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_____Michael McKee_____
Major Professor

We have read this dissertation
and recommend its acceptance:

_Robert A. Bohm_____

_Henry W. Herzog, Jr._____

_Donald G. Hodges_____

Accepted for the Council:

__Anne Mayhew_____
Vice Chancellor and Dean of
Graduate Studies

(Original signatures are on file with official student records.)

Endangered Species and U.S. Military Training - What's the Value?

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Jeffrey S. Smith
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DEDICATION

This dissertation is dedicated to my best friend and partner in life, Lisa Smith, and the two best children a father could hope for, Jeffrey Stewart and Phillip William, for their love, support, encouragement and understanding, all of which made this journey possible.

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Abstract

The purpose of this study was to value military training using tradeoffs associated with endangered species. Because of urban sprawl, endangered species are encroaching upon many military training facilities throughout the United States. This encroachment interrupts military training activities and may affect the grounds where training takes place. Laws associated with the Endangered Species Act prevent any activities that may harm or destroy critical habitat necessary to ensure endangered species survival.

Choice modeling, which is a subset of contingent valuation, is a stated preference methodology that allows researchers to question respondents about complex scenarios, and to calculate values based on the responses. Using both mail and the Internet to survey the American public about two different military facilities, this study found that the public is willing to pay the amount required to alleviate conflicts between endangered species and the military. The study also found that the public values continued survival of endangered species as much as military readiness.

The study recommends that the U.S. Government develop a suitable alternative that will facilitate peaceful coexistence between species and soldiers and fund its implementation.

Preface

The views expressed in this paper are those of the author and do not necessarily reflect the official policy or position of the Air Force, the Department of Defense, or the U.S. Government

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List of Abbreviations

AFB - Air Force Base
APA - Administrative Procedures Act
ASC - Alternative Specific Constant
BLM - Bureau of Land Management
BRAC - Base Closure Realignment Commission
CL- Conditional Logit
CNMI - Commonwealth of North Marianas Islands
CV - Contingent Valuation
DOD - Department of Defense
DOI - Department of Interior
DWMA - Desert Wildlife Management Area
ESA - Endangered Species Act
FDM - Farallon de Medinilla
FTX - Field Training Exercise
FWS - Fish and Wildlife Services
GAO - General Accounting Office
GED - General Educational Development
HASC - House Armed Services Committee
HTML - HyperText Markup Language
IIA - Independence of Irrelevant Alternatives
IIN - Independence of Irrelevant Nests
IP - Internet Protocol
INRMP - Integrated Natural Resources Management Plan
ISP - Internet Service Provider
LAV - Light Armored Vehicles
LCAC - Landing Craft, Air Cushioned
MBTA - Migratory Bird Treat Act
MCAS - Marine Corps Air Station
MCB - Marine Corps Base
MEU - Marine Expeditionary Unit
MMPA - Marine Mammal Protection Act
MOU - Memorandum of Understanding
NAS - Naval Air Station
NL - Nested Logit
NMFS - National Marine and Fisheries Services
NTC - National Training Center
OHV - Off-Highway Vehicle
PGM - Precision Guided Munitions
TDY - Temporary Duty
USMC - United States Marine Corps
USN - United States Navy
USPS - United States Postal Service
VADM - Vice Admiral
WTA - Willingness To Accept
WTP - Willingness To Pay
WWII - World War II

1. Introduction

3 October 1993 - U.S. Army Rangers and other Special Forces units (Task Force Ranger) are dispatched to the Olympic Hotel, in Mogadishu, to capture Mohammed Farreh Aidid, a local Somali warlord suspected of ordering an earlier massacre of 24 Pakistani peacekeepers. 24 hours after being dispatched, the U.S. had lost 18 American soldiers, another 84 were wounded, and two UH-60 "Black Hawk" helicopters were downed. A large number of local militia and civilians were also killed in the Battle of Mogadishu (estimates place the number killed and wounded in the thousands).[1] Most Americans still remember the pictures of a dead American serviceman being drug through the streets of Mogadishu. How is this a relevant economic issue? The mission of the Department of Defense (DOD) is national security, which, by definition, includes the use of deadly force. It is the severity of the consequences that result from military members performing their duty and the costs associated with providing realistic training opportunities that defines this as an important topic worthy of more research.

According to the Deputy Undersecretary for Defense, Installations and Environment, DOD currently manages approximately 25 million acres on more than 425 military installations in the U.S., of which 300 species on these lands are federally listed as threatened or endangered.[2] Many facilities currently experience conflicts between endangered species and the DOD training mission, including: Fort Bragg, NC; Camp Lejeune, NC; Camp Pendleton, CA; Coronado Amphibious Base, CA; Farallon de

[1] Facts cited from Philly.com, The Inquirer Online. By Staff Writer Mark Bowden, Dec 2002.
[2] Armed Forces Press Service article, May 14 2002.

Medinilla, CNMI (Commonwealth of North Marianas Islands); Barry M. Goldwater Range, AZ; Eglin AFB, FL; Miramar MCAS, CA; Oceana NAS, VA; Vieques, PR, and the National Training Center (NTC) at Fort Irwin, CA, just to name a few.

Environmental concerns also extend to the oceans, where the Marine Mammal Protection Act severely restricts the United States Navy (USN) from testing and practicing with their long-range, high-powered sonar. In fact, Deputy Undersecretary Dubois delivered a statement to a U.S. House subcommittee on 13 Jun 02 citing anti-submarine warfare as the number one Naval warfighting challenge; a priority hindered by the National Marine Fisheries Service "overly broad definition of harassment…which is presumed to occur when marine mammals react to the generated sounds or visual cues." Likewise, carrier battle groups deploying to the Pacific (in support of Operation Enduring Freedom) have run afoul of the Migratory Bird Treaty Act of 1918 at the only live fire training range in the Western Pacific Ocean, the island of Farallon de Medinilla, near Guam.[3]

It is against this backdrop that I plan to consider the dilemma of peaceful coexistence between the U.S. military and affected endangered species. Endangered species enjoy statutory protection under the auspices of the Endangered Species Act. The Endangered Species Act is an attempt by Congress to recognize the intrinsic value of all species. It is also designed to prevent the unwitting extinction of any species. However, the Act places special restrictions on all Federal entities. Because DOD manages 425 installations on 25 million acres, the location of these installations and the process of

[3] Operation Enduring Freedom is the mission name for what is commonly referred to as the war in Afghanistan.

urbanization around these installations causes indigenous species to migrate onto these installations seeking refuge. DOD groups species migration under the broad heading of encroachment. Encroachment encapsulates all outside interferences that impact the mission of the DOD. While the conflicts between species and DOD are obvious, the solution is less so. The limitations imposed by the Endangered Species Act on installations make realistic training impossible for all DOD installations that host endangered species. Therefore, my research plans to directly estimate the amount of money the American public is willing to pay to ensure that DOD is able to complete its training mission while minimizing outside interference. Indirectly, I will argue that this willingness to pay serves as a proxy for the value the American public places on successful DOD training.

The rest of the dissertation is organized as follows. Chapter 2 deals with endangered species, both the theory behind the safe minimum standard, the Endangered Species Act and the issues associated with critical habitat designation. Chapter 3 addresses the issue from the DOD perspective, including pitfalls of critical habitat designation, impacts to training and develops the background information for two case studies. Chapter 4 develops the foundations of choice modeling, the empirical estimation procedure, my experimental design strategy and questionnaire development, and the administration of the survey. Chapter 5 presents the empirical results of the estimation procedure and Chapter 6 concludes.

2. Endangered Species

2.1 The Safe Minimum Standard

Why are conservation and the preservation of biodiversity important issues anyway? Randall and Farmer (1995) argue that the progress of technology and the number of species known and unknown suggest with some probability that any species alive today will prove useful in the future.[4] In light of species value today (both as a raw material and any non-use values), Randall and Farmer (1995) advocate that the essence of the species conservation argument is that society should incorporate the idea of a safe minimum standard into the societal decision-making process, while only allowing some sacrifice of biodiversity in the face of "intolerable costs."

So what is this safe minimum standard? Ciriacy-Wantrup (1952) discusses the concept of the safe minimum standard. The safe minimum standard is an absolute floor for minimum resource preservation, be it animal, plant or mineral. As such, going beneath this floor is only acceptable in the face of extreme circumstances, because the consequences of such an action may, in fact, be catastrophic. Ciriacy-Wantrup (1952) argued that the safe minimum standard should be defined not in specific numbers, but in specific conservation measures required to “avoid the critical zone”. Here, the critical zone refers to that point in a species’ existence where extinction is all but certain. Ciriacy-Wantrup did acknowledge that efficiency dictates that the safe minimum standard be realized with a minimization of total costs to society, and that sometimes, extreme

[4] Rob Norton in Fortune magazine documented the debate about Taxol, a very effective cancer fighter, which was discovered in the Pacific Yew tree (previously considered no better than a worthless weed).

circumstances may warrant allowing a resource to fall into the critical zone. If society accepts the underlying rationale behind Ciriacy-Wantrup's argument, then the safe minimum standard becomes a defacto decision rule to use when performing Cost Benefit Analysis when considering issues associated with biodiversity.

Berrens *et al.* (1998a) note that *a priori* preservation of at-risk species is considered the status quo. This requires that the burden of proof, with respect to the safe minimum standard, resides with those trying to prove the extreme circumstances (defined as the opportunity costs of preservation) that actually dictate extinction. Through a simple graphical exposition, Randall and Farmer (1995) identify the safe minimum standard, based on a stochastic regeneration function, to be the level to withhold from current production that will provide the minimum resource necessary for future periods. It should be obvious that in this context, production refers to any use, other than passive, by humans. This requirement to ensure species survival under all but the most extreme circumstances appears to encapsulate the evolving arguments behind the Endangered Species Act, from the Act's inception, through its various amendments.

2.2 Applicable Laws

Congress passed an earlier version of the endangered species act in 1966. While this was a good first step in recognizing the importance of conservation, it lacked sufficient teeth to be an effective tool for species management, due to the absence of specific authorization that would allow the U.S. Fish and Wildlife Service to prevent the killing of endangered species (Mann and Plummer, 1995). Ironically, it seems as if conflict between endangered or threatened species and the DOD is nothing new.

Congress first enacted what we now know as the Endangered Species Act (commonly referred to as the ESA) in 1973, when a dispute erupted between the Departments of Defense and Interior over the listing of sperm whales (Mann and Plummer 1995).[5] Within the act, the Department of Interior (DOI), more specifically the Secretary of Interior, was given regulatory responsibility to enforce the ESA, while the U.S. Fish and Wildlife Service (FWS) became the lead agency within the Department of Interior for enforcing the ESA.

So what was the actual intent of Congress when they passed the newly strengthened version of the Endangered Species Act? It is conveyed in section 2 of the ESA, where Congress found that inadequate concern for conservation in the United States had led to the extinction of various species of fish, wildlife, and plants in the United States, while depletion had threatened other species to the point of extinction. Congress further defined their intent to "...provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section." A key modification of the ESA occurred in 1978, changing the listing procedure to require designation of a species' critical habitat concurrent with its listing. This set the stage for the tug-of-war between training and species preservation. Specifically, the requirement to designate "critical

[5] At the time, a profitable market existed for the oil from sperm whales, which was used for subMarines. Both the Departments of Commerce and Defense fought an initial listing of sperm whales (Mann and Plummer, 1995).

habitat" and the consequences associated with this designation are the root cause of the training controversy. But first, we quickly review the relevant sections of the ESA.

The ESA defines "take" as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to do so."[6] The intent of the ESA is to prevent "takings" which will contribute to the extinction of any species. Section 4 of the ESA deals with the determination of endangered and threatened species. It empowers the Secretary of the Interior, working through the U.S. Fish and Wildlife Services, to list all organisms. However, marine mammals fall under the jurisdiction of the Secretary of Commerce and are only listed by the Secretary of the Interior after the National Marine Fisheries Service (NMFS), acting as the lead agency for the Department of Commerce, makes a determination. The ESA identifies several criteria for consideration when determining if there is a need to list a species and if concurrent designation of critical habitat for the species is also required.[7] The ESA identifies the criteria for critical habitat designation as the best scientific and commercial data available.[8] The ESA does contain an exclusion clause for critical habitation designation. Section 4(b)(2) gives the Secretary of Interior power to exclude an area from designation if the "benefits of such exclusion outweigh the benefits of specifying such an area" unless failure to designate the critical habitat "...will result in extinction."[9]

Section 7 of the ESA is titled "Interagency cooperation" and it only applies to Federal agencies. It specifically requires any Federal agency to consult with the Secretary of Interior to insure "that any action authorized, funded or carried out by such

[6] ESA of 1973, as amended, Sec. 3(19)
[7] ESA of 1973, as amended, Sec. 4(a)(3)(A)
[8] ESA of 1973, as amended, Sec. 4(b)(1)(A)
[9] ESA of 1973, as amended, Sec. 4(b)(2)

agency is not likely to jeopardize the continued existence of any endangered species...or result in the destruction or adverse modification of habitat of such species...unless such agency has been granted an exemption for such action."[10] This is the consultation process that is designed to prevent any unnecessary takings. While the details of the consultation process are not specifically of interest in this paper, the consultation process between DOI and any agency proposing a potential action is the most important process of section 7 (Rohlf 1989). After conducting a biological assessment and consulting with DOI, an agency may be granted an exemption from section 7a(2) if the Committee determines that no reasonable and prudent alternatives exist and the benefits of exemption outweigh the benefits of alternative courses of action.[11] One other avenue available solely for DOD is the national security exemption, which requires the Committee to "grant an exemption for any agency action, if the Secretary of Defense finds that such exemption is necessary for reasons of national security."

Finally, section 9 lists the prohibitions as defined by the Act. Section 9a(1)(B) makes it unlawful to take any endangered species within the United States previously listed under section 4 procedures, unless an exemption is specifically granted from section 10 of the ESA. Relevant to the subject of this paper, Section 10a(1)(B) of the ESA allows the Department of Interior to issue a permit authorizing the incidental taking, as long as the taking is not the purpose of the activity and the activity itself is otherwise lawful. Concurrent with a request for a permit, however, is the requirement to submit a conservation plan for the species in question. This plan must include likely impacts,

[10] ESA of 1973, as amended, Sec. 7a(2). Section 7a(4) extends this protection to species that are proposed to be listed but have not yet made the list.
[11] ESA of 1973, as amended, Sec 7h(1). Brown and Shogren refer to the committee as the "God Squad".

steps to be taken to minimize impacts, alternative actions considered and why these alternative actions are insufficient to the point of requiring the taking of the species.

