 yielded 51 individual PKBM, including 8 of the originally released mice. Mice were found throughout habitat at GSP south of Highway 182 (FWC 2010). A 3-day trapping effort the week of May 7, 2012, continued to find PKBM distributed throughout habitat south of Highway 182. Two reproductively-active male PKBM were found north of Highway 182 (Gore pers. comm. 2012). According to current track tube data and recent limited trapping, the reintroduced population at GSP is still present in

2014 and PKBM are occupying all three public lands for the first time since being listed as endangered in 1985.

No significant trapping of the public lands on Perdido Key has occurred since May 2012. GINS was trapped in July 2012 for one night to obtain DNA samples. However, recent tracking data show PKBM are present at 85%-95% of the tracking tubes set across suitable habitat in all three public land areas (FWC, 2013 and FWC, 2013).

In summary, PKBM appear to have increased in number and distribution in recent years. This is likely due to reduced pressure from new development, the absence of tropical storm events, the release of PKBM at GSP, and active management of predators throughout Perdido Key. These factors have likely contributed to an increase in high quality coastal dune habitat within the dynamic coastal ecosystem. However, the area within PKBM's historic range continues to experience development and suitable habitat on private lands is becoming increasingly fragmented. PKBM remain vulnerable to impacts from known threats despite the current suspected high population numbers. Less than 10 years ago, they were close to extinct resulting from impacts due to multiple threats on the overall population.

*Demographic features.*
Long-term trapping data have shown that beach mouse densities are cyclic and fluctuate greatly on a seasonal and annual basis. These fluctuations can be a result of reproduction rates, food availability, habitat quality and quantity, catastrophic events, disease, and predation (Blair 1951; Bowen 1968; Smith 1971; Hill 1989; Rave and Holler 1992; Swilling et al. 1998; Swilling 2000; Sneckenberger 2001). Without suitable habitat and connectivity sufficient in size to support the natural cyclic nature of beach mouse populations, subspecies are at risk from local extirpation, and may never attain the densities necessary to persist through storm events and seasonal fluctuations of resources.

Researchers at UF used population genetics to further examine connectivity in PKBM on Perdido Key. Recent genetic data have provided a snapshot of connectivity between the three parks between 2010 and 2012 (Austin 2012, Austin et al. in review). Using 16 microsatellite loci, the researchers detected mixed ancestry individuals between parks (n=18 mice; 78 samples) with another three individuals having high probability of being migrants from PKSP. In contrast, one GSP mouse was detected out of 137 PKSP samples. Though hybridization analyses were not conducted between PKSP and GINS from 2010, there was no evidence that migrants or mixed-ancestry mice were sampled during that period (Austin et al. in review). In contrast, the PKSP and GINS analysis from 2012 (137 and 87 mice in PKSP and GINS respectively) identified

one GINS migrant in PKSP, and two PKSP migrants in GINS. There was one hybrid identified as a hybrid in PKSP and five in GINS.

Two factors may have contributed to the timing of dispersal detected in 2012. First, mice appear to have increased in number considerably between 2010 and 2012. PKBM dispersal probability would be inversely related to the carrying capacity of the habitat (McPeek and Holt 1992). While this hypothesis requires further examination, it is reasonable that as PKBM density increases, dispersal probability should as well, assuming no constraints on dispersal (e.g. such as habitat suitability). Beach mice are considered to be habitat specialists which in turn means increased extinction risk in relation to fragmentation of native vegetation and decreased rescue effects (Brown and Kodric-Brown 1977).

The second factor is suitable habitat for connectivity. Much of the developed areas between the three parks possess little contiguous suitable habitat. The majority of the contiguous habitat between the parks is found along the primary beachfront dunes. Construction of frontal sand berms began in 2005, and these berms were planted with native plants beginning in 2008. Beach mice are known to regularly use these berms. It is thought that these vegetated berms in conjunction with recent demographic increases have resulted in dispersal detected through genetic means.

Unlike long-lived species with single breeding seasons per year, beach mice breed year-round with up to 13 generations (overlapping and asynchronous among individuals) within one year. Peak breeding occurs in the winter season (Austin et al, in review). To calculate demographic and population growth rates for beach mouse populations, trapping would need to occur on a monthly or bi-monthly basis. Furthermore, because of annual and seasonal population fluctuations common to small mammals and differences between sites, abundance data alone carry little meaning, particularly when trapping is incidental. Consequently, as the data we currently collect or have access to are limited, population trends of PKBM are based on presence data and trends in recent tracking or trapping sessions.

Because of their close ancestry and analogous life histories, research on one beach mouse subspecies is often inferred to the other subspecies. Based on research on old-field mice and beach mouse species, beach mice are considered monogamous (Smith 1966; Foltz 1981; Lynn 2000). While a majority of individuals appear to pair for life, paired males may sire extra litters with unpaired females (Foltz 1981). Beach mice are considered sexually mature at 55 days of age; however some are capable of breeding earlier (Weston 2007). Gestation averages 28 to 30 days (Weston 2007) and the average litter size is four pups (Fleming and Holler 1990). Littering intervals may be as short as 26 days (Bowen 1968). Peak

breeding season for beach mice is autumn and winter, declining in spring, and falling to low levels in summer (Blair 1951). However, pregnant and lactating beach mice have been observed in all seasons (Moyers et al. 1999).