Closely related to the Endangered Species Act is the Migratory Bird Treaty Act (MBTA). The enactment of the laws pertaining to the MBTA are found in U.S. Code, Title 16, Chapter 7, sections 703-715. The same basic provisions of the ESA are encapsulated in the MBTA, except that prior to the passage of the Bob Stump National Defense Authorization bill for FY03, there were no provisions in the U.S. Code to allow exemptions from the prohibition of takes for reasons of national security.[12] Additionally, Executive Order 13186, as published in the Federal Register (Vol. 66, No. 11), required all Federal agencies to develop a Memorandum of Understanding (MOU) with the FWS that shall promote the conservation of migratory bird populations. This MOU required, among other items, that an agency identify where unintentional takes are having a measurably negative effect and develop standards and procedures to lessen unintentional takes. As I will highlight later in the paper, a recent case argued before the U.S. Circuit Court of Appeals (Washington D.C.) highlighted the inability of the DOI to issue incidental take permits as a severe impediment to the training of warships and aviators entering a hostile theater of operations.

These various acts, the subsequent amendments and the judicial interpretations surrounding the designation of critical habitats are the nexus of the problem for DOD training. While they serve their purpose in promoting recovery of endangered species, as

[12] In response to lobbying by the DOD and high Congressional interest regarding the problems associated with migratory birds at Farallon de Medinilla, CNMI, Congress passed section 315 of the National Defense Authorization Act, permitting the incidental taking of migratory birds during a military readiness activity. The evolution of this case is of interest and will be explored further in Chapter 3.

we will see in the next section, DOD and DOI argue that the same outcome can be accomplished without designating a critical habitat.

2.3 Critical Habitat

As already discussed, section 4 of the ESA directs the DOI to make a critical habitat designation upon federally listing an endangered or threatened species. Section 3(5) of the ESA provides the following exposition of the term critical habitat: "the specific areas within the geographical area occupied by the species...on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protections; and specific areas outside the geographical area occupied by the species...upon a determination by the Secretary that such areas are essential for the conservation[13] of the species."[14] Also recall that section 7a(2) requires Federal agencies to insure authorized actions do not destroy or adversely modify this critical habitat. Unfortunately for DOD, the manner in which it conducts even routine daily training missions adversely modifies the habitat where this training takes place.

Why is endangered species management now becoming such a big issue for DOD? Deputy Undersecretary Dubois identified the problem as slow-growing early on, because most U.S. military installations were located in remote locations during or soon after World War II (WWII). However, population growth and urban creep since WWII have resulted in DOD ranges and training areas becoming the last refuge for many

[13] Here conservation means recovery of the species to the point at which the measures provided are no longer necessary.
[14] Section 3(5)(C) does limit the critical habitat designated area from including the entire geographical area which can be occupied by the threatened or endangered species.

species, endangered or otherwise. As an example, the Federal Register (Vol. 65, No. 25) contains background information regarding the California Gnatcatcher, an endangered species that historically ranged from coastal southern California to northwestern Baja California, Mexico. By the 1960s, however, the species had apparently experienced a significant population decline in the United States attributable to widespread destruction of its habitat. Camp Pendleton, a Marine Corps base located on the coast of southern California, requires large areas of varied and unoccupied terrain for realistic training scenarios. Camp Pendleton also provides the last vestige of sanctuary to the California Gnatcatcher and increasing numbers of other species. As will be demonstrated in Chapter 3, designation of critical habitat to protect the California Gnatcatcher greatly affects the DOD training mission.

In most cases, the point of contention for DOD is the designation of critical habitat. DOD can not realistically train without adversely affecting terrain. Thus, critical habitat designations that are superimposed on training areas severely restrict that area's ability to efficiently function as a training range. However, DOD (and FWS) believe that successful implementation of the Sikes Act (as amended in 1997) provides a much broader and more complete remedy for all involved; certainly more encompassing than simply designating land as critical habitat. The Sikes Act requires DOD to develop an integrated natural resource management plan (INRMP) for each military installation in the United States. This plan is required to be coordinated with the Secretary of Interior (working through the FWS) and must also include applicable state and/or local fish and wildlife agencies of any affected state. The plan provides for the conservation and rehabilitation of natural resources on military installations. Required elements of the plan

include "fish and wildlife management, land management, forest management, and fish- and wildlife-oriented recreation; fish and wildlife habitat enhancements or modifications; wetland protection, enhancement, and restoration, where necessary for support of fish, wildlife, or plants..."[15]

Strong supportive testimony was given by Associate Secretary Craig Manson, the Assistant Secretary for Fish and Wildlife and Parks in the Department of Interior, at a House Armed Services Committee (HASC) subcommittee hearing on Military Readiness in March 2002. Associate Secretary Manson noted that FWS and the military have an effective partnership through the Sikes Act, resulting in proactive natural resource management while enabling the military to successfully carry out its mission. DOI and DOD both agree that biodiversity is better served through the use of INRMPs versus designation of critical habitat, because the INRMP focuses on management of the environment as a system. Much of the literature seems to agree with the premise that focusing on the environment as a system is the preferred form of biodiversity management. Loomis and White (1996) conclude, "More emphasis on a multi-species ecosystem or habitat approach to decision making would be a welcome enhancement in a re-authorized ESA for biologists and economists alike." Similarly, Ando (2001) finds that declining marginal benefits and costs of individual species protection suggests that economies of scope exist in species protection and all involved should shift to an ecosystem approach to accomplish species preservation. These opinions lend support to recent Congressional action with their passage of the Sikes Act Amendment in 1997 and its heavy emphasis of the INRMP. Opposition to the use of INRMPs comes from several

[15] Title 16, Chapter 5C, Sec 670a.

environmental groups who oppose this course of action because they believe that INRMPs do not afford the same level of protection as critical habitat designation.

In testimony designed to emphasize this view, David Henkin, staff attorney for Earthjustice, highlighted many issues associated with the DOD, endangered species and proposed legislation regarding critical habitat designation on ranges. Speaking before the Senate Environment and Public Works Committee hearing on S. 2225 and also the Readiness and Range preservation initiative, Mr. Henkin identified several problems with the DOD proposal to supplant critical habitat designation with the use of INRMPs. Mr. Henkin noted, "There is no requirement that the INRMP management be adequate to the species' need." He then dismissed DOD's position that an on-going requirement for consultation with FWS under ESA section 7a(2) remains a compelling regulatory action, because Mr. Henkin believes that any place where essential recovery habitat is currently unoccupied may be exempt from formal consultation, unless the very critical habitat designation that DOD seeks to avoid is actually declared. Mr. Henkin believes that critical habitat designation "allows these species to recover to a non-imperiled status, the ultimate goal of the ESA." Furthermore, he argued that endangered species need to disperse into currently unoccupied territory for a true chance at recovery. He also believes that INRMPs provide inferior protection as compared to critical habitat designation, because the INRMP specifically mentions the dual goal of species conservation and military readiness, laying the legal foundation for military readiness to eventually override conservation as the preeminent goal. Finally, Mr. Henkin stated his belief that the national security exemption inherent in the ESA already provides DOD an

avenue for relief, if so desired; thus, extending a blanket exemption by adopting the Sikes Act is too great a risk given the nature of the consequences.

Most recently, legislation has been introduced into the 108th Congress called the "Encroachment on Military Bases Prevention Act." H.R. 1235 was introduced to amend the ESA to include language that will not allow the DOI to designate critical habitat on any "lands or other geographic areas" controlled/owned by DOD, if an INRMP is properly prepared in accordance with the Sikes Act. H.R. 1235 also explicitly requires the DOI to consider impacts on national security from any such designation, even if an INRMP is not in place. Passage of this piece of legislation may soon obviate the discussion regarding critical habitat. There is no guarantee that such a law will withstand legal scrutiny; therefore, other potential remedies must still be investigated. To that end, let us shift focus to DOD, their training needs, and two specific examples of encroachment that have real world impacts.

3. Department of Defense

Picture the description provided by Deputy Undersecretary DuBois to Armed Forces Press correspondent Jim Garamone regarding a night flight from Los Angeles to San Diego. "You leave Los Angeles and below, you see a blanket of lights. As you approach San Diego, you see the same blanket of lights. But right in the middle of all these lights is a 17-mile stretch of darkness, that is Camp Pendleton." It is a 120-mile trip from Los Angeles to San Diego but only the 17 miles that are Camp Pendleton remain undeveloped. To provide factual support to the picture painted by Deputy Undersecretary DuBois, consider the change in population in both counties. From 1950 to 2000, the combined population in San Diego County and Los Angeles County increased from approximately 4.7 million to 12.3 million. Deputy Undersecretary DuBois used the term "megalopolis" to describe this process where both cities have essentially grown together, except for the buffer zone that is Camp Pendleton. It is easy to imagine the type of pressure this level of growth is causing the endemic species in this region.

Unfortunately, this trend is not an insolated incident. The General Accounting Office (GAO), in their June 2002 report to Congress, note that population growth and urbanization have hit DOD especially hard, with urban growth rates that are higher than the national average occurring near 80 percent of all DOD installations. This should come as no surprise, though, as Mehay and Solnick (1990) show that defense spending

significantly impacts both state employment and state income.[16] More recently, Poppert and Herzog (2003) find both short-run and long-run county employment losses are associated with a reduction in military installation personnel, when the reduction in military personnel is unrelated to the Base Closure Realignment Commission (more commonly known as BRAC). While the focus of their study is employment losses, I would expect the converse to also hold. This is to say that consolidation of missions at DOD installations has, in part, generated the increased urbanization trend noted by the GAO. Data show that over 90 installations currently host at least one endangered species (mammalian, reptilian, aquatic or crustacean). With recent population trends mirroring those referenced earlier, undeveloped land is becoming almost as endangered as the displaced species currently losing their habitats. Going forward, we can only expect the problems of encroachment to grow larger. I have selected two installations as case studies, to represent all of DOD and to characterize the struggles between encroachment and training, but there are many examples where realistic training suffers from the same type of encroachment. Before we develop our two case studies, let us look at some other examples of training conflicts that have generated large amounts of publicity over the last few years.

3.1 Examples of Impeded Training

This research focuses on the continental United States; however, training impacts are not limited to this area of concern. As reported by the New York Post, three ships deploying in support of Operation Enduring Freedom were forced to deploy without

[16] Mehay and Solnick (1990) disaggregate DOD spending into two categories, investment and expenditures. Investment spending significantly affects both employment and income, while expenditures only affects employment. See referenced article for more information.

crucial anti-ship cruise missile training because the use of target drones could "potentially disturb" resident seals. Likewise, one quarter of airborne anti-submarine training missions at the Pacific Missile Range Facility have been cancelled due to marine mammal sightings. Also, the Naval component of the Special Operations Command reports that the Navy Special Warfare units (commonly referred to as SEALs) can no longer practice immediate action drills on Coronado Island. Specifically, they cannot conduct combat swimmer training nor can they conduct live-fire and maneuver exercises during some seasons. Clearly, DOD is impacted by the presence of endangered species. Similarly, endangered species face their own challenges trying to exist while their range of habitat continues to shrink.

One illustration that encapsulates the level of opposition from various environmental groups is a lawsuit filed by the Center for Biological Diversity. In the matter of Center for Biological Diversity v. Robert B. Pirie, Jr. and Donald H. Rumsfeld, the plaintiffs (Center for Biological Diversity) filed suit against the Secretary of the Navy and the Secretary of Defense, on December 21, 2000. Their suit, which was filed in United States District Court in the District of Columbia, alleged that the Navy violated both the MBTA and the Administrative Procedures Act (APA) by continuing live fire training on the island of Farallon de Medinilla (FDM) without a proper incidental take permit.[17] The plaintiffs were seeking an injunction to prevent the Navy from further harming any more migratory birds until FWS issued a take permit. The Navy had requested a permit from the FWS on April 15, 1996 but the FWS denied the request

[17] The island of FDM is located of the coast of Saipan. It is approximately 1.7 miles long and .3 miles wide, roughly equal to 206 acres. The island is uninhabited by humans.

because the MBTA and relevant U.S. Code do not allow incidental take permits to be issued. In its decision, the FWS stated that the defendants' (U.S. Navy) actions "are consistent with the responsibility of the U.S. under the MBTA"and the FWS was using "enforcement discretion" by not taking action against the Navy. The D.C. Court of Appeals did not recognize any legal basis for the U.S. Fish and Wildlife Service's contention that they were exercising "enforcement discretion", and therefore found for the plaintiff's request for summary judgment, ordering the Navy to cease live fire training. Almost immediately thereafter, the court issued a 30-day injunction to allow DOD to file for an MBTA permit with FWS. On June 5, 2002, the court granted an emergency motion for stay of injunction pending an appeal, based on the Navy's demonstration of irreparable injury and likelihood of success. Finally, on Jan 23, 2003, the U.S. District Court granted the motion to vacate the order due to language included in the Bob Stump National Defense Authorization Act, which granted DOI interim authority to issue permits for incidental takings resulting from military readiness activities.

So why is 206 acres of uninhabited volcanic rock, located 45 nautical miles northeast of the island of Saipan, so important to both the United States Navy and the Center for Biological Diversity? FDM, while uninhabited by humans, is home to diverse vegetation which provides shelter and foraging opportunities for many different species of migratory birds. Thousands of birds use FDM, if not permanently, then at least as a temporary respite during flight. FDM also hosts one of only two great frigate bird breeding colonies in the Marianas and it is the largest known nesting site for masked boobies. Finally, FDM is home to an endangered, non-migratory flightless bird, the Micronesian megapode.

Equally important to the U.S. Navy, FDM is the only U.S. air-to-ground range in the West Pacific. Major General Cartwright, 1st Marine Air Wing Commander stated that FDM was "integral to combat readiness." Mandatory training for all naval aviators is conducted at FDM. Absent the use of FDM, the Navy will have to leave the Western Pacific Area of Operations to conduct mandatory training, a move accompanied by significant costs both in manpower and in dollars. Assistant Secretary of the Navy, H.T. Johnson, himself a former combat pilot, testified before the HASC that "aviation combat losses drop significantly after a pilot has experienced the first five decisive engagements...realistic training is quantifiably more valuable."[18] According to Vice Admiral (VADM) Metzer, while losing one target range will not render military readiness utterly useless, it will make the task of maintaining an acceptable level of readiness all the more difficult and more costly. These are but two examples that illustrate the severity of the problem to which we now turn to in-depth. Let us look at the two case studies that form the core of this study.