Apparent survival rate estimates (products of true survival and site fidelity) of beach mice along the Gulf Coasts of Florida and Alabama have demonstrated that their average life span is about nine months (Swilling 2000). Other research indicated that 63% of Alabama beach mice lived (or remained in the trapping area) for four months or less, 37% lived five months or greater and 2% lived 12 to 20 months (Rave and Holler 1992). Less than half (44 percent) of beach mice captured for the first time were recaptured the next season (Holler et al. 1997). Greater than 10% of mice were recaptured three seasons after first capture; and 4-8% were recaptured more than one year after initial capture. Beach mice held in captivity have lived three years or more (Blair 1951; Holler 1995).

**b. Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.)**

Three genetic studies have been conducted on PKBM and provided trends in genetic variation:

Selander et al. (1971) conducted a study using allozyme markers on 30 populations of *Peromyscus polionotus.* He estimated that the level of allozyme variation found in beach mouse populations was at least 40 percent lower than the level of variation in nearby inland populations, which likely reflects the smaller, isolated nature of island populations. Island populations of vertebrates typically have reduced genetic variation and should not be discounted as a potential factor contributing to greater population extinction rates (Frankham 1997). An already low level of genetic variation is an important consideration considering translocations and founding of captive colonies for reintroductions.

The effects of Hurricane Frederic (1979) coupled with increased habitat fragmentation due to human development led to the extirpation of all PKBM except for one population of fewer than 30 individuals at GSP (Meyers 1983, Holler et al. 1989). Beach mice from this site were used to re-establish PKBM at GINS between 1986 and 1988 (Holler et al. 1989), and PKBM from GINS were translocated to PKSP in 2000. By that time, the GSP population was considered extirpated (Moyers et al. 1999). Wooton and Holler (1999) genotyped 20 mice collected at GINS in February 1999 at five microsatellite loci and concluded the following: (1) founder effect (from GSP to GINS) did impact the GINS subpopulation and loss of rare alleles and allele frequency shifts were noted; (2) a low to moderate level of overall genetic divergence was observed; (3) data

suggest that some effects of genetic drift were mediated by continued transfer of individuals; (4) levels of heterozygosity were unexpectedly high given recent history; (5) average level of relatedness among individuals is high which may portend future inbreeding related problems and no substantial evidence of existing close inbreeding was observed in the data; and 6) the overall level of microsatellite variation retained in the GINS subpopulation was higher than anticipated.

More recent genetic investigation of neutral genetic structuring across the entire range of PKBM has advanced our understanding of existing variability, the impact of captive breeding on standing genetic variation and has provided important insight into the dispersal capabilities of PKBM island-wide. In 2010 and 2012, the three core habitat areas (GSP, PKSP, and GINS) were sampled and genotyped at 16 microsatellite loci (Austin et al, in review). GSP was re-established in 2010 by a release of 48 captive bred mice. The specific objectives for this research effort were to document the level of genetic drift associated with the reintroduction and growth of that population at GSP over a two year period, and to test connectivity between the three main protected areas. In 2010, the three park populations were significantly genetically different than 2012. This level of differentiation can be easily explained by the known history of bottlenecks, reintroductions from an inbred captive colony, and natural re-colonization of PKSP by a few GINS founders in 2009. Genetic levels were highest in GINS, which is consistent with the relatively long history of PKBM occupation of that park.

**c. Taxonomic classification or changes in nomenclature**

Since the listing of the PKBM, further research concerning the taxonomic validity of the subspecific classification of beach mice has been conducted. According to Mullen et. al. 2009, studies support the separation of beach mice from inland forms and the current taxonomy (Bowen 1968) that each beach mouse group represents a unique and isolated subspecies. These studies were based on genetic differences and phenotype classification.

**d. Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range**

Historically, PKBM were documented to occur on Perdido Key in coastal dune habitat between Perdido Bay, Alabama and Pensacola Bay, Florida (50 FR 23872). Habitat loss and fragmentation associated with residential and commercial real estate development has reduced the distribution of the PKBM to a portion of its historic range, and is the primary threat contributing to the endangered status of beach mice (Holler 1992; Humphrey 1992). Coastal development on private lands has fragmented

the habitat used by the subspecies between each of three public lands; GSP, PKSP, and GINS. These private lands are fragmented to various extents, but beach mice are known to occur at varying densities within these areas. The connectivity function of the secondary dune and coastal strand habitat interspersed within these developed areas is largely unknown.

Gulf State Park

Gulf State Park consists of 128 acres of PKBM habitat (115 acres of Critical Habitat) in southern Baldwin County, Alabama, on the westernmost region of Perdido Key. PKBM were known to inhabit this unit during surveys in 1979 and 1982, and by 1986 this was the only known existing population of the subspecies (Humphrey and Barbour 1981; Holler et al. 1989). This population of less than 30 individuals was the donor for the reestablishment of PKBM into Gulf Islands National Seashore in 1986. This project ultimately saved Perdido Key beach mice from extinction as the population at Gulf State Park was considered extirpated in 1998 due to tropical storms and predators (Moyers et al. 1999). In 2010, captive bred mice were released at Gulf State Park. This reintroduction was deemed a success and the population has continued to increase. The track tube monitoring was established at GSP in 2010, which began with only a 9% detection rate and as the new population grew mice were detected at 83% of tubes by the end of the year; and the detection rate ranged from 73% - 85% through 2011 (FWC 2012a and FWC 2014). A 3-day trapping effort the week of May 7, 2012, continued to find PKBM distributed throughout habitat south of Highway 182. Two reproductively-active male PKBM were found north of Highway 182 (J. Gore pers. comm. 2012). Genetic data from released mice and from subsequent wild-born mice revealed a decrease in genetic diversity through 2010, corresponding to the post-released limited survival and reproduction. However, diversity rebounded to similar or higher values by May 2012 sample date (Austin 2012, Austin et. al. in review). Recent track tube data for 2013 shows an average of 93% occurrence of PKBM in the tracking tubes at GSP (FWC 2013a and FWC 2013b). The reintroduced population of PKBM is still present in 2014 and PKBM are occupying all three public lands for the first time since being listed as endangered.