3.2 Marine Corps Base (MCB) Camp Pendleton, California

Camp Pendleton is considered by the Marine Corps to be the premiere amphibious assault training facility on the West Coast. It has continuously provided training to Marines for the last 60 years. Camp Pendleton is made up of approximately 125,000 acres, with terrain ranging from sandy shores and seaside cliffs, coastal plains and rolling hills, canyons and mountains rising to 2,700 feet. Most importantly, Camp

[18] Secretary Johnson noted that during the Vietnam conflict, the ratio of enemy aircraft shot down per American aircraft shot down increased from 1-to-1 to 13-to-1 after the Navy established the Navy Fighter Weapons School (commonly referred to as Top Gun). Similarly, aircrews that have recently received realistic training in precision guided munitions (PGMs) have twice the hit to miss ratio as non-trained aircrews.

Pendleton contains 17 miles of beaches. The mission of Camp Pendleton is to "...***train Marines for combat...***" (SRS Technologies, 2003). Camp Pendleton trains 60,000 Marines annually, in all formats of combat, including air, ground and sea assault. Located within 30 miles of Camp Pendleton is Marine Corps Air Station (MCAS) Miramar, a separate installation suffering similar encroachment issues as Camp Pendleton.

It seems trivial to say but the type of training required by the military dictates the potential use of the affected area. Marines must be ready for all types of combat, be it insertion by sea, by air or over land. So what is typical training for a Marine? According to the INRMP for MCAS Miramar, all Marines must complete annual training consisting of open area classes, fieldwork (including land navigation and static displays), weapons qualifications, and overnight bivouac activities. Impacts associated with training activities may result from foot traffic, tracked and wheeled motor vehicle operations, combat engineering support operations, and others. Additionally, Marines need training to remain proficient in vehicle operations, which include High Mobility Multipurpose Wheeled Vehicles, 5-ton six-wheel drive trucks, Light Armored Vehicles, tanks and commercial all-terrain vehicles. Vehicle operations include wheeled and tracked vehicles on improved and unimproved terrain. Add to this the requirement for amphibious assault operations and all the support functions required for successful operations and it is easy to see that a critical habitat designation that requires terrain to remain undisturbed is inconsistent with an effective training mission.

At Camp Pendleton, designation of critical habitat has restricted the use of off-road vehicles, prevented the digging of defensive fighting positions (foxholes) and

modified how amphibious assault training must be conducted (GAO-02-614). In his testimony to Congress, Secretary Johnson (Mar 2002) noted that during a training exercise in March 2000, the 13th Marine Expeditionary Unit (MEU) was restricted to 500 yards out of 17 miles of open beach, while units "coming ashore" on LCACs (Landing Craft, Air Cushion) were off-loaded inland from the beach.

More specifically, the Marines commissioned a study to determine the effectiveness of the base to deliver on its stated mission. Recently published, the picture portrayed within this study is grim. Training is characterized as area-avoidance driven versus tactical military objectives driven. The study assessed 739 training tasks required by Marine Corps regulations and revealed that a Battalion Landing Team exercise, which is a scenario designed to replicate real world conditions, is only completed at less than 68 percent of the Marine Corps standard. So what causes this degradation in training? Of the 125,000 acres at Pendleton, 23,000 acres are inaccessible, while the remaining acreage is divided into 33 training zones. Of these 33 zones, 28 are impacted by endangered species or their habitat. Of greater concern is the 17 miles of usable beach on Camp Pendleton, where effective beach access for training is reduced to less than one mile, or 6 percent of overall beach access, when restrictions enacted due to the presence of endangered species and other state uses are included.[19] As illustrated in the study (SRS Technologies 2003), one example of affected activities is the restriction that limits the number of LCACs allowed on the beach at any given time, due to habitat restrictions. LCACs are used to deploy the Light Armored Reconnaissance Company with their Light

[19] The breakout of the 17 miles is as follows: 5.7 miles of state beach, 1 mile for San Onofre Nuclear Generating station, 7.5 miles combined for the California Gnatcatcher and vernal pools, and several smaller restrictions associated with the I-5, a railroad and utility easements that run parallel to the coastline (SRS Technologies 2003).

Armored Vehicles (LAVs). Once deployed, LAVs are only authorized limited maneuvering ability, essentially restricted to hard-packed sand and existing roads. Additionally, the accompanying mortar platoon would be expected to rapidly construct mortar positions to cover the ongoing landing. Mortar positions require digging for fighting holes and also digging to fill 6,000 sand bags per mortar position; this digging is prevented due to the presence of endangered species habitat. Even individual Marines are prevented from digging a fighting hole on the beach, a force protection measure that is considered a critical aspect of individual discipline. These examples depict the rapid departure from a combat situation that Camp Pendleton Marines currently experience.

With this as a backdrop, a review of the case of the California Gnatcatcher at Camp Pendleton will further illuminate Camp Pendleton's growing problem. The FWS determined not to designate a critical habitat at the time that the California Gnatcatcher was listed as endangered. More specifically, DOI determined designation would not be beneficial to the species and may in fact make them more vulnerable to prohibited activities. They reached this determination because of specific instances where intentional habitat destruction on private lands had occurred during the listing process. Simply put, if people suspected their property might fall within a critical habitat area, they destroyed all potential habitats, thereby removing any reason to compel a listing (Federal Register Vol. 65, No. 25). Since the majority of designated habitat is on private land and there did not exist a compelling Federal nexus (critical habitat designation has regulatory applicability only for activities authorized, funded or carried out by Federal agencies), critical habitat was deemed to be of no benefit and potentially detrimental to the species (Federal Register Vol. 65, No. 25).

The National Resources Defense Council, a private environmental organization, challenged the Department of Interior decision. The 9th Circuit Court agreed with the challenge, saying that Congress intended for the "not prudent" exclusion to be used "only in rare circumstances." FWS reconsidered, based on the 9th Circuit Court's opinion, and published notice of intent to designate approximately 800,000 acres in California as critical habitat. Of the 800,000 acres, 62,000 acres are located either at Camp Pendleton or MCAS Miramar and would affect 45 percent of the training lands specifically at Camp Pendleton. MCAS Miramar was exempted from critical habitat designation because the installation has an approved INRMP in place. Camp Pendleton was later granted a similar exemption due to an impending INRMP that would cover the same substantive issues as addressed in the Miramar INRMP. It remains to be seen if the exemptions by the Department of Interior, due to a published INRMP, will stand up to any legal challenges.

With unfettered use of Camp Pendleton currently in doubt, few options are available to the Marine Corps. Given the nature of the development along the coast, translocation of affected endangered species to other coastal California locations may not be feasible. Similarly, there is not enough inland space available for translocation of those non-coastal species that require large open spaces to roam. Other potential options include using Camp Pendleton merely as a home station location, sending the troops to other locations for large-scale combat training. This option involves substantial amounts of time, material and funds. Almost as important, this option also presumes the existence of a suitable substitute training location that can handle a constant influx of Marines.

For our case study, we assume that Camp Pendleton is unavailable for amphibious warfare training in its current situation. In spite of this, the requirement for Marines to conduct amphibious training has not diminished. All inland training not conducted at Camp Pendleton would require the use of large training ranges that are scattered throughout the United States. Funding for this would pay for transportation of troops and equipment, food and lodging that DOD pays for troops who are assigned to temporary duty (TDY). Amphibious training must also be conducted, with options including the use of Camp Lejeune or some other, as yet undiscovered location. Likewise, land could be purchased to allow the establishment of a wildlife preserve. These lands could be adjacent to or simply close enough to Camp Pendleton that issues associated with translocation would be minimized. Admittedly, I have not investigated the feasibility of either of these assumptions. It is safe to say that if Camp Pendleton becomes completely unavailable due to environmental concerns, the Marines will do something to get the required training. I use the land purchase option as a point of departure to examine how much the general public would be willing to pay to implement this option. Let us now turn to a review of the circumstances at Fort Irwin.

3.3 The National Training Center, Fort Irwin, California

What follows is a compilation of information taken from several Federally sponsored reports regarding the then proposed expansion plan for Fort Irwin and the National Training Center. Fort Irwin was selected as the site to host the National Training Center in 1980 and was reactivated as an active duty Army installation on 1 Jul 1981. The National Training Center (NTC) at Fort Irwin, California, has become the only instrumented training area in the world that is suitable for force-on-force and live

fire training of heavy brigade-sized military forces. The mission of the NTC is to provide tough, realistic combined arms training. This training is to be conducted under conditions that remain a reflection of the combat situations U.S. forces currently face. Technological advances in equipment (e.g. longer engagement ranges of weapon systems), changes in current Army doctrine (expansion of the battlespace by at least a factor of four), and the ongoing Army Transformation require an expansion of the existing training facility.

Beginning with the genesis of the NTC, tactics and requirements were structured around then-current equipment, which effectively engaged the enemy at ranges of 1 to 12 miles. This range has constantly expanded through time and currently reaches a maximum range of up to 60 miles away. In addition to range, the pace of tactical operations has quickened. Where before tactical operations were conducted at 10 miles per hour (mph), these operations are now being conducted at speeds of up to 25 mph. To facilitate realistic training opportunities, the Army must establish a second, brigade-sized maneuver corridor at the NTC. Currently, the Army has only one maneuver corridor suitable for brigade-sized maneuvers. According to Army Pamphlet TC 25-1, Battlefield Operating Systems can only be integrated at the brigade level (4,500 to 5,500 personnel) and no lower. So, a second corridor will allow the Army to conduct free-flowing, brigade-sized exercises

What constitutes the right amount of land to perform heavy brigade training? Appendix C of Army Pamphlet TC 25-1 identifies the spatial requirements to perform a

free-flowing, heavy brigade[20] level field training exercise (FTX), which is approximately 173,000 acres.[21] A brigade-level exercise can be completed within a minimum area of approximately 123,000 acres, but this requires the simulated battle to execute a phase, then stop and reposition the forces for the following phase. A typical, extended FTX will include the following four phases: movement to contact, offensive operations, defensive operations, and retrograde operations.

Two Land Use Requirements Studies performed in the early eighties determined that a shortfall in training space at the NTC existed. As a result of the two studies, the Army identified 193,000 acres as the amount of additional land required to satisfy training requirements. After negotiations with all affected parties, the Army proposed an expansion consisting of the acquisition of 110,000 new acres (owned by the Bureau of Land Management), combined with the return to training use of 22,000 acres (currently designated off-limits due to environmental concerns). This would satisfy the most critical needs for additional maneuver lands. The expansion finally occurred, but utilization of the newly withdrawn lands has been delayed to ensure the environmental impacts, namely continued existence of the desert tortoise, have been adequately addressed.

According to information found in Federal Register Vol. 54, No. 149, the desert tortoise is a large, herbivorous reptile (the only naturally occurring tortoise in the Mojave Desert) reaching 15 inches in length. The desert tortoise occurs primarily on flats and

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[20] TC 25-1 defines the composition of the heavy brigade in the scenario as three infantry or armor battalions tailored to three battalion task forces.

[21] This figure is derived as follows: 31 km x 16 km rectangle for movement to contact and retrograde operations. 17 km x 12 km for offense and defense. (31x16)+(17x12)=700 km^2. 700 km^2 x 247.1 acres per square kilometer = 172,290 acres. For more exposition, see Army pamphlet "Training Land", TC 25-1.

bajadas characterized by scattered shrubs and large spaces for herbaceous plant growth (U.S. Fish and Wildlife Service 1994).[22] Optimal habitat is creosote bush scrub, which is found within the Mojave Desert. Desert tortoises may occur in the California desert from below sea level to an elevation of 7,300 feet, but the most favorable habitat seems to occur at elevations below 4,000 feet (U.S. Fish and Wildlife Service 1994). Tortoises require sufficient suitable plants to provide foraging and cover opportunities, and suitable soil types that allow both burrow and nesting sites (U.S. Fish and Wildlife Service 1994). Desert tortoises begin to breed upon reaching sexual maturity, which occurs sometime between the age of 10 and 15 years of age (U.S. Fish and Wildlife Service 1994). Desert tortoises expect extremely high mortality rates, though, with only 2 percent of tortoises reaching reproductive age (U.S. Fish and Wildlife Service 2001). As a result of several factors, some due to humans, a pattern of widespread decline in the number of desert tortoises in the western Mojave Desert has become evident.

The FWS, in an emergency determination, first listed the desert tortoise on August 4, 1989. The emergency determination was declared due to a "recently documented outbreak of a virulent desert tortoise upper respiratory disease..." (U.S. Fish and Wildlife Service 1993). The final rule, dated 2 Apr 1990, determined the desert tortoise was threatened due to loss and degradation of habitat caused by numerous human activities including urbanization, agricultural development, military training, recreational use, mining and livestock grazing. While the increased mortality was credited to the discovery of the respiratory disease, overall declines in desert tortoises due to increased

[22] Bajadas (Spanish word for a descent) are shallow slopes that lie at the base of rocky hills, where materials accumulate from the weathering of the rocks. They typically have a mixture of boulders, stones, gravel, sand and silt particles, creating a deep and complex soil structure that retains water and supports a rich vegetation (helios.bto.ed.ac.uk/bto/desbiome/bajada.htm).

predation by common ravens, collection by humans for pets or consumption, collisions with vehicles on paved and unpaved roads, and severe degradation of their habitat contributed to the decision to list the tortoise**.** In 1994, the FWS designated substantial tracts of lands on and around Fort Irwin as critical habitat.[23] The lands designated as critical habitat were first identified in a draft recovery plan for the desert tortoise.

The desert tortoise recovery plan recommends prohibition of off-highway vehicle (OHV) activity, habitat-destructive military maneuvers, grazing, etc. within several Desert Wildlife Management Areas (DWMAs). For recovery, the plan recommends at least 10 adult tortoises per square mile as the minimum density necessary to promote a viable tortoise population (U.S. Fish and Wildlife Service 1994). Each DWMA should be at least 1,000 square miles but may vary between 200 and 5,000 square miles. DWMAs of less than 1,000 square miles are acceptable, if actively managed for recovery and they contain a combined total of at least 1,000 square miles. The plan recommends a total of 14 DWMAs; four DWMAs are located within California, with Fort Irwin and its proposed expansion area located in one of these four areas.[24] Finally, the plan recommends a list of activities that should be prohibited within DWMAs, of which habitat-destructive military maneuvers is one of several items mentioned.

Expansion was proposed to allow the NTC to accommodate a second, brigade-sized maneuver corridor. This second corridor, including the expansion lands, occurs in

[23] Federal Register Vol. 59, No.26 lists total critical habitat for desert tortoise as 6,446,200 acres. Of this total, 4,754,000 are located in California, with 242,200 of these acres located on Department of Defense lands. Note: Not all 242,200 acres are located on Fort Irwin, CA.

[24] The recovery plan identified 4 proposed DWMAs in the Western Mojave Recovery Unit. One of the four DWMAs, Superior-Cronese, was assessed as posing an extremely high threat to the survival of the desert tortoise. Approximately 15% of the Superior-Cronese DWMA is currently owned by DOD (U.S. Fish and Wildlife 1994).

the area that up until now has been unavailable due to the presence of the desert tortoise. Force-on-force training will likely occur within all areas of the training corridors (in the expansion area) that have slopes of less than 20 percent. Even though direct military "taking" of desert tortoises is extremely rare (estimated at 3 - 5 per year), the FWS has projected that deserted tortoises will be extirpated from all areas that wheeled and tracked vehicles use regularly (U.S. Fish and Wildlife 2001). This type of training will also result in long-term loss of desert tortoise habitat, which is crucial for survival because it provides shrub cover from both the sun and predators.

The expansion plan identified several conservation measures that may be needed to offset the effects of this expansion, some of which include the following: contributing offsetting lands to Desert Wildlife Management Areas (DWMAs) that are managed to promote recovery of the desert tortoise; construction of barriers and fences, etc. which are designed to prevent accidental deaths that occur from vehicular collisions; conduct research on the desert tortoise; and acquisition of private lands to add to the proposed DWMA areas. Acquisition of private lands is the focus of the case study of Fort Irwin.

Public Law 106-554, the Consolidated Appropriations Act of 2001, made available $75,000,000 to fund conservation measures necessary to offset the then proposed Fort Irwin expansion. However, in a cover memorandum released by William Haigh, the West Mojave Plan Project Manager, the Fort Irwin Tortoise Panel convened in January and again in February 2000, and identified 460,000 acres of private lands that would need to be acquired for the proposed DWMAs. Mr. Haigh estimated a cost of

$300,000,000 to purchase 80% of the 460,000 acres identified above.[25] Subsequent modification of the plan has reduced this estimate to $220,000,000. Regardless of the specifics behind the amount needed, there is a large disparity between what Congress has approved and what is required. Furthermore, is this a decision that the American public would agree to if their opinions were solicited?

In the case study involving Fort Irwin, we will survey the American public and present them with several different policy options, which are designed to elicit their willingness to pay to ensure the Army can use this land for future training events. While we save the development of the theory and the survey until Chapter 4, the basic idea is to present survey respondents with several different combinations of policy options that will identify exactly what the American people are willing to fund. The Fort Irwin expansion has already occurred. The lands have been withdrawn from the public real estate portfolio and turned over to the DOD. However, until successful mitigation efforts that will ensure continued survival of the desert tortoise are implemented, DOD is prevented from using this land. Thus, it is critical for the Congress and the American people to fund the offsetting land acquisitions and other recommended measures to ensure the continued survival of the desert tortoise, while simultaneously affording the American service member every opportunity possible to achieve realistic combat training.

I have chosen to highlight just a few of the well-publicized conflicts. From the red-cockaded woodpecker in North Carolina to the california gnatcatcher on the coast of California, issues abound regarding the optimal sharing arrangement of the co-desired

[25] His estimate breaks down as follows: Land costs - (460,000 acres * 80%)*$700=$257,600,000. $100 per acre for closing costs, title insurance and other fees (368,000*$100)=$36,800,000, and $2,800,000 for a seven-person staff to work for five years implementing the acquisition (CA 062.97).

habitat. So, let us turn our attention to the methodology that will enable us to estimate the willingness to pay of the general public for Department of Defense training.

4. Methodology and Empirical Strategy

Economists typically quantify values according to the price paid for goods and services in the marketplace. This type of action is called revealed preference because the observations of people's actions reveal their actual preferences. Assuming rationality in consumers' behavior, it should be easy to believe that people, when choosing to make a purchase for consumptive reasons, will only pay what they believe an item or service is worth. At the risk of overstating the obvious, there is no defined market for either the continued survival of endangered species or the continued ability for the military to conduct realistic combat training. Environmental amenities, as a subset of public goods, are typically labeled non-market goods for this reason.[26] To attempt to place a value on either of these issues, we turn to non-market valuation techniques. Non-market valuation typically involves the use of stated preference techniques, where a hypothetical situation is presented to survey participants and they answer questions designed to elicit how they value the specific issue. More insight into this non-market valuation methodology would seem to be appropriate at this time.

In existing literature, non-market valuation is estimated in a variety of ways, the most prevalent of which is the contingent valuation approach. Before we can value something, though, we need to be aware of all of its potential uses. Non-market values are subdivided into two categories, use and non-use. Use values are values associated with a person's interaction with the environmental good in question, such as observing

[26] Although empirical studies of non-market goods typically value environmental resources, we attempt to use this process to value a pure public good (the ability to conduct military training) that most would consider outside the realm of environmental economics.

the previously mentioned masked boobies in flight or hiking through the Great Smoky Mountains. Non-use values are less tangible, albeit still measurable, and include such categories as existence value and option value. Existence value, as defined in *Environmental Economics and Policy*, "is a value placed on an environmental good or service that is unrelated to consumption of that good or service." Existence values include the desire to ensure that an environmental amenity or endangered species is available for the enjoyment of future generations (bequest value). Existence values also include the feelings of goodwill a person may experience from the knowledge that an amenity is preserved, even if they never intend to "use" the amenity. Bishop *et al.* (1995) identify a problem with accurately estimating existence values because survey participants are expected to assign monetary values to a non-market good that is contingent upon the existence of both a market and means of payment. This is the problem where we now focus our attention.

Contingent valuation (CV) studies are simple in purpose, even if their execution is somewhat less simple. In performing a contingent valuation study, the researcher typically uses a survey to elicit a respondent's willingness to pay (WTP), which is the maximum amount of money an individual will pay to gain an improvement in a specific situation. Surveys may also be used to elicit willingness to accept (WTA), which is the minimum amount of money an individual requires to forego an improvement that would otherwise be experienced or to accept a harmful situation. When designing the study, the researcher must choose the most appropriate method to capture the surplus, which depends on who has the “right”; in the case of endangered species, it seems logical that society "owns" the right to continued preservation of endangered species and should be

surveyed regarding their willingness to accept the possibility of a given species extinction. However, transactions costs associated with educating survey respondents on the effects of accepting compensation versus making a payment, and the difficulty in measuring the empirical results from WTA estimates, causes current researchers to estimate WTP (Loomis and White, 1996).

CV studies typically contain three items: 1. a good description of the environmental commodity to be valued, 2. the method by which the hypothetical payment would be made (is it a tax or user fee, is it paid annually, one-time, etc.), and 3. the correct method to convey the information to the participants (dichotomous choice questions, open-ended questions, will the survey be conducted by mail, phone, in-person interview, etc.). Designing CV surveys is a painstaking process, requiring the researcher to exercise great care when developing the questions, so the respondent will provide unbiased responses. Bishop *et al.* (1995) discuss three measures of validity to consider when developing the survey: content, construct and criterion. Bishop *et al.* emphasize the development of the scenario, which is how survey participants learn about the environmental amenity and the terms governing the hypothetical transaction. Even with properly defined surveys, critics of the CV process still exist.

There is a large volume of literature advocating both for and against the use of CV techniques. One issue associated with the use of CV studies is that willingness to pay values are remarkably similar across a host of issues that economic theory would suggest, and may well require, a diverse range of responses (Diamond and Hausman 1994).[27]

[27] For further expostion on the pitfalls of contingent valuation studies, including this embedding effect, see Diamond and Hausman (1994).

Loomis and White (1996), attempting to empirically address this question, perform a meta-analysis on existing contingent valuation studies that estimated willingness to pay values for endangered species. They find CV can provide estimates of total economic value that are sensitive to the necessary explanatory variables and thus, they conclude CV studies are a valid tool for decision-makers.

CV studies as defined above suffer several biases, such as strategic bias, embedding effects, part-whole bias, hypothetical bias and starting point bias. One major limitation of CV studies is the limited ability to analyze complex policy questions. CV studies typically provide survey respondents with background information regarding the status quo and then ask how much they would be willing to pay for an improvement in the situation. This question can take many formats, such as dichotomous choice, open-ended, payment cards, bidding, etc. Dichotomous choice, or some variant of the dichotomous choice model, is typically chosen for current research work. Survey respondents are asked a yes or no question to determine if they would support an environmental change for a given payment. The payment is varied over a specific range among the differing respondents and a willingness to pay is calculated.

Beginning in the seventies and eighties, researchers focused on developing a more flexible and powerful tool for modeling an individual's choice. Early applications were applied to the fields of transportation and marketing, but this work has recently been extended to non-market valuation of environmental resources. Conjoint analysis, or more specifically choice modeling as it is applied to environment goods, works to overcome several of the biases identified above. The major advantage of choice modeling over previous contingent valuation methods is its ability to provide survey respondents with

more intricate and complicated policy questions. The combination of more intricate questions with socioeconomic characteristics allows researchers to tease out interactions between the attributes that are considered important to the decision-making process, as well as calculating an overall willingness to pay for all survey respondents. This next section will fully develop the theory behind choice modeling as a research strategy.

4.1 Theoretical Development of the Choice Model

Probabilistic choice theory owes its illumination to Luce, a professor of psychology teaching at the University of Pennsylvania in 1959. Most simply, Luce (1959) states that "...when a person reaches a decision between, say, *a* and *b*, we will assume that there is a probability *P(a,b)* that the choice will be *a* rather than *b*." Early theoretical work stemming from Luce formed the basis of random utility theory. Luce (1959) notes that the probabilities for *a* and *b* typically differ from 0 and 1. In fact, if the probabilities are always 0 and 1 and the choice that we observe tells us which probability it is, then probabilistic choice may not be an entirely accurate perception with which to view individual choice. Given that we observe violations of transitivity and inconsistent choices when people are offered the same choice multiple times, this hints that probabilistic choice is the correct lens with which to view the world (Luce 1959).

Luce's probabilistic choice model melded well with Lancaster's (1966) proposed new approach to describe consumer behavior, where goods are not "the direct object of utility". Utility is derived from the combination of characteristics or attributes that define the good. So, the rank ordering of characteristics possessed by each good forms utility; any ranking of a collection of goods is a byproduct of the original process of rank

ordering characteristics. For example, a person does not receive utility from sitting in a reclining chair, she receives utility from the attributes that the chair possesses. These attributes may be the ability to rest her feet in an elevated position and sit on a soft, foam cushion while watching television. The soft cushion and the elevation of their feet actually generate the realization of the utility, not the chair itself. An individual thus picks a specific chair because of its bundle of attributes.

Manski (1977) credits McFadden for realizing that economists could use random utility models as a way to represent individual maximizing behavior. To see how, we follow the work of McFadden (1974), defining the universe of choice objects as *X*. Likewise, the universe of vectors of all measured attributes of the individuals making choices is defined as *S*. If we randomly select an individual from the population, that individual will have a specific vector of attributes $s \in S$; the same individual will face a set of alternatives *B*, where *B* is a subset of *X*. Now, let $P(x|s, B)$ represent the conditional probability that our randomly drawn individual chooses alternative *x*, given the fact that he has the attributes defined by *s* and faces alternatives *B*.

McFadden (1974) then defines an individual behavior rule as a function which "maps each vector of measured attributes *s* and possible alternative set *B* into a chosen member of *B*." Given the existence of rules that govern individual behavior, a model exists, *H*, that includes the set of all individual behavior rules *h*. If *H* is truly representative of the population, then the probability that a randomly selected individual will choose *x*, given the individual's attributes *s* and the alternatives available *B*, is equal

to the probability that there exists a decision rule that causes this choice to be made. McFadden represented this mathematically as:

$$P(x|s,B) = \pi[\{h \in H | h(s,B) = x\}] \tag{4.1}$$

So far, McFadden has shown that by assuming the probability π is a member of a specific probability distribution and that individual behavior can be summarized by the combination of attributes for a randomly selected individual and the choices faced by that individual, an "econometric model of quantitative choice..." can be constructed. He then extended this to the rational, neo-classical economic agent. McFadden defined the utility function as:

$$U = V(s,x) + \varepsilon(s,x) \tag{4.2}$$

McFadden assumed that V is nonstochastic and thus "reflects the representative tastes" of the population, while ε is stochastic. Ben-Akiva and Lerman (1985) stress that V is the "systematic" component of utility, where V is a deterministic function. Louviere *et al.* (2001) further delineate the difference between the two components of utility. The systematic (*V)* component captures that portion of utility contributed by attributes that an observing analyst notices, while random utility is utility from unobserved attributes. As discussed in Louviere *et al.* (2001), the observer cannot observe the "complete decision calculus" an individual uses when making a choice.

Ben-Akiva and Lerman (1985) succinctly summarize this as the probability that a randomly selected person, n, chooses alternative i from a choice set C_n, as

$$P(i|C_n) = \Pr(U_{in} > U_{jn}, \forall j \neq i \in C_n). \tag{4.3}$$

In words, person *n* chooses alternative *i* when the utility derived from alternative *i* is greater than the utility derived from any of the other *j* alternatives. Using McFadden's definition of utility, Ben-Akiva and Lerman (1985) define the random utility of an alternative as

$$U_{in} = V_{in} + \varepsilon_{in} \tag{4.4}$$

Now, substitute this definition of random utility into the above equation

$$P(i|C_n) = \Pr[V_{in} + \varepsilon_{in} > V_{jn} + \varepsilon_{jn}], \ \forall\ j \in C_n,\ j \neq i \tag{4.5}$$

After rearranging, we see

$$P(i|C_n) = \Pr[\varepsilon_{jn} < V_{in} - V_{jn} + \varepsilon_{in}], \ \forall\ j \in C_n,\ j \neq i \tag{4.5a}$$

McFadden (1974) summarized Luce's Independence of Irrelevant Alternatives (IIA) axiom by stating "the relative odds of one alternative being chosen over a second should be independent of the presence or absence of third alternatives not chosen." Combining the assumptions that the elements are identically and independently distributed (IID) with Luce's IIA axiom and using the definition of the multinomial logit model,[28] defines the probability as

$$P_n(i) = \frac{e^{V_{in}}}{\sum_{j \in C_n} e^{V_{jn}}} \tag{4.6}$$

McFadden assumes that the joint cumulative distribution of the random utility elements associated with all the alternatives ($\varepsilon(s, x_j)$) follows a "Weibell (Gnedenko, extreme value) distribution". If we further assume a linear-in-parameters functional form versus the unspecified functional form *V*, then we get

[28] See Train (2003) page 40 and section 3-10 for the complete derivation of the logit probability.

$$P_n(i) = \frac{e^{\beta' x_{in}}}{\sum_{j \in C_n} e^{\beta' x_{jn}}}, \tag{4.7}$$

where $\boldsymbol{x_{in}}$ and $\boldsymbol{x_{jn}}$ are vectors which describe the attributes in alternatives *i* and *j*, respectively (Ben-Akiva and Lerman, 1985). This form allows us to analyze the data, once we receive our input from the survey respondents. As such, we now turn to the issues behind the development of our choice experiment, which will produce the data necessary for analysis.