Perdido Key State Park

Perdido Key State Park consists of 248 acres of PKBM habitat (238 acres is Critical Habitat) in southern Escambia County, Florida. Trapping efforts in this area were limited in the past. In 2000, a successful relocation program reestablished mice at PKSP. In 2004 and 2005, hurricane/tropical storm damage to the habitat at PKSP dropped PKBM detection to only 10 percent of the available habitat, indicating low densities (FWC 2007). In 2005, the FWC started monitoring the presence

of PKBM on public lands by tracking tubes. The Service and other land managers have relied on this data as a means of tracking the presence of PKBM in GSP, PKSP, and GINS. Tracking data from June 2006 indicated that about 25% of the available habitat was occupied at PKSP (FWC 2007). Trapping at PKSP and GINS in March 2007 was cancelled after one night after the capture of only one mouse (a fatality) and very limited sightings of beach mouse sign (tracks, burrows) (FWC 2007). Trapping conducted in April of 2008 found no mice on PKSP (Loggins 2008). According to 2009 tracking data, there were no mice occurrences at PKSP until May 2009, then only sporadic occurrences until November 2009 as the occurrence data started to show a slow but steady increase (FWC 2014). Tracking data from 2010 showed a dramatic increase in PKBM occurrences within PKSP with 20% occurrence at the beginning of the year, and 84% occurrence at the end of 2010 (FWC 2010). Trapping in 2010 on PKSP captured 11 individual beach mice (11 total captures) in February and 36 individuals (106 total captures) in May. Additionally, genetic data from a sample of 36 (Austin 2012, Austin et. al. in review) revealed relatively high levels of diversity (as high as or higher than GINS from the same time period). Although diversity was relatively high, PKSP was still highly differentiated from GINS as a result of the "founder effect" process resulting from dispersal of a relatively small number of mice that were a limited representation of the genetic variation from GINS in 2009. At that time, information was insufficient to accurately estimate population size. These captures represent the minimum number of mice in the park for those months. Trapping at GINS and PKSP by Service and FWC staff in spring 2010 confirmed the population was increasing with PKBM widely distributed at both public lands.

The number of track tubes visited by mice has increased over the past several years and recent years indicate almost all track tubes contain PKBM tracks. This is likely due to the fact that the storm-impacted coastal habitats have continued to recover and development and predator pressures have decreased. PKBM have been detected at >96% of 81 track tubes in PKSP each year since 2011, indicating mice are again distributed throughout the park. (J. Gore pers. comm. 2011, FWC 2012a, FWC 2012b, FWC 2012c and FWC 2014).

Gulf Islands National Seashore

Gulf Islands National Seashore consists of 753 acres of PKBM habitat (638 acres Critical Habitat) in southern Escambia County, Florida, on the easternmost region of Perdido Key. Beach mouse habitat on GINS provides the longest contiguous expanse of frontal dune habitat within the historic range of the PKBM. PBKM were known to inhabit this unit in 1979, though the population was impacted by Hurricane Frederic that same year. The unit was unoccupied at the time of listing. However, no beach mice were captured during surveys in 1982 and 1986 (Humphrey

and Barbour 1981; Holler et al. 1989). In 1986, PKBM were re-established at GINS as part of the State of Florida and Service recovery efforts. In 2000 and 2001, PKBM captured from this site served as founders to re-establish beach mice at PKSP. Due to damage from storm surge during the 2004 and 2005 storm seasons, the PKBM population was slow to rebound, and by 2007, only trapping conducted in April of 2008 was more encouraging with the capture of 35 mice at GINS (S. Sneckenberger pers. comm. 2008). Through 2008-2010, the population continues to expand from GINS to PKSP. This is the first known natural recolonization of a park since monitoring began. From 2010 to 2013, the track tube occurrences have averaged 84%, 94%, 95%, and 94% respectively (FWC 2012a, FWC 2012b, FWC 2012c, FWC 2013a, and FWC 2013b, FWC 2014; see Table below).

| | GSP | PKSP | GINS |
|---|---|---|---|
| 2009 | NA | 2.9% | 48% |
| 2010 | 48% | 55% | 84% |
| 2011 | 88% | 96% | 94% |
| 2012 | NA | 99% | 95% |
| 2013 | 93% | 97% | 94% |

Table depicting the percentage of PKBM occurrences in track tubes within the three public lands

Beach mice naturally persist through local extirpations due to storm events or the harsh, stochastic nature of coastal ecosystems. Historically, these areas would be recolonized as population densities increased and dispersal occurred from adjacent populated areas. From a genetic perspective, beach mice recover well from population size reductions (Wooten 1994), given sufficient habitat is available for population expansion after the bottleneck occurs. As residential and commercial development has fragmented the coastal dune landscape, beach mice can no longer recolonize along these areas as they did in the past (Holliman 1983). Conservation and restoration of contiguous tracts of suitable habitat throughout Perdido Key should increase the probability of beach mice persisting into the future.

**e. Habitat or ecosystem conditions**

The primary and secondary dunes (frontal dunes) were previously considered optimal beach mouse habitat since it is where the mice were thought to reach their highest densities (Blair 1951; Meyers 1983; Holler 1992). Because the scrub dunes appeared to support lower densities of beach mice, this habitat was believed to be of lower quality (Blair 1951, Bowen 1968). As a result, the scrub dunes were not considered to be of great importance to beach mice (Swilling 2000), and little attention was paid to this habitat (Sneckenberger 2001). Evidence now indicates that

scrub dunes are an important component of beach mouse habitat (Swilling 2000, Sneckenberger 2001) serving as refugia for beach mice during and after a tropical storm event (Holliman 1983, Swilling et al. 1998), as the frontal dunes rebuild (Swilling et al. 1998, Sneckenberger 2001). The 2006 revision of critical habitat includes scrub dune habitat.