Practitioners of choice modeling categorize the choice approach as an experiment instead of a simple survey. This is because choice models contain policy scenarios, or alternatives, that typically consist of a subset of the total possible choice sets (Louviere 2001). Louviere *et al.* (2000) define a designed experiment as a way to test various hypotheses that are interesting to the experimenter by manipulating the attributes of the hypotheses and their levels. Given this definition, our first step in designing a choice experiment is to identify the hypothesis of interest and the attributes that define this hypothesis. Louviere *et al.* (2000) provide the steps to performing a choice study, essentially a checklist of stages that are common to all choice experiments, as does Bennett and Adamowicz (2001). While almost identical, I have blended the two lists for my own edification, as follows: a characterization of the problem that is to be decided, a definition of the number of attributes and selection of the appropriate levels for each, development of the instrument to collect the data, use of statistical design methodology to develop the experiment, determination of the sample size and data collection, model estimation and finally policy analysis. We will apply this checklist to the research problem at hand.

4.2 Study Objectives

The objective of this study, as mentioned previously, is to quantify how much the American public is willing to pay to ensure realistic training can be conducted in a way which simulates actual combat conditions, while simultaneously preserving the status of endangered species. Policymakers can then take this information and use it to make decisions regarding the encroachment vs. training trade-off. Our specific areas of concern are the situations at both Camp Pendleton and Fort Irwin. Neither installation is being used to its maximum effectiveness due to regulatory limitations associated with the presence of endangered species and/or any critical habitat designation. Bennett and Adamowicz (2001) note that choice modeling is most effective in performing analysis 'at the margins'. As such, we developed the objective using an alternative that is the current status as its foundation. The current status, also referred to as the status quo, is the constant alternative that forms a basis of comparison.

It is here that we make the distinction between the situations at each installation. This allows us to explore both the issues surrounding endangered species and military training and some issues associated with the actual experiment itself. We have clearly defined our overall objective, as it pertains to the valuation issue, but the specific scenarios at each installation allow us to investigate potential experimental problems associated with the framing and scope of the issue. The interaction of how the issue is framed and the overall scope of the issue plays an important role in how the issue is perceived by the participants in the experiment (in our case, the survey respondents). By framing, we simply mean the manner in which the situation is presented. Rolfe *et al.* (2000) sum up the difficulties with framing by noting there are problems with giving the

same level of information for all the alternatives in question and also choosing the best approach to describe the complex interaction between the goods. Scope involves the perceived size of the issue, with respondents failing to differentiate between different sizes upon reaching a minimum standard (Rolfe *et al.* 2000).

Our secondary objective is to test whether or not these issues are manifested in our choice experiment. We provide a quick summary below, with more specifics to follow. The issue at Camp Pendleton is presented in the context of juxtaposing the continued survival of endangered species against the impact on soldiers' readiness. We describe the scenario at Camp Pendleton by explaining that urban sprawl has caused endangered species to migrate (encroach) to the last open coastal space in Southern California, which is located on Camp Pendleton. However, this migration prevents the U.S. Marines from completing realistic training, causing a potential decline in their levels of readiness. At Fort Irwin, we made the comparison between the impact on a facility to conduct training and the impact on habitat declared critical to the survival of the endangered species. In general terms, declaration of critical habitat at Fort Irwin limits the facility's ability to conduct training. The competing land issues at Fort Irwin are, in essence, prerequisites to the survival of species or soldiers' readiness. Effectively, we are attempting to value the same issue using two different scenarios. More specifically, soldiers' readiness is directly correlated with a facility's ability to train, just as the survival of endangered species is directly correlated with the ability to maintain the required critical habitat or equivalent protection. We will use the same choice sets, where only the payment values and the presented scenarios differ, to determine if the willingness to pay values are the same relative to the scope of the problem or whether

they yield differing relative values. The results will provide further evidence to affirm or refute the importance associated with how a choice modeling issue is presented. With two clearly defined objectives for our study, we must now identify the attributes that survey respondents will consider to make their decision, and the levels associated with each attribute.

4.3 Define the Number of Attributes and Levels

When we first began to design the experiment, we identified five attributes as germane to the decision-making process. These five attributes are: 1. impact on a facility to conduct training, 2. impact on soldiers' readiness, 3. impact on critical habitat, 4. impact on endangered species survival, and 5. the costs associated with the various possible alternatives. After carefully analyzing the issues surrounding the problem, we concluded that there are truly only three main attributes relevant to the decision-making process. Why did we reach that conclusion? While refining the attribute definitions, it became clear that impact on critical habitat and impact on a facility to conduct training are simply upstream inputs to the final result, which is the impact on species' survival and soldiers' readiness, respectively. Even though there is nothing that precludes inclusion of both upstream and downstream attributes, this would seem prudent only when doing so serves to further clarify an issue (Bennett 2001). Within the framework of this study, including all the attributes did the opposite; it added confusion to the issue and increased the cognitive burden on the respondent. It was at this point we decided to test whether or not the public would perceive the true issue, even when framed within two different but essentially equal scenarios. It is important to remember that we defined

these attributes against the status quo. We now more fully define the attributes and their prescribed levels.

4.3.1 Impact on a Facility to Conduct Training

As it stands now, the presence of endangered species and any associated critical habitat status directly translates into a reduction in training opportunities. These reduced opportunities take many forms, such as the inability to maneuver as planned, the inability to dig fighting holes and even the outright cancellation of planned missions. Reduced opportunities also include the prohibition against full use of an installation's training grounds due to habitat concerns. It is currently estimated that the ability to train has suffered a significant reduction.[29] The following levels were derived from a study commissioned by the USMC specifically assessing Camp Pendleton's ability to train given the presence of endangered species:

1. A high impact means the presence of endangered species and its critical habitat has a substantial impact on the ability of the base to provide training, identified as being "capable of supporting training for some wartime missions."

2. A medium risk means the presence of endangered species and its critical habitat has a moderate impact on the ability of the base to provide training, identified as being "capable of supporting training for most wartime missions"

3. A low risk means the presence of endangered species and its critical habitat has no impact on the ability of the base to provide training opportunities.

It is our opinion that the current status is that Fort Irwin suffers a substantial impact on the ability of the base to provide training.

[29] SRS Technologies (2003) identified several, quantifiable effects to training due to the presence of endangered species. Similarly, the NTC is currently unable to use recently acquired land due to the presence of endangered species.

4.3.2 Impact on the Critical Habitat

Military training is presumed to have a negative impact on the areas where it is performed. Any areas where critical habitat and training lands coincide are at risk of being adversely impacted by military training activities. Using qualitative terms, we have categorized the levels of risk in the following manner:

1. A high risk means that it is likely that critical habitat will be destroyed in this region.

2. A medium risk means that it is likely that critical habitat will be damaged in this region.

3. A low risk means that it is likely that critical habitat will be unaffected in this region.

It is our opinion that the current status at Fort Irwin is that critical habitat is unaffected in this region.

4.3.3 Impact on Endangered Species Survival

Currently, in accordance with the Endangered Species Act, once a species is listed as endangered, a critical habitat is designated, unless the Secretary of the Interior grants a waiver. After a species is listed, all federal entities affected must consult with the U.S. Fish and Wildlife Service (FWS) before adversely impacting either the species or its habitat. Additionally, DOD is required to establish an Integrated Natural Resource Management Plan that provides a plan for managing the ecosystem of the installation. Given the lawsuits and testimony issued by several environmental groups, and indeed findings by the FWS, one can only conclude that different levels of training correspond to

different risk levels for any endangered species that may be present. Again, using qualitative terms, we have categorized the levels of risk as such:

1. A high risk means that it is likely that an endangered species will become extinct in this region.

2. A medium risk means that it is likely that an endangered species will experience a further decline in this region.

3. A low risk means that it is likely that no affected species will become extinct.

It is our opinion that the current status at Camp Pendleton is that no affected species will become extinct.

4.3.4 Impact on Soldiers' Readiness

Many experts have testified that a reduction in realistic training will ultimately lead to a decline in the effectiveness of the military member to accomplish their assigned mission. While it is not known exactly what threshold of reduced training leads to a degradation in effectiveness, soldiers who are unable to participate in realistic combat training scenarios must, by definition, suffer some degradation in their effectiveness. We have previously noted that the introduction of the Naval Fighter Weapons School (Top Gun) increased the air-to-air kill ratio in the Vietnam War from 1-to-1 to 13-to-1, an impressive increase. We can only assume that the causality runs in either direction, so that the inability to experience realistic combat training is detrimental to effectiveness. The risks associated with the different management policies for endangered species are as follows:

1. A high risk means that it is likely the soldier will suffer a significant decline in combat readiness.

2. A medium risk means that it is likely the soldier will suffer some decline in combat readiness.

3. A low risk means that it is likely there will be no decline in combat readiness.

It is our opinion that the current status at Camp Pendleton implies that soldiers will suffer significant declines in readiness.

4.3.5 The Costs

As highlighted in chapter 3, there are few alternatives for the military to consider if they are prohibited from performing realistic combat training. Possible alternatives include the establishment of new training facilities that do not suffer from the same training impediments associated with endangered species or the purchase of additional lands for use as a preservation location for the endangered species. Both options are predicated upon the fact that substitute lands exist that could be used for either option. Assuming the existence of suitable lands, acquisition would be costly and is not currently funded in the Federal budget. Implementation of either of these options would require a one-time levy on each U.S. household, which could be collected with the payment of the Federal income tax. For Camp Pendleton, the range of payment options includes $0, $25, $50 and $75. For Fort Irwin, the range of payment options includes $0, $5, $10 and $15.

For each alternative, we computed the range of payments using current information versus the use of hypothetical values. At Camp Pendleton, 64,000 acres had previously been designated critical habitat.[30] One alternative we mentioned is the possibility of purchasing additional land adjacent to or near Camp Pendleton, to use either as a training ground or as a wildlife preserve. A search of Landtrader.net, an

[30] Critical habitat designation was originally considered in the case of the california gnatcatcher.

online website that lists open acreage, determined that large vacant lots in the immediate vicinity of Camp Pendleton were selling for $75,000 per acre. Note that the overall price per acre for large land parcels in San Diego County was $13,500. We multiplied $75,000 times 64,000 acres and then divided by the number of U.S. households to calculate an average household cost of $45.51. We rounded this figure to $50 and established it as the midpoint of all nonzero payment values. While it may appear that we arbitrarily chose the highest amount, in fact, our search only identified 6,600 acres of unoccupied large parcel land, approximately one-tenth of the requirement. If land purchases were to actually take place, per acre prices would skyrocket (certainly eclipsing the current $13,500 per acre average across the county), as focus shifted to ever-smaller land parcels selling closer to retail prices. Based on this rationale, we felt justified in our above methodology.

Regarding the payment options for Fort Irwin, similar calculations were used to derive the payment amounts. Recall from page 29 that William Haigh, BLM project manager for the West Mojave Region, estimated total cost to acquire 460,000 acres to be $300,000,000, which was subsequently revised downward to $220,000,000. Using the same land search method as we did for Camp Pendleton, we determined that large parcel lands in the same county as Fort Irwin were selling for approximately $2,100 an acre. Using Mr. Haigh's closing cost estimate and his estimated requirement that a 7-person staff would be required to oversee the land acquisition process, we calculated a total project cost of $1,010,105,253. Our estimate differed from his in that he assumed only 80% of the land would be purchased at a much lower per acre cost ($700 vs. our $2,084); also, I adjusted the values for both closing costs and salaries to account for inflation.

Thus, $1,010 million divided by 105.5 million households equaled $10 per household, after rounding to the nearest whole number. As with Camp Pendleton, we believe the limited availability of large parcel lands and the inevitable per acre price explosion that would accompany any significant land purchases justified the higher per acre figures used in our calculations. We chose $10 to be the midpoint of our nonzero payment values, giving us the range $0 through $15.

The payment values associated with Camp Pendleton are larger by a factor of five than the payment values for Fort Irwin. Why is this important? The surveys for Camp Pendleton and Fort Irwin use the same statistical design process, such that the choice sets are identical, only the payment values differ. The descriptions of the attributes and the effects of the attributes also differ across surveys, but the attributes have the same values within the exact same choice set, except for the before-mentioned payment attribute. For example, option A under choice set 6 (survey question #10) in the survey has the values $10 (which is the midpoint of the nonzero payment values for Fort Irwin), "Low" and "Medium", for the following categories on the Fort Irwin survey: payment per household, impact on critical habitat, and impact on training opportunities, respectively. The same choice set takes the same values for the last two categories on the Camp Pendleton survey, endangered species survival and impact on soldiers' readiness, while the choice set takes the value $50 (which is the midpoint of the nonzero payment values for Camp Pendleton) for the payment per household category.

We designed the survey in this manner to allow us to answer the following question, "Does the American public recognize the relative importance of critical habitat and a facility's ability to train as an upstream input on their respective downstream

products?" The descriptions for the categories concerning critical habitat and military facilities were developed in such a manner as to imply that failure to provide either attribute would adversely impact its downstream user. It seems only natural to investigate whether the willingness to pay for improvements at Camp Pendleton vs. Fort Irwin exhibit the same relative values.

4.4 Develop the Instrument to Collect the Data

Now that the attributes are defined with their respective levels, we must turn our attention to development of the instrument to collect the data. Given the complexity of the choice sets that survey respondents will face, a telephone survey is unlikely to facilitate the proper transmission of the information in such a manner that any data collected would be deemed reliable. There are also numerous technical roadblocks to telephonic survey administration, such as the use of caller identification, voice mail, answering machines, etc. With the wildly popular state and federal do-not-call lists, it is evident that many people are not receptive to intrusions while they are at home. We therefore turn to the development of a questionnaire which will be administered as both a mail-out survey and an Internet survey.