Approximately 1,711 acres of PKBM habitat currently exists and approximately 50 percent of their remaining habitat is public land. The frontal and scrub dunes at GSP are relatively low due to past disturbance from hurricanes. Scrub habitat is separated from the frontal dunes by a four-lane highway in some areas. Consequently, the population inhabiting GSP can be especially vulnerable to impacts from tropical storm events, and therefore further linkage to scrub habitat and/or habitat management would improve connectivity.

On PKSP, habitat has been restored passively by nature and actively by park personnel. Maintaining undisturbed habitat and continuing to restore where needed would provide more functional connectivity for dispersal, exploratory movements, and population expansion. As the majority of the PKBM habitat at GINS consists of frontal dunes, the population inhabiting this area is particularly threatened by storm events. Threats common to all three public land areas that may require special management considerations include artificial lighting, presence of feral cats as well as other predators at high levels, and high recreational use that may result in soil compaction, damage to dunes, and/or a decrease in habitat quality. Dispersal inferred indirectly (through genetic testing) has supported the hypothesis that the reconstructed frontal berms may have played an important role in allowing for increased connectivity between PKSP and GSP, and between PKSP and GINS (Austin 2012, Austin et al. in review). Therefore maintaining these vegetated berms along the frontal dunes is a high priority for conservation of PKBM.

Maintaining habitat on private lands continues to be imperative to preserve connectivity and allow for population expansion. While the habitat continues to recover from past hurricane damage, new and re-development projects have slowed down, and feral cats and other predators have largely been removed, these threats still remain and current conditions and population estimates are only a snapshot in time and could change in the future. Land acquisition and preservation remain to be the key in providing future habitat to enable PKBM to recover from these threats when they occur.

**f. Other natural factors (tropical storms and hurricanes)**

Tropical storm events affect beach mouse population densities in frontal dune and scrub habitats. Possible effects include direct mortality of

individuals, relocation/dispersal, and subsequent long-term effects of habitat alterations (i.e., impact on food resource availability and dune structure). Additionally, unnatural debris and material can get dispersed throughout the dune habitat causing a change in habitat composition and further impacts from clean-up. Habitat impacts can be widespread, encompassing the range of the subspecies.

Tropical storms and hurricanes affect PKBM habitat in the following ways:

1) Tidal surge and wave action overwashes habitat leaving flat sand surface denuded of vegetation;
2) Sand deposition completely or partially covers vegetation;
3) Blowouts occur between the Gulf and bay/lagoon leaving a patchy landscape of bare sand, dune, and scrub habitat;
4) The frontal portion of the primary dune habitat is sheared (damage to landward areas varies in severity);
5) Vegetation is killed by salt spray and/or prolonged inundation; and
6) Islands may be breached entirely and channels from the Gulf to bay/lagoon may be created.

Although tropical storm events especially hurricanes can significantly alter PKBM habitat and population densities in certain habitats, some physical effects may benefit the subspecies. Tropical storm events are responsible for maintaining coastal dune habitat upon which beach mice depend through repeated cycles of destruction, alteration, and recovery of dune habitat. Tropical storm events could function to break up population subgroups and force population mixing (Holler et al. 1999). The resultant breeding between members of disparate subgroups increases genetic heterogeneity and could moderate effects of genetic drift and bottlenecks.

## 2. Five-Factor Analysis

### a. Present or threatened destruction, modification or curtailment of its habitat or range:

Due to coastal development, from the PKBM's historic range of 16.9 miles of coastal dune habitat, an estimated nine miles of habitat with relatively moderate fragmentation remains. Habitat destruction is the primary threat to PKBM. All populations of PKBM on public lands have been extirpated at least once due to the various threats facing the PKBM. Through translocation efforts, at least one population has remained viable to present day (see II.C.1.b). Currently, PKBM are present on all three public land areas. Less than 1,711 acres of PKBM habitat remains in its entirety, portions of which include heavily fragmented habitat on private lands. These heavily fragmented areas make it difficult to maintain

connectivity to and between each of the three public lands and the coastal scrub refugia on private lands. Portions of these areas are also degraded due to recreational pressure (primarily foot traffic in coastal dune habitat), introduction of non-native predators, and other anthropogenic factors.

The conservation of multiple large, contiguous tracts of habitat is key to the persistence of beach mice. At present, large parcels exist mainly on public lands. Protection, management, and conservation of beach mice and coastal dune habitat on public areas have been complicated by increased recreational use by humans as public lands are rapidly becoming the only natural areas left on the coast. Where protection of large contiguous tracts of beach mouse habitat along the coast is not possible, establishing multiple independent populations is the best defense against local extirpations and complete extinctions due to storms and other stochastic events (Shaffer and Stein 2000; Oli et al. 2001; Danielson 2005). Protecting multiple populations increases the chance of at least one population within the range of a subspecies surviving episodic storm events and persisting while vegetation and dune structure recover.

Isolation of small populations of beach mice also reduces or precludes gene flow between populations and can result in the loss of genetic diversity. Factors such as predation (especially by domestic cats), diseases, and potential competition with house mice, are intensified in small, isolated populations which may be rapidly extirpated by these pressures. Especially when coupled with events such as tropical storms, reduced food availability, and/or reduced reproductive success, isolated populations may experience severe declines or extirpation (Caughley and Gunn 1996).

Habitat connectivity also becomes essential where mice occupy fragmented areas lacking one or more habitat types. If scrub habitat is lacking from a particular tract, adjacent or connected tracts with scrub habitat are necessary for food and burrow sites when resources are scarce in the frontal dunes, and are essential to beach mouse populations during and after tropical storm events. Trapping data suggests that beach mice occupying the scrub following hurricanes recolonize the frontal dunes once vegetation and some dune structure have recovered (Swilling et al. 1998; Sneckenberger 2001). Similarly, when frontal dune habitat is lacking from a tract and a functional pathway to frontal dune habitat does not exist, beach mice may not be able to attain the resources necessary to expand the population and reach the densities necessary to persist through the harsh summer season or the next storm (Sneckenberger 2001). Functional pathways may allow for natural behavior such as dispersal and exploratory movements, as well as gene flow to maintain genetic variability of the population within fragmented or isolated areas. To that

end, contiguous tracts or functionally connected patches of suitable habitat are essential to the long-term conservation of beach mice.

Several projects have been conducted in the past decade that have and will continue to aid in the recovery of PKBM and increase our understanding of PKBM population dynamics and life history. Following Hurricane Ivan, Escambia County (with some FEMA funding) constructed a protective, vegetated berm seaward of beachfront condominiums on Perdido Key. This man-made berm provided connectivity through the developed areas to the three public lands by creating a "dune-like" structure that acted as a thoroughfare. This project also supplied sand to the area to facilitate natural dune creation. In a project funded by the Service, the Florida Department of Environmental Protection (FDEP) collected and raised cuttings and seeds from coastal dune plants that were unavailable at nurseries. These plants were used to naturally revegetate the state and federal parks. The Service also partially funded the rebuilding of dune walkovers at PKSP to provide beach access and minimize impacts to the dune habitat.

Currently, Escambia County is in the final stages of approval for their Perdido Key Habitat Conservation Plan (HCP) which will provide for sustainable development and conservation areas. Additional PKBM habitat has been purchased in conjunction with the HCP and future parcels have been identified for further conservation efforts. This has been jointly funded by the Service and Escambia County.

**b. Overutilization for commercial, recreational, scientific, or educational purposes**

Not known as a threat at the time of listing or at present. Although scientific research does involve trapping (fitting mice with ear tags) and taking genetic samples (ear tissue snips), there has not been a significant loss of PKBM to scientific purposes.

**c. Disease or predation**

Beach mice have a number of natural non-native predators including the coachwhip (*Masticophis flagellum*), corn snake (*Elaphe guttata guttata*), pygmy rattlesnake (*Sistrurus miliarius*), Eastern diamondback rattlesnake (*Crotalus adamanteus*), short-eared (*Asio flammeus*) and great-horned owl (*Bubo virginianus*), great blue heron (*Ardea herodias*), northern harrier (*Circus cyaneus*), loggerhead shrike (Lanius ludovicianus), gray fox (*Urocyon cinereoargenteus*) striped skunk (*Mephitis mephitis*), long-tailed weasel (*Mustela frenata*), raccoon (*Procyon lotor*), bobcat (*Lynx rufus*), ghost crabs (*Ocypode quadrata*), red fox (*Vulpes vulpes*), coyotes (*Canis latrans*), free-roaming and feral cats (*Felis* sp.) (Blair 1951; Bowen 1968;

Holler 1992; Novak 1997; Moyers et al. 1999; Van Zant and Wooten 2003). Large healthy beach mouse populations that have sufficient recruitment in good habitat are typically able to persist despite the presence of numerous predators.

Conversely, increased predation pressure on isolated beach mouse populations from natural and non-native predators can have a substantial impact. Free-roaming and feral cats are believed to have a devastating effect on beach mouse persistence (Bowen 1968; Linzey 1978) and are considered to be the primary cause of the extirpation of isolated populations of beach mice, and a contributing factor to the extinction of the Pallid beach mouse (Bowen 1968; Holliman 1983; Humphrey 1992). Predation of beach mice by feral cats has been documented (Van Zant and Wooten 2003), and with habitat loss is considered the most serious threat to beach mouse populations (Gore 1994). Cat tracks have been observed in areas of low trapping success for beach mice (Moyers et al. 1999) and Gore and Schaefer (1993) found beach mouse tracks were inversely correlated with the presence of cat tracks.

A predator control program has been implemented since 1996 on coastal public lands across northwest Florida. The program is ongoing, and a permanent USDA position was established in northwest Florida to conduct the control work (Northwest Florida Partnership 2000; Daniel et al. 2002). Multiple partners contribute to this fund as the issue crosses many lands and programs. Feral cats remain a threat to all beach mouse populations. Recently, the FWC was awarded a grant from the Deepwater Horizon National Resource Damage Assessment Phase II project to increase predator control efforts in northwest Florida. There are now three dedicated USDA positions in the area.

Diseases and parasites pose no known threat to beach mouse populations at this time.

**d. Inadequacy of existing regulatory mechanisms**

Numerous guidelines, conservation measures, and regulatory mechanisms are in place to minimize impacts to PKBM and their habitat. Construction guidelines and best management practices for development projects were developed and updated by the Service. These are provided to developers, consultants, and other agencies. These guidelines offer recommendations aimed to minimize impacts pre-construction, during construction, and in operation and management following construction. Such measures include prohibiting cats and unleashed dogs, providing controlled access to the beach, use of predator-proof refuse containers, prohibiting use of clay materials in roadbeds within coastal areas, and use of wildlife-friendly lighting.