Much has been written concerning the proper construction of surveys to minimize the number of non-respondents. Dillman (2000) discusses several survey errors in the context of tailored survey design. Two errors relevant to the development of this questionnaire are measurement error and non-response error. Dillman (2000) credits measurement error to the poor choice of words when writing questions and also to poor construction of the questionnaire. Non-response errors are errors that arise because

significant numbers of sampled individuals do not respond, and their characteristics differ from those who do respond. The mail-out survey employed a three contact strategy in accordance with the techniques espoused in Dillman (2000) in an attempt to limit errors of the nature identified above. The details of how we conducted the survey follow.

4.4.1 Survey Mechanics

Forty-eight hundred people were invited to participate in our choice experiment. Of this number, half were selected to complete the mail-out survey and half were selected to complete the survey on the Internet. This design methodology added an additional dimension to the study. Given the disparity in costs to use the different mediums and the ever-expanding Internet saturation across U.S. households, it seemed a natural evolution to maximize the use of the Internet, all else being equal. In fact, as reported in the August 2000 Current Population Survey, the percentage of households with Internet access in the home has more than doubled from 1997 to 2000, from 18% to 42%. While recently the rate of this growth has slowed, it is currently estimated that three out of every four Americans has access to the Internet in his or her home.[31] To test the viability of conducting more survey research using the Internet versus the postal system, we first developed the mail-out questionnaire and then converted this questionnaire into a nearly identical Internet questionnaire. The specifics behind each questionnaire and distribution methods now follow.

[31] In a press release issued by Nielsen/NetRatings on March 18, 2004, NetRatings estimated that 204 million Americans have Internet access in the home. Their figures are based upon a random digit dial phone survey. Specifically, Nielsen estimates 204,307,000 people have access out of an estimated 272,810,000 total persons in the U.S. with a fixed line phone. This second figure is based on 2004 projections using the 2000 Census. Nielsen/NetRatings is a subdivision of Nielsen research and they are specifically tasked with the job of tracking Internet access and usage statistics,

Two basic surveys were developed using the background previously provided in chapter 3 and earlier in this chapter. Each survey begins with two warm-up questions designed to get the respondent comfortable with making choices between goods or services that require tradeoffs. Following this, each survey has a carefully worded description designed to capture the essential elements of both sides of the existing conflict, while keeping the overall length such that it is not overwhelming for the average American. The scenario for Camp Pendleton provided details about Camp Pendleton's location, which is surrounded by urban growth, the unique characteristics of its training mission, and the number of endangered species that currently exist on Camp Pendleton. Fort Irwin's scenario discusses the need to open a new corridor for heavy armor training, the impact on this need by the presence of the endangered desert tortoise, and the attempts to secure an adequate training facility while ensuring adequate lands are available for the desert tortoise. Following the scenarios, each survey presents nine choice model questions with each question containing two choice set alternatives to be compared against the status quo. Finally, the survey concludes with two attitudinal and several socioeconomic questions. At this point, it would seem appropriate to take a closer look at the development of the choice sets.

4.4.1.1 Experimental Design

A choice modeling framework was chosen to try to elicit the value that the American public places on the ability to perform realistic combat training while simultaneously reducing the risk of harm to any endangered species currently present in the training area. As has been discussed previously, the choice modeling strategy

requires respondents to select from a set of alternatives with varying levels. Using econometric techniques such as the conditional logit model, we are able to assign values to the different alternatives, compute the mean willingness to pay and value the incremental change resulting from different levels within the attributes. Experimental design techniques were used to develop an experiment that is nearly orthogonal. Near orthogonality ensured that all main effects are independently estimatable (Louviere 2001).

Balance is a concept we use to help ensure orthogonality in the experiment. Balance simply means that for each attribute, the levels are either equal to one another or they are a multiple of the levels of the other attributes. For example, if we have a four-attribute choice experiment with three attributes consisting of two levels, then our fourth attribute should either have two or four levels to maintain a balanced design. Maintaining balance in our experimental design was not feasible, due to the qualitative definitions used for the two attributes (excluding the payment attribute) that defined each problem. We selected categories that had the highest probability of familiarity for each respondent (High, Medium and Low), thereby hoping to increase response rates. With two attributes each having three levels, a balanced design would dictate a payment attribute identified by either three or six levels. Given that one level of the payment attribute was set to zero as a reflection of the status quo, to maintain balance we were left to choose from either two or five other payment levels. Instead, to reflect more closely reality, we chose four total payment levels, corresponding to the no cost option of the

status quo, our estimated cost of implementing one solution, and a payment level equally higher and lower than our estimated cost of implementation.[32]

Therefore, our choice experiment has two attributes with three levels and one attribute with four levels. Choice models estimate the probability of a given choice as a function of the levels of the attributes contained within the chosen alternative; by differing the attribute levels, we observe how probabilities change based on the respondents' choices (Bennett 2001). A complete (full) factorial is required to ensure that each respondent has a chance to answer all possible combinations of attributes and levels. Louviere (2001) notes that all attribute effects are guaranteed to be independent in a full factorial design. This allows their effects to be estimated independently of one another (orthogonality).

While the full factorial provides some statistical advantages, in practice, it becomes too cumbersome for all but the simplest choice experiments. For example, a choice experiment that contains three attributes, each consisting of three levels, would require 27 alternatives (3*3*3 or 3^3) to represent the full factorial. In this simple example, assuming each choice set[33] consists of 3 alternatives, a full factorial representation would generate 9 choice sets. More advanced choice experiments conducted in recent research (see Rolfe *et al.* 2000, Blamey *et al.* 2000, Blamey *et al.* 1999, Adamowicz *et al.* 1998) contain far greater numbers of both attributes and levels. This would require 3^6, or 729 different alternatives. Again, with 3 different alternatives grouped into a choice set, we now see 243 different choice sets presented to an

[32] Increasing the number of payment values from 4 to 6 would have increased d-efficiency scores from 2.24 to 1.73, although the standard errors for the variables increased in the 6 payment variable design.
[33] Here the use of the term choice set is equivalent to one question on a survey.

individual. However, more information can be garnered by performing more comparisons than can be achieved by spanning the full factorial across the range of alternatives. To illustrate this by going back to our simple example (3^3) where we want each question to consist of 3 alternatives (without a status quo option), a richer candidate set exists if we treat each alternative as its own full factorial. Therefore, instead of having a 3^3 problem, alternatives A, B and C each are characterized by a 3^3 problem.[34] For our research, our experiment has 2 attributes with 3 levels and 1 attribute with 4 levels, giving a complete factorial of 36 different alternatives. Given that we are comparing 2 alternatives against the status quo, alternatives A and B each have 36 different design combinations respectively, or 1,296 total combinations. Therefore, we must turn to fractional factorial designs.

Fractional factorial designs allow experimenters to develop an orthogonal experiment that efficiently estimates most of the information available from the full factorial. You must sacrifice some statistical accuracy when estimating anything less than the full factorial. Estimation of the fractional factorial leads to a design where not all the effects from the model can be estimated. That is to say, while proper design selection will ensure we can still estimate the effects from the main attributes, we will lose the ability to estimate all effects from the interactions of all attributes and levels. This sacrifice is necessary to minimize non-response error. Louviere (2000) states that main effects account for between 70 and 90 percent of explained variance. Therefore, we lose little by minimizing the number of higher order interactions that can be estimated by using a fractional factorial design. Using SAS, we are able to determine that at least 72

[34] This would lead to 9^3, or 729 different combinations.

choice sets are required to achieve a 100 percent efficient design, or we can sacrifice some measure of efficiency and use 18 choice sets.[35] The cognitive burden required to respond to a survey with 72 choice questions is too great to expect the answers to be statistically meaningful. Therefore, we opt to use 18 choice sets, accepting the higher standard errors as a tradeoff, in the hope that lessening the number of questions will both increase response rates and increase our own confidence in the answers provided.

Our experimental design calls for 18 choice sets. To develop this experimental design, again, we turn to SAS. Kuhfeld (2002) provides procedures written in SAS that allow for the development of fractional factorial design experiments. SAS started from a full factorial candidate list as the pool for selecting the 36 alternatives and subsequently added the status quo alternative. From the full factorial and additional status quo alternative, SAS selects a typical experimental design corresponding to the constraints provided, and then swaps various alternatives from the pool (in my case the full factorial), trying to create the most efficient experimental design possible. Allowing SAS to test 100 different designs, where each design continues to improve upon itself until the efficiency converges, provides the confidence that the experimental design selected for this choice model experiment is highly efficient. But how is efficiency determined?

Using a generic set of alternatives and then including a status quo option does not allow the researcher to make any stand-alone efficiency calculations. Calculated efficiency ratings are relative, not absolute; therefore, we can only compare efficiency between designs. The choice sets in this survey have an overall efficiency level of

[35] Standard errors for the individual variables ranged from .34 to .44 for the 72 choice set design, whereas they ranged from .69 to .87 for the 18 choice set design.

2.2940.[36] This efficiency was achieved after SAS searched 100 different designs, with each design processing several different iterations trying to reach a convergence in the D-error. Earlier attempts to estimate the choice set using 15 different design iterations yielded a D-efficiency rating of 2.2224. It is believed that any additional gains derived from additional, larger design searches will only be marginally beneficial, with insignificant gains in D-efficiency.[37,38]

Having selected an experimental design which yielded 18 choice sets, this is still too many choice sets for the average respondent to complete and allow us to maintain confidence that the same level of attention was given to the last choice set as was given the first. One strategy suggested to alleviate this is to group the experiment into smaller subsets, commonly referred to as "blocking". Blocking the sample assumes identical preferences across respondents. Blocking also has implications as they apply to sample size because it now takes multiple respondents to review the entire range of alternatives. Again, it seems prudent to accept the tradeoffs associated with blocking versus the potential non-response errors or protest responses.[39] To that end, we blocked each survey

[36] The correct terminology is D-efficiency, which is calculated by taking the reciprocal of the D-error. See Zwerina, Huber and Kuhfeld (1996) for more information.
[37] D-error for the 100 design search routine is .435922. The associated D-efficiency is 2.293990, which is the reciprocal of the D-error (1/.435922=2.293990). The D-error for the 15-design search routine is .449957, yielding a lower D-efficiency (1/.44957=2.222434). Allowing SAS to search through 10,000 different designs did little to meaningfully lower the D-error.
[38] One possible improvement we could have made to our design was to avoid the use of implausible scenarios. While the literature fails to reach a consensus on this point, comments received from a small number of participants indicate that blatantly obvious implausible alternatives caused some consternation. For my survey, an alternative that included high impact on both species survival and soldiers' readiness is unlikely given the status quo starting point. However, designs which excluded implausible alternatives still exhibited dominated strategies within choice sets. Any attempt to manually adjust the experimental design could lead to declines in orthogonality. We decided to use the design as it was configured based upon the original, full factorial of alternatives.
[39] Protest responses, in the context of a choice modeling approach, typically involve a situation where respondents simply give up when answering the survey and always select the same alternative in every choice set (e.g. alternative B) or by always selecting the no-cost option, if one is available.

instrument into 2 blocks of 9 choice sets. Thus, we distributed two survey versions for both Camp Pendleton and Fort Irwin by mail and by Internet.

4.4.1.2 Sample Population

As alluded to earlier, our desired sample population is the American public. As such, our sample was randomly drawn from each of the 48 states. Alaska and Hawaii were excluded due to time constraints. Each state was grouped by region, in accordance with the U.S. Census, and population percentages were calculated accordingly. Table 4.1 shows the regional groupings. The West region was further subdivided into two smaller categories, the Pacific and Mountain, to isolate any effects specific to the Western coastal states. Additionally, the South was subdivided to mitigate any issues associated with the South's large percentage of the overall sample size and their diverse geographical makeup.[40] Forty-six hundred surveys were originally allocated along strict population percentages, with 200 surveys reserved to over sample any regions with significant population disparities. Table 4.2 shows how the surveys would have been distributed by

Table 4.1: Breakdown of States by Census Region and Subdivision

Census Regions	Subdivision	Included States
West	Pacific	CA, OR, WA
	Mountain	AZ, CO, UT, NV, NM, ID, MT, WY
Midwest		IL, OH, MI, WI, ND, SD, IN, MS, MN, IA, KS, NE
South	East South Central and South Atlantic	FL, GA, NC, SC, MD, MS, AL, TN, KY, D.C., VA, WV, DE
Southwest	West South Central	TX, LA, OK, AR
Northeast		NY, PA, NJ, MA, CT, VT, ME, RI, NH

[40] Defining the Southern region exactly in line with the U.S. Census creates a region that spans from Texas and Oklahoma to Maryland and Delaware. This region seems too large to share similar characteristics.

Table 4.2: Sample Distribution by Census Region and Subdivision

Census Region	Subdivision	4,800 Sample	Final Sample (including 200 over sample)
West	Pacific	742	712
	Mountain	310	496
Midwest		1,104	1,056
South	Excluding SW	1,181	1,128
Southwest		540	528
Northeast		919	880

region without withholding 200 surveys and then the actual distribution with the 200 surveys used to adjust overall representation by region. Notice that almost the entire over sample was used to increase the representative percentage of the Mountain subdivision of the West region. Other marginal changes were made to ensure each state received multiples of four surveys, where possible. This was done to ensure equal coverage of both survey versions and their respective blocks throughout the state. That is to say, this method ensured that Idaho did not receive a disproportionate share of Camp Pendleton block 1 surveys, for example. Specifics on how many mail and Internet surveys were distributed to each state can be found in Appendix A, Table A1.1.

4.4.1.3 Mail Survey

Regarding the distribution of surveys by mail, households were sent a pre-announcement postcard informing them of their selection to participate in a survey that would arrive by mail within the next couple of days. Each pre-announcement postcard was individually hand-signed in blue ink, an attempt to demonstrate the importance of

this issue.[41] The pre-announcement salutation was not personalized to the recipient, unlike the cover letter that was included with each survey. Three days elapsed between the time the pre-announcement postcards were mailed and the time the surveys were mailed. Each survey included the following: a cover letter, the survey and a self-addressed, stamped envelope. Table 4.3 details the specific distribution across survey versions and states.

The survey was distributed in 9" x 12" manila envelopes, with The University of Tennessee address labels prominently displayed on the front of each envelope. The included cover letter was mailed on The University of Tennessee letterhead. We personalized each cover letter, using their name, address and a personalized salutation in lieu of a generic salutation, e.g. Dear John Doe vs. Dear Survey Participant. This required us to print each individual cover letter instead of using a photocopying service. Each cover letter was hand-signed in blue ink, as with the pre-announcement postcard. Dillman (2000) indicates that every attempt should be made to personalize the experience between the survey respondent and the surveyor. This compels the respondent to feel an obligation to complete the survey, thereby minimizing non-response errors. Return envelopes (5" x 8") affixed with a first-class stamp were supplied with every survey, and each return envelope was numbered to facilitate tracking of individual responses.[42]

[41] As an aside, one survey respondent thanked us for announcing our intentions by mail, noting that it was refreshing to receive a postcard versus the typical intrusive evening telephone call.