Perdido Key beach mice are also a state-listed species. While the FWC no longer issues permits for incidental take of PKBM, the Service works closely with them on recovery efforts and to monitor the subspecies. Coastal dunes are protected from pedestrian traffic on state and federal lands (through the Florida Administrative Code 62D-2 2.013(2) and national seashore-specific laws and policies, respectively), but there are no such regulations pertaining to coastal dunes on private lands.

Escambia County has an ordinance that addresses animal control, though feral cats are found on Perdido Key. The ordinance states that cats must be "confined to your property or under direct control if it is off your property." Pets are not permitted to roam at large off one's property; nor are they permitted on the public beaches. County Animal Control has also been a partner in addressing the number of feral and free roaming cats found in PKSP. The USDA and/or PKSP call the County Animal Control once a cat has been trapped and they collect the cat and determine if it is suitable for adoption.

A Perdido Key conservation fund was set up as a voluntary mitigation option based on *A Conservation Strategy for the Perdido Key Beach Mouse*, which outlined measures needed to conserve the subspecies (FWC et al. 2005). The conservation objectives for the strategy are to create, enhance, and maintain PKBM and habitats in PKSP, GINS, and GSP; and restore, enhance, and maintain beach mice and contiguous PKBM habitat in the primary, interdunal, secondary, and scrub dune systems within and between GINS, PKSP, and GSP. As part of this intergovernmental agreement, Escambia County adopted an ordinance that prohibits building or placing structures seaward of the 1975 Coastal Construction Control Line. This is estimated to permanently protect 5 acres of PKBM habitat.

While land acquisition is a component of the Conservation Strategy, funding for land acquisition within the Conservation Fund is minimal, keeping the cost of the initial and annual contributions low. Consequently, avoidance and minimization on each project site to the extent practicable must be accomplished before using the conservation fund to offset impacts.

**e. Other natural or manmade factors affecting its continued existence:**

Tropical storms and hurricanes:
Tropical storm events affect beach mouse population densities in various habitats. Effects include direct mortality of individuals, relocation/dispersal of individuals out of natural habitat, and subsequent long-term effects of habitat alterations (i.e., impact on food resource

availability and dune structure). Habitat impacts can be widespread, encompassing the range of the subspecies.

Although tropical storm events can significantly alter PKBM habitat and population densities in certain habitats, some physical effects may have modest benefits to the subspecies (see section II.C.1.f.). Although it is likely that any potential benefits to PKBM caused by tropical storm events are outweighed by the adverse impacts.

Artificial lighting:
Artificial lighting increases the risk of predation and influences beach mouse foraging patterns and natural movements as it increases their perceived risk of predation. This alteration in behavioral patterns causes beach mice to avoid otherwise suitable habitat and decreases the amount of time they are active (Bird et al. 2004). Escambia County has provided the Service with a draft lighting ordinance that would cover Perdido Key.

Because of the increasing recreational use of Perdido Key beaches, educating the property owners and visitors on the importance of threatened and endangered species conservation is important. The Service funded the design and distribution of "Share the Shore" signs for installation on coastal public lands. Both the National Park Service and Florida Park Service have installed the signs at beach access points.

Sea level rise:
Sea level rise is an increasing threat to PKBM and all other coastal dependent species based on numerous prediction models. According to the Third National Climate Assessment, release May 2014, sea level rise and increasing storm surge events are occurring and are impacting coastal species and ecosystems (Melillo et al. 2014 and Wolf 2014). It is expected that low-lying coastal habitat will be affected most severely by sea level rise. According to the NOAA Sea Level Rise and Coastal Flooding Impacts Viewer (NOAA 2014), the Ft. McRae area of GINS becomes disconnected by a 2 ft. rise in sea level. Significant loss of PKBM habitat range-wide becomes apparent around 6 ft. of sea level rise. Based on the Sea Level Rise Affecting Marshes Model (SLAMM), a 6 ft. rise would remove significant amounts of habitat within PKSP and the surrounding Key. The existing development would not allow for the natural regression of the dune habitat. This could result in a shrinking of available frontal dune habitat, thus securing coastal strand habitat would be important for long term subsistence. However, a young patch of sea oats can accumulate a foot of sand in one year, which is faster than sea level rise. For this reason, barrier islands are a persistent (though dynamic) component of the coastal landscape through eons of fluctuating sea levels.

## D. Synthesis

New studies and baseline data have increased our understanding of the subspecies, thus this five-year review provides a current assessment of the subspecies status and threats.

PKBM population numbers are at a suspected all time high largely due to the absence of recent hurricanes. There are PKBM populations at each of the three public lands on Perdido Key. The recent slump over the past several years in development within the PKBM range has lessened the continual pressure from development and habitat loss. However, development interests on Perdido Key are starting to return. Currently, feral and outdoor cats appear to be minimized; though, the threat is still relevant.

Despite the current status of PKBM populations, the threats have not been abated and will likely increase as development paradigms shift on Perdido Key. Perdido Key beach mouse is mainly threatened by habitat destruction and fragmentation, and recovery actions for PKBM will always be in conflict with development. In addition, they are vulnerable to feral cats and tropical storm events. Even considering their current status and quality of their habitat, PKBM populations may not be able to persist following a stochastic event (i.e., unnatural predator levels, loss of habitat, tropical storm event).

Development activity is beginning to show signs of a rise, and likely to peak once again. Habitat conservation and preservation are needed to ensure the PKBM has suitable habitat and corridors to repopulate from in the event of a threat that causes a population crash. This can be pursued by working closely with partners and private landowners to minimize impacts and promote sustainable development for a coastal barrier island.

Previous and current genetic studies have generally demonstrated that, PKBM possess reduced genetic variation (consistent with island populations) and that the three public parks are highly differentiated. The difference between the three public parks is less important from an adaptive standpoint as the current population can be traced back to the ancestral mice that were in GINS in 2004. The degree of differentiation is entirely due to founder effects from reintroductions from inbred captive mice (GSP) and founder events associated with colonization of PKSP from GINS in 2009. Of importance, genetic data has revealed strong patterns of dispersal and inter-breeding between all three parks in 2012. This dispersal has been hypothesized to have been driven by the concurrent re-establishment of vegetated frontal berms along the length of the island, together with the recent suspected robust numbers in all three parks (Austin et al, in review).

Based on recent tracking tube data: GSP has a 93% detection rate of PKBM; PKSP has a 97% occurrence rate; and GINS has a 94% rate of PKBM occurrence (FWC 2013a and FWC 2013b). The current estimated population is thought to be at a record high since its time of listing (J. Gore pers. comm. 2013). Specific population estimates are expected to be gathered later this year for monitoring purposes. There are PKBM populations at each of the three public lands on Perdido Key. We have established an existing captive breeding program as a recovery action to buffer against local extirpation events when needed. The nature of PKBM populations will always be cyclic. High and low population numbers are expected for a small mammal that lives in such harsh conditions. The threats to PKBM have not been abated and will likely increase as development increases on Perdido Key. Recovery actions for PKBM will likely always be in some level of conflict with development.

The approved recovery plan for PKBM (1987) does contain recovery criteria, though it is not up-to-date in regard to subspecies' status and threats. Emphasis on recovery should be based on current knowledge of the subspecies and its needs until the Recovery Plan can be updated.

Regulatory mechanisms are in place to track impacts to PKBM habitat and aid in minimizing impacts from development on public lands. However, the subspecies' requirements for corridor size and level of tolerance for fragmentation are unknown. Predator control programs have been in place on public lands since 1996, though non-native predators continue to pose a threat to beach mice.

PKBM should remain as an endangered species, because the present threat of habitat destruction and fragmentation, non-native predators, and tropical storm events remains significant. In addition, the criteria for downlisting the species; 3 distinct, self-sustaining populations in each of the critical habitat areas, and a minimum of 50% of the critical habitat is protected and occupied by beach mice, have not been met.

## III. RESULTS

### A. Recommended Classification

**__X__ No change is needed**

### B. New Recovery Priority Number __n/a___

## IV. RECOMMENDATIONS FOR FUTURE ACTIONS

The following suggested recommendations are in order of priority. Please note that these actions are not necessarily specific to PKBM. To that end, many actions listed are appropriate for all

beach mouse subspecies, and in most cases research conducted or plans developed for one subspecies would serve all subspecies.

**A. Additional Biologist**
A second biologist position should be filled to aid in the identified recovery actions. Another biologist could assist in the heavy workload for all beach mice and allow for in-office coordination and consistency with Section 7 and 10 permitting aspects, monitoring and trapping, permit compliance, research, and recovery activities such as translocations and outreach. This position could be an entry level or student trainee position and should work under the lead Recovery biologist. Without such a position, few of the recommendations suggested can be accomplished for PKBM and other beach mouse subspecies.

**B. Revise Recovery Plan**
The recovery plan should be updated to define objective measurable criteria and better address the five factors.

**C. Population and Habitat Assessment program**
The track tube monitoring program has been developed since our last 5-year review and should continue to be implemented for PKBM. Funding for this action is critical. The development of a habitat mapping tool has also been initiated and will soon be peer reviewed and put to use to see landscape connectivity and potential dispersal routes on Perdido Key. An updated PVA needs to be done to estimate future population trends and the likelihood of extinction. This would be beneficial to do while the population is high.

**D. Emergency Response Plan**
A contingency plan to outline actions taken in case of severe threats to the persistence of PKBM (i.e., forecasted category 5 hurricane, feral cat population increase, population crash) (Traylor-Holzer and Lacy 2007) has been initiated since our last 5-year review. Finalization and implementation is recommended. This plan is associated with the PKBM captive breeding program.

**E. Land Acquisition**
Appropriate parcels for land acquisition have been identified using LIDAR data (to identify high-elevation habitat) and current knowledge of PKBM movements and habitat use. The Service should keep this list as relevant as possible to the current landscape and needs of PKBM. Recently, Escambia County purchased a parcel with grant money from the Service. This practice should continue as intact coastal dune habitat is limited.

**F. Corridor size persistence, HCP, genetic studies**
Research should be conducted to investigate the effectiveness of corridors currently set aside in HCPs. Studies should determine the minimum dimensions needed by PKBM to ensure movement of individuals and genetic exchange through corridors. The use of genetic markers to evaluate the effectiveness and trends of existing corridors (i.e., frontal berms) is a promising tool to examine dispersal given the resources needed to conduct traditional capture-mark-recapture studies.

**G. Translocation**
While translocations are not needed at present time, future actions may once again require. Multiple core populations of PKBM are crucial for their long-term persistence. A comprehensive translocation plan is needed to identify key sites, set criteria for when translocations are needed, consider genetic as well as demographic characteristics of the donor and recipient populations, and should include an assessment of the suitability of the recipient habitat (i.e., habitat quality, have feral cats and other threats been minimized or removed). Public-private partnerships and easements should also be explored.

**H. Outreach/Education**
Opportunities to convey the importance of coastal dune habitat to the public should be sought and pursued whenever possible. In addition, an outreach/education program focused on the threats feral cats pose to wildlife and people should also be developed.