[42] Dillman (2000) talks about the use of nominal, intrinsic monetary rewards as a way to compel the person receiving the survey to respond. One such method is by including an actual first class stamp on the return envelope instead of using an account with the USPS, which only charges you based on the number of envelopes that are actually returned. The theory is that people are hesitant to discard anything of value, even something as small as an envelope with one first-class stamp.

Table 4.3: Mail Survey Distribution by Survey Version and State

		Camp Pendleton		Fort Irwin	
Region	**State**	**Version 1**	**Version 2**	**Version 1**	**Version 2**
Pacific	California	70	70	70	70
Pacific	Washington	12	12	12	12
Pacific	Oregon	7	7	7	7
Mountain	Arizona	13	14	14	13
Mountain	Colorado	12	12	12	12
Mountain	Utah	7	8	8	8
Mountain	Nevada	7	7	7	8
Mountain	New Mexico	7	7	6	7
Mountain	Idaho	6	5	6	6
Mountain	Montana	5	5	5	5
Mountain	Wyoming	4	4	4	4
Midwest	Illinois	25	26	25	26
Midwest	Ohio	23	23	23	24
Midwest	Michigan	21	20	20	21
Midwest	Indiana	13	12	12	13
Midwest	Missouri	12	11	11	12
Midwest	Wisconsin	11	11	11	11
Midwest	Minnesota	10	10	10	10
Midwest	Iowa	6	66	6	6
Midwest	Kansas	5	6	6	5
Midwest	Nebraska	3	4	4	3
Midwest	South Dakota	1	2	2	1
Midwest	North Dakota	1	2	1	1
South	Florida	32	33	33	33
South	Georgia	17	17	17	16
South	North Carolina	16	17	17	16
South	Virginia	14	15	14	15
South	Tennessee	12	12	12	11
South	Maryland	11	11	11	11
South	Alabama	9	9	9	9
South	Kentucky	9	8	8	8
South	South Carolina	9	8	8	8
South	Mississippi	6	6	6	6
South	West Virginia	4	4	4	3
South	D.C.	1	1	1	1
South	Delaware	2	1	2	2
Southwest	Texas	43	42	43	43
Southwest	Louisiana	10	10	10	10
Southwest	Oklahoma	7	7	7	7
Southwest	Arkansas	6	6	6	6
Northeast	New York	39	39	39	39
Northeast	Pennsylvania	25	25	25	26
Northeast	New Jersey	17	17	17	18
Northeast	Massachusetts	13	13	13	13
Northeast	Connecticut	7	7	7	7
Northeast	Maine	3	3	3	2
Northeast	New Hampshire	3	2	3	2

Table 4.3: Continued

		Camp Pendleton		Fort Irwin	
Region	**State**	**Version 1**	**Version 2**	**Region**	**State**
Northeast	Rhode Island	2	2	Northeast	Rhode Island
Northeast	Vermont	2	1	Northeast	Vermont

Individuals who did not respond within 10 days of the initial survey mailing were mailed a hand-signed postcard to remind them of the importance of their participation.

4.4.1.4 Internet Survey

The Internet survey was developed in tandem with the paper survey. A program developed by SPSS called Data Entry Builder was used to create an Internet survey that was almost identical to the paper survey. The opening screen required the user to input an access code that was provided with the cover letter. The access code consisted of a single character and a seven-digit number. This code was used to ensure that only answers from selected survey respondents are included in the final database. One additional question included on the Internet survey that was not on the mail survey provided respondents with four choices and asked them to select the choice where they completed the survey, with the four choices being work, home, school or public library.

The decision on how to draw the sample presented a challenge. The basic problem was to select from respondents who already maintained an electronic mail (e-mail) address or to solicit respondents from the same sample population from which the mail survey respondents were selected. The issue here is one of sample selection bias. As reported in the Current Population Reports, households making more than $75,000 were four times more likely to have home Internet access than households making less

than $25,000 a year. Likewise, households where education is a bachelor's degree or higher are two times more likely to have Internet access than households with a high school diploma or GED. There are additional nuisance issues associated with unsolicited contact by e-mail, similar to unwanted telephone intrusions (commonly referred to as "Spam"). Considering all these factors, including the previously cited high percentage of homes with Internet access, we decided to randomly select from the same database that we used to select our mail survey respondents. Table 4.4 on the following page shows the distribution across states.

Households chosen to participate in the Internet survey received a cover letter on The University of Tennessee letterhead, hand-signed in blue ink, although the Internet cover letter provided more specifics regarding the survey topic. Information regarding the specific alternatives was printed on the back of each cover letter, to facilitate the completion of the survey once the respondent began the online process. Reminder postcards were printed but not mailed due to the unusually low response rate, which will be discussed further in Chapter 5.

The software we used presented two major limitations, one of which may have contributed to the extremely low response rate we experienced from the Internet survey. The first limitation was the ability to give each respondent their own access code and then exclude invalid codes. The online survey actually included a question that required the respondent to input an access code; however, there was no installed security feature that would reference a database of valid security codes and only allow access for valid code entries. Potential problems with this set-up include the fact that non-randomly selected respondents could participate in the survey, survey respondents with valid access

Table 4.4: Internet Survey Distribution by Survey Version and State

		Camp Pendleton		Fort Irwin	
Region	**State**	**Version 1**	**Version 2**	**Version 1**	**Version 2**
Pacific	California	70	70	70	70
Pacific	Washington	12	12	12	12
Pacific	Oregon	7	7	7	7
Mountain	Arizona	14	13	14	13
Mountain	Colorado	12	12	12	12
Mountain	Utah	8	8	8	7
Mountain	Nevada	7	8	7	7
Mountain	New Mexico	7	7	6	7
Mountain	Idaho	6	6	6	5
Mountain	Montana	5	5	5	5
Mountain	Wyoming	4	4	4	4
Midwest	Illinois	26	25	26	25
Midwest	Ohio	24	23	23	23
Midwest	Michigan	21	20	21	20
Midwest	Indiana	13	12	13	12
Midwest	Missouri	12	11	12	11
Midwest	Wisconsin	11	11	11	11
Midwest	Minnesota	10	10	10	10
Midwest	Iowa	6	66	6	6
Midwest	Kansas	5	6	5	6
Midwest	Nebraska	3	4	3	4
Midwest	South Dakota	1	2	1	2
Midwest	North Dakota	1	1	1	2
South	Florida	33	32	33	33
South	Georgia	17	17	17	16
South	North Carolina	17	16	17	16
South	Virginia	15	14	15	14
South	Tennessee	12	12	12	11
South	Maryland	11	11	11	11
South	Alabama	9	9	9	9
South	Kentucky	8	8	8	9
South	South Carolina	8	8	8	9
South	Mississippi	5	6	6	6
South	West Virginia	3	4	4	4
South	D.C.	1	1	1	1
South	Delaware	1	2	1	2
Southwest	Texas	43	43	43	43
Southwest	Louisiana	10	10	10	10
Southwest	Oklahoma	7	8	7	7
Southwest	Arkansas	6	6	6	6
Northeast	New York	39	39	39	39
Northeast	Pennsylvania	25	25	26	25
Northeast	New Jersey	17	17	17	18
Northeast	Massachusetts	13	13	13	13
Northeast	Connecticut	7	7	7	7
Northeast	Maine	3	3	2	3
Northeast	New Hampshire	2	3	2	3

Table 4.4: Continued

		Camp Pendleton		Fort Irwin	
Northeast	Rhode Island	2	2	2	2
Northeast	Vermont	1	1	1	2

codes could complete the survey multiple times (by making slight changes to their access code), etc.[43] The survey was designed to only accept input from one IP address but most home users operate under a dynamic IP address protocol versus a static IP address protocol, so this safeguard would be highly ineffective.[44] The second limitation precludes a respondent from beginning the survey and then saving their progress if they are unable to complete the entire survey at one time. The absence of this feature may prevent people from taking the survey, or more likely, will simply result in many partially completed surveys. In spite of the drawbacks, Data Entry Builder is the online survey software supported by the University and its use saved countless hours of HTML code programming.

While the survey process was a major project in and of itself, it is by no means the end result. Chapter 3 provided the background while chapter 4 set the stage upon which we will now build the results of our efforts. Chapter 5 describes the characteristics of the respondents and presents the results for the various estimation procedures and their respective tests.

[43] Random numbers consisting of 7 numerals and one alphabetic character were assigned to each respondent. Internet answers were manually compared against a database as a validity check.

[44] An IP address is required to access the Internet. Most computer users who access the Internet through an Internet Service Provider (ISP) at home receive a dynamic IP address, which means that the IP address changes each time the computer logs into the ISP. Even broadband Internet connections, sometimes referred to as "always on" Internet connections, periodically refresh the IP address for the computer, because the assigned IP addresses expires.

5. Empirical Results

Firsthand data collection efforts can be challenging, to say the least. As mentioned earlier, we mailed out 4,800 invitations to complete our survey, half of which were sent to individuals inviting them to fill out the provided mail surveys, and the other half were invited to a website where they could complete the survey online. The response rate for both media, but especially the Internet survey, was significantly lower than what we anticipated when we began the project. With the considerable political upheaval and ongoing military conflicts, we assumed a low response rate would not be an issue. Unfortunately, we were mistaken in this assumption. As Table 5.1 demonstrates, only 14% of the households selected to participate in the mail survey completed and returned the actual survey, while a dismally low 1% completed the online survey. Such a low response rate for the Internet survey precludes one of our stated goals, which was to compare the two media for consistency. The low Internet response rate may be an indication that choice modeling is too complex for online media.

Table 5.1: Survey Completion Results

Mail Survey	Completed	Bad Address	Mailed Out	% Comp	% Bad
Pacific	42	22	356	13%	6%
Mountain	37	18	248	16%	7%
Midwest	74	41	528	15%	8%
South	66	58	565	13%	10%
Southwest	33	20	263	14%	8%
Northeast	55	37	440	14%	8%
Grand Total	307	196	2400	14%	8%

	Completed	Bad Address	Mailed Out	% Comp	% Bad
Internet	20	232	2400	1%	10%

Further research is needed to confirm or reject this supposition.

It is unfortunate but the amount budgeted for our survey did not allow for data collection from non-respondents. If funding had been available, we would have attempted to collected demographic data on the non-respondents, to include asking why the individuals did not complete the survey. It would be interesting to learn the main reason behind our low response rate. Several reasons we have considered include: 1) the subject being uninteresting to a majority of the sample, 2) the lack of a financial incentive, 3) the length of the survey, or 4) the use of choice modeling instead of the more commonly used contingent valuation methodology. Whatever the reason, we acknowledge the low response rate may draw criticism when we try to extend our conclusions to the entire population.

5.1 Demographic Information

Table 5.2 shows the demographic characteristics for the survey respondents. For reference, Table D1.1 in Appendix D contains a complete list of variables, including their definitions. Reviewing the data, we see the average survey respondent is 52 years old and had a household income in 2003 of $68,361. The large standard deviation associated with income is somewhat a reflection of the categorical definition, with each category representing $20,000 increments until $99,999, at which point the top two categories are $100,000 to $199,999 and greater than $200,000, respectively.[45] The sample is skewed towards the male population, given that 72% of the respondents are male. The political

[45] The midpoint of the category was selected so we could represent income as a continuous variable. We arbitrarily chose $250,000 to represent the final category of "greater than $200,000."

Table 5.2: Descriptive Statistics for the Sample

Variable	Obs	Mean	Std. Dev.	Min	Max
news	322	2.608696	0.9581519	1	4
cur_view	321	1.872274	0.616855	1	3
age	320	52.16562	15.9124	20	87
sex	326	0.2852761	0.45224	0	1
political	313	2.089457	1.125883	1	4
educ	326	4.055215	1.426136	1	6
race	312	3.778846	0.6307765	1	4
marital	314	1.576433	0.9195526	1	4
income	306	68300.65	50955.34	10000	250000
stat_num	326	24.50307	14.73536	1	49
region	326	3.622699	1.587055	1	6
comments	326	1.702454	0.4578815	1	2
version	327	1.522936	0.5002392	1	2
mail	327	0.058104	0.2342985	0	1
survey	327	1.464832	0.4995261	1	2
newsspec	322	0.1397516	0.3472687	0	1
newstrain	322	0.310559	0.4634427	0	1
newsequal	322	0.3509317	0.4780044	0	1
newsother	322	0.1987578	0.3996864	0	1
curspec	321	0.2616822	0.4402368	0	1
curtrain	321	0.6043614	0.4897509	0	1
curother	321	0.1339564	0.3411372	0	1
democrat	313	0.3738019	0.4845867	0	1
repub	313	0.3801917	0.4862111	0	1
green	313	0.028754	0.1673819	0	1
indep	313	0.2172524	0.4130361	0	1
lhs	326	0.0398773	0.1959717	0	1
hs	326	0.1748466	0.3804198	0	1
trade	326	0.0644172	0.245872	0	1
assoc	326	0.291411	0.455111	0	1
bachelor	326	0.2699387	0.4446101	0	1
postgrad	326	0.1595092	0.3667131	0	1
lbachelor	326	0.5705521	0.4957583	0	1
some_col	326	0.7208589	0.4492666	0	1
asian	312	0.0128205	0.1126803	0	1
black	312	0.0737179	0.2617311	0	1
hispanic	312	0.0352564	0.1847235	0	1
white	312	0.8782051	0.3275741	0	1
nonwhite	312	0.1217949	0.3275741	0	1
married	314	0.6624204	0.4736392	0	1
single	314	0.1592357	0.3664797	0	1
divorced	314	0.1178344	0.3229266	0	1
widowed	314	0.0605096	0.2388091	0	1
nonmarried	314	0.3375796	0.4736392	0	1

Table 5.2: Continued

Variable	Obs	Mean	Std. Dev.	Min	Max
cp	327	0.5351682	0.4995261	0	1
irwin	327	0.4648318	0.4995261	0	1
envmbr	316	0.2088608	0.4071394	0	1
military	316	0.3037975	0.4606257	0	1
fammbr	316	0.0949367	0.2935924	0	1
afghaniraq	316	0.0348101	0.1835893	0	1

distribution seems to mirror statistics reported in the popular press, with 38% of the respondents identifying themselves as Republicans, 37% as Democrats, 22% as Independents and only 3% responding that they belong to the Green party. Forty-three percent of respondents have at least a college education (where college is defined as bachelor's degree or higher) and 16% of respondents have a postgraduate degree. Note, if we created a new category called "some college" which consisted of associate's degrees and higher, this category would include 72% of the respondents. Eighty-eight percent of respondents are white, while 66% of all respondents are married.