**I. Hurricane response studies**
Further research should be implemented to determine the response of beach mice to storm events. This could determine whether (or to what extent) beach mice retreat to the scrub dunes, remain in their burrows, or perish. Further studies to investigate the effects of revegetation and habitat modification on beach mouse habitat use and foraging patterns following storm events should be conducted.

**J. Coastal dune habitat restoration protocol**
A protocol should be developed and adopted to inform partners and applicants of proper, sustainable dune restoration practices. Funding is needed for a researcher to work closely with the Service to gather existing literature, conduct studies where information is lacking, and draft a protocol.

The State greenhouse project should be continued to conduct research on cultivating and to produce commercially unavailable vegetation for dune restoration of PKBM habitats.

**K. Lighting**
Additional research on the effects of artificial lighting on beach mice should be undertaken. The research should focus on the different types of "wildlife lighting lamps" and how they affect beach mouse breeding, foraging and movement behavior and home range.

**L. Coordination with stakeholders and partners**
Continue fostering a working partnership with the State Parks, Gulf Islands National Seashore, Escambia, Walton, and Gulf Counties, the City or Orange Beach, and Eglin and Tyndall Air Force Bases for recovery of all beach mice subspecies.

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**U.S. FISH AND WILDLIFE SERVICE**
**5-YEAR REVIEW OF THE**
**PERDIDO KEY BEACH MOUSE (*Peromyscus polionotus trissyllepsis)***

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

**__X_ No change is needed**

Review Conducted By: ___Kristi Yanchis, Panama City Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve Cathy D. Phillips Date 12-5-14

*The lead Field Office must ensure that other offices within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. The lead field office should document this coordination in the agency record. For any 5-year review that does not recommend a change in status, the lead Field Office Supervisor has now been delegated the authority to sign these 5-year reviews.*

Appendix A: Summary of peer review for the 5-year review of the Perdido key beach mouse

**A. Peer Review Method:**
The draft 5-year review was provided to beach mouse experts on July 1, 2014. Reviewers were asked to respond in writing by July 20, 2014, or request an extension if needed.

**B. Peer Review Charge:**
The following instructions and guidance was provided to the peer reviewers:

- Review all materials provided by the Service.
- Identify, review, and provide other relevant data that appears not to have been used by the Service.
- Not provide recommendations on the ESA classification (endangered or threatened) of the species.
- Provide written comments in track changes on:
    - validity of any models, data, or analyses used or relied on in the review.
    - Adequacy of the data (e.g., are the data sufficient to support the biological conclusions reached). If data are inadequate, identify additional data or studies that are needed to adequately justify biological conclusions.
    - Oversights, omissions, and inconsistencies.
    - Reasonableness of judgments made from the scientific evidence.
    - Scientific uncertainties for the technical conclusions drawn are clear.
    - Strengths and limitations of the overall product.
- Keep in mind the requirement that we must use the best scientific data (published and unpublished) in determining the species' status. This does not mean we must have statically significant data on population trends or data from all known populations.

**C. Summary of Peer Review Comments/Report**

Dr. Jeff Gore clarified some occurrence data regarding trapping in GINS and PKSP based on his data sheets. He also suggested some missing cited literature. Suggested using language to indicate PKBM are continuing to recover as to not lead the reader to imply they have recovered. He clarified that there is no evidence that suggest house mice compete with beach mice. Clarification was given as to natural predation still of some concern for PKBM. Dr. Gore clarified that any benefits from hurricanes would likely be outweighed by adverse impacts. He clarified that PKBM populations have not been self-sustaining in the past as opposed to is not self-sustaining. Made sure to reference 1985 (listing year) as the starting point of when we started monitoring population numbers. Dr. Gore helped flush out the recommendations for future actions as our two agencies often work together on these.

Dan Greene suggested that subspecies be used where applicable when referring to PKBM or other subspecies. Had the same suggestion as Dr. Gore regarding PKBM are continuing to recover. He suggested clarifying that the PKBM population continued to expand from GINS to beyond PKSP. Suggested removing "without the need for a translocation" in reference to GINS discussion. He also suggested adding prolonged inundation as a reason for vegetation to be killed. Dan recommended deleting the word "immediately" in reference to frontal dunes being

essential to PKBM after hurricanes. Dan agreed with Dr. Gore in that predation of PKBM is always a concern. He suggested removing the words successful and failsafe in reference to the captive breeding colony.

William Lynn mostly gave suggestions regarding specifics that were more suited to a different type of document. He did recommend some literature to cite. He also suggested more studies are needed for scrub dune management/restoration that was captured in the Future Recommendations Section.

Dr. Jim Austin focused on the genetics component of the review and filled in significant missing data and explanation of past studies. He also provided detail pertaining to genetics in other sections where pertinent.

Sandra Sneckenberger suggested adding the specific 5 factors in the text to the reader would know what they are when referenced throughout the document. She also stressed that even though the Recovery Plan was not up to date, recovery knowledge and actions should be based on current knowledge of the species until the Plan can be updated. Sandra suggested moving some text under Abundance to under Demographic features and to strengthen the discussion about vulnerability to tropical storms and near extinction. Sandra identified and suggested deleting duplicate text throughout the document. She also stressed to make sure the threats are still acknowledge even as the PKBM population is thought to be doing well the past couple years. Sandra expressed caution using the term "self-sustaining" and decrease in development.

Comments from Ben Frater included clarifying the fact that development pressures have not gone away. He also clarified the expansion of PKBM as happening rapidly in 2009 not gradually between 2008-2010 and the FWC predator control grant recent award. Ben enhanced the sea level rise section by giving an example scenario.

**D. Response to Peer Review**

The Service agreed to most of comments and suggestions provided by the peer reviewers. The draft five-year review was modified in accordance with the reviewers' suggestions.