Contrasting these summary demographic statistics against the entire U.S. population highlights an additional area of concern for this study. While 72% of our sample is composed of males, males only represent 49% of the total U.S. population. Similarly, the average age of the adult U.S. population is 46.3 years, while our sample on average is approximately 6 years older.[46] Median household income in 1999, as reported by the 2000 Census, was $41,994 for all U.S. households. Adjusting this figure by the growth in the employment cost index from 2000 to 2004 gives us a median household

[46] Average age of the adult U.S. population is approximated by selecting the midpoint of every 5-year age category from the 2000 Census, multiplying by the number of adults in the 5-year category, and dividing by the total number of adults. The 5-year age group categories start at "20 - 24 years old" and end at "95 or greater". 97 years old was selected as the final age midpoint.

income of $47,633, which is considerably lower than the $68,361 average income that is reported by our respondents. Eighty-eight percent of our sample respondents were white vs. 69% of the U.S. population. Our sample is also better educated than the U.S. population, on average. Only 4% of our sample have less than a high school education versus 20% for the U.S., 77% report attending some college versus 52% for the U.S., and 43% have a bachelor's degree or higher versus 24% for the U.S. In light of this, it is important to realize that our typical respondent is a married white man who is wealthier, older and better educated than the average American.

Drilling down deeper into the demographic data, we find that the average household income of male respondents is $76,977 and the average household income for female respondents is $47,778 (Table 5.3). Even more interesting, we see in Table 5.4 that Green party members earn an average of $81,000 more than Democrats, while out earning Republicans by $43,000. This observation is most likely skewed by the small number of Green party respondents. The income disparity between Republicans and Democrats is also large, with Republicans earning $28,000 more than Democrats and $12,000 more than Independents. Table 5.5 reports income statistics for each racial

Table 5.3: Summary of Household Income by Sex

	Mean	Std. Dev.	Freq.
Female	$ 47,777.78	$ 39,370.83	90
Male	$ 76,976.74	$ 52,929.81	215
Total	$ 68,360.66	$ 51,028.25	305

Table 5.4: Summary of Income by Political Affiliation

	Mean	Std. Dev.	Freq.
Democrat	$ 52,056.08	$ 42,642.40	107
Republican	$ 80,357.14	$ 56,312.01	112
Green	$123,333.33	$ 65,574.39	9
Independent	$ 67,812.50	$ 44,666.98	64
Total	$ 68,561.64	$ 51,659.60	292

Table 5.5: Summary of Income by Race

	Mean	Std. Dev.	Freq.
Asian	$105,000.00	$ 57,445.63	4
Black	$ 61,428.57	$ 63,426.00	21
Hispanic	$ 50,000.00	$ 44,721.36	11
White	$ 68,801.50	$ 49,978.06	267
Total	$ 68,085.81	$ 50,980.12	303

category surveyed. Noting the same warnings about small numbers of observations, we see the average White household earned $68,801, while the average Black household earned $61,429 and the average Hispanic household earned $50,000.

Regarding education, the picture is just as interesting. Table 5.6 shows the percentage of respondents who fell within the various educational categories, by race. Of the total sample population, 56% have less than a Bachelor's degree, with Hispanics and Blacks doing worse than average at 73% and 61% respectively, while Whites hover around the sample mean at 56%. From those who have a Bachelor's degree or higher, we see that again Hispanics lag behind the other major categories of racial respondents. Twenty-seven percent of Hispanics have a 4-year or advanced degree, compared to 39% of Black respondents and 44% of White respondents. Pertaining to political affiliation, as we show in Table 5.7, Democrats do not compare as well in all education categories.

Table 5.6: Summary of Education by Race

	< H. School	High School	Trade	Assoc. Deg	< Bachelors	B.A./B.S.	Postgrad	Freq
Asian	0%	0%	0%	0%	0%	100%	0%	4
Black	9%	9%	13%	30%	61%	26%	13%	23
Hispanic	0%	9%	9%	55%	73%	18%	9%	11
White	3%	18%	6%	28%	56%	27%	17%	273
Total	4%	17%	7%	29%	56%	27%	16%	311

Table 5.7: Summary of Education by Political Affiliation

Political	< H. School	High School	Trade	Assoc. Deg	< Bachelors	B.A./B.S.	Postgrad	Freq
Democrat	6%	21%	10%	28%	65%	22%	13%	117
Republican	3%	16%	4%	32%	55%	29%	16%	118
Green	0%	0%	11%	22%	33%	33%	33%	9
Independent	4%	16%	3%	26%	50%	29%	21%	68
Total	4%	17%	6%	29%	57%	27%	16%	312

Sixty-five percent of Democrats have less than a college education, while they lag below the sample mean in both Bachelor's degrees and Postgraduate degrees. Republican's tend to mirror the sample averages, while Green party and Independent members as a group have received the most formal education of all the respondents. Finally, 76% of males reported attending "some college" (as defined previously) versus the sample mean of 72%, while 62% of females reported attending some college.

Concluding our review of the demographic information, Table 5.8 shows us that when respondents were asked whether they favored either endangered species, military training or both equally when they read or hear about them in the news, 20% of Democrats and 26% of Independents favored endangered species, while only 4% of Republicans favored endangered species. Approximately half of the Republicans favored

Table 5.8: Summary of News Stories by Political Affiliation

	Endangered	Military	Equal	Other	Total
Democrat	20%	19%	41%	20%	115
Republican	4%	46%	30%	19%	119
Green	0%	50%	25%	25%	8
Independent	26%	21%	33%	20%	66
Total	15%	31%	35%	20%	308

the military, as did the Green party, while 20% of either Democrats or Independents favored the military. Interestingly, 35% of respondents favored endangered species and the military equally. This result was surprising considering the current public support exhibited for the American military, even during a time when America is engaged in two different conflicts, with flagging public approval. However, when we removed the neutral category and followed up with a question which attempted to learn the respondents' current views by forcing them to choose between the two, the results differ remarkably. As shown in Table 5.9, when forced to choose, support for endangered species grows from 15% of respondents to 27% of respondents, with Democrats and Independents percentages virtually identical at 36%. Republican support for endangered species climbs from 4% to 13%. Regarding the military, 60% of respondents favored the military when forced to choose between the two. Seventy-six percent of Republicans favored the military, while almost half of both Democrats and Independents also favored the military. In both questions, the category labeled other was defined as either "don't know or haven't heard of the issue".

Table 5.9: Summary of Current Views by Political Affiliation

Political	Endangered	Military	Other	Total
Democrat	36%	47%	18%	113
Republican	13%	76%	10%	119
Green	13%	88%	0%	8
Independent	36%	52%	12%	66
Total	27%	60%	13%	306

5.2 Model Specification and Estimation

As discussed in Chapter 4, our chosen method of estimation is McFadden's conditional logit model.[47] The conditional logit model was originally fitted to the data in a variety of specifications. Model 1 included the attributes of the choice set and a constant. Model 2 included the choice set attributes, a constant and those socioeconomic variables that proved to be statistically significant. Model 3 built upon the second model by adding dummy variables for both attitudinal questions concerning news story perspectives and respondents' current views. As it pertains to the constant, the conventional choice modeling approach identifies an alternative specific constant (ASC) for each alternative excluding the comparison alternative. However, our choice sets were not developed in such a way that meaningful information can be associated with a selected alternative. Each alternative was unlabelled, a generic alternative, and potentially included values from across the range of all possible values, including the status quo. Given that there was no informational value from estimating an ASC for each

[47] The literature sometimes refers to the conditional logit model as a multinomial logit model, even when it pertains to probabilistic choice models where the probability varies across the attributes. The conditional logit model is used to estimate probabilities when the varying attributes of the alternatives drive the change in probabilities. The multinomial logit model is used when the characteristics of the respondent vary and cause any changes in the choice probabilities.

alternative, all model specifications contain a constrained ASC, which indicates that either alternative A or B was selected.[48]

5.2.1 Camp Pendleton Conditional Logit Results

Table 5.10 shows the results of fitting the data for Camp Pendleton with the conditional logit model for all three specifications. All qualitative and dummy variables in the three models were coded using traditional dummy coding techniques versus effects coding. It is well known that traditional dummy coding techniques select a base category for the alternative (dummy variable) and set the value for that category to zero. Other categories for that alternative (dummy variable) are then given a value of one, if present, or zero if absent. Effects coding is accomplished by selecting the base category for the attribute (dummy variable) and setting the value for this category equal to -1. Other categories are then coded exactly as described for traditional dummy variables.
For example, with respect to endangered species, the attribute is assigned L-1 variables, where L is the number of levels (here L = 3). So, the impact on endangered species would be identified by two variables, call them species_medium and species_high. Using low as the base level, any alternative where the impact on endangered species takes the value medium, then the variable species_medium would be assigned a value of one and 0 otherwise. Likewise, for any alternative where impact on endangered species takes the value high, the variable species_high would be assigned the value of one and zero otherwise. Finally, any alternative where the impact on endangered species takes the

[48] The application of choice modeling to environmental situations grew from our understanding of conjoint analysis as it was applied in the marketing and transportation disciplines. Within each of these fields, it is more likely that the alternatives themselves will also convey specific information, such as a mode of travel or information related to a specific product. In those cases, constraining the model to only estimate one ASC would be inappropriate and may result in misspecification of the model.

Table 5.10: Camp Pendleton Conditional Logit Results

	Model 1			Model 2			Model 3		
Variable	***Coefficient***		***Std. Error***	***Coefficient***		***Std. Error***	***Coefficient***		***Std. Error***
Payment	-0.0125	***	0.0017	-0.0135	***	0.0019	-0.0133	***	0.0019
Constant (C1)	0.2154		0.2086	1.4027	***	0.3727	1.1239	***	0.4179
Species_Medium	-0.2274	**	0.1133	-0.2914	**	0.1242	-0.2946	**	0.1265
Species_High	-0.8130	***	0.1221	-0.8457	***	0.1323	-0.8570	***	0.1344
Soldiers_Low	0.6857	***	0.1355	0.5667	***	0.1430	0.5909	***	0.1455
Soldiers_Medium	0.4365	***	0.1363	0.3239	**	0.1437	0.3506	**	0.1464
C1*Age				-0.0198	***	0.0045	-0.0220	***	0.0049
C1*Income				0.00001	***	0.00000	0.00001	***	0.00000
C1*Sex				0.3610	**	0.1512	0.3015	*	0.1622
C1*Less than Bachelor				-0.3130	*	0.1618	-0.2690		0.1702
C1*Postgraduate				0.5846	**	0.2297	0.8369	***	0.2486
C1*Democrat				-0.3077	**	0.1526	-0.4193	**	0.1650
C1*Independent				-0.3652	**	0.1733	-0.3779	**	0.1835
C1*Green				-1.6006	***	0.3868	-1.6454	***	0.3980
C1*News_Species							0.5123		0.3913
C1*News_Equal							0.5484	***	0.1793
C1*News_Other							0.1293		0.2003
C1*Current View_Species							-0.0314		0.1997
C1*Current View_Other							0.6386	**	0.2591
Model Statistics									
Log L	-1406.246			-1188.732			-1146.737		
adj. Rho-square (%)	0.062			0.091			0.108		

*** - significant at 1%, ** - significant at 5%, * - significant at 10% level respectively

value of low, both species_medium and species_high take the value of -1. While there are pros and cons to either method (see Hardy (1993) for a full exposition of the use of dummy variables), estimation using the two different coding methods yielded identical model statistics (ρ^2, log likelihood values, etc.) and willingness to pay calculations, while only the coefficients on the variables vary (willingness to pay is also calculated slightly differently). We chose traditional coding because, for inexplicable reasons, the medium levels for both species and soldiers were statistically insignificant using effects coding, but they yielded statistically significant results for all model specifications using traditional coding, except for the soldiers' medium level attribute in the nested logit specification for Camp Pendleton.

Model 1 suffers from poor goodness of fit measures, with a large log likelihood value and an adjusted ρ^2 value of .062.[49] The coefficients on all the attributes have the expected sign and all are at least statistically significant at the 5% level, except for the alternative specific constant. Hensher (1981) and Ben-Akiva and Lerman (1985) report that ρ^2 values in the .2 to .4 range are indicative of a good fit between the model and the data. One technique used both to improve goodness of fit measures and to try and correct any violations of the IIA assumption is to include socioeconomic variables in the model. Therefore, model 2 was estimated using those socioeconomic variables that proved to be statistically significant. While the log likelihood value showed an improvement, the

[49] ρ^2 is also referred to as the likelihood ratio index. In either case, it is calculated the same: $\rho^2 = 1 - \frac{LL_{\max}}{LL_0}$, while the adjusted ρ^2 is calculated by adjusting the numerator by a factor, *A*, $\bar{\rho}^2 = 1 - \frac{LL_{\max} - A}{LL_0}$. *A* has been suggested to be equal to the number of parameters, K, (Ben-Akiva and Lerman) or K/2 by Horowitz (Hanemann 1998).

adjusted ρ^2 value only improved from .062 to .091. All attribute variables retained the signs of their respective coefficients, while the coefficient for the constant is now highly significant. Negative coefficients on socioeconomic dummy variables indicate that the category represented by that dummy variable is less likely to choose either alternative A or B versus the status quo. Given that the status quo is highly impacted training with a low impact on endangered species, we conclude that negative coefficients indicate a lower probability of choosing to pay to improve training opportunities. It may also be that negative coefficients indicate a preference for preserving endangered species, no matter the costs. In either case, older Americans are less willing to pay to improve military training opportunities. Similarly, individuals with less than a bachelor's degree are less likely to pay for training improvements as compared to individuals with a bachelor's degree, while those with postgraduate education are more likely to choose to pay for training. Democrats, Independents and members of the Green party are all less likely to choose an option to pay for training when compared to Republicans. As will be seen shortly, willingness to pay values did not change significantly with the inclusion of either socioeconomic or attitudinal variables.

Attempting to further improve the model by adding attitudinal variables yielded little improvement. The log likelihood value improved slightly, while adjusted ρ^2 improved from .091 to .108. All previous analysis as it applied to model 2 carries forward to model 3, except that the coefficient on the variable "C1*less than bachelor" became statistically insignificant. Adding the attitudinal variables shows that only those respondents that view new stories without a bias and those who would not disclose their current views as they pertain to the military and endangered species are significant.

There is obviously no reason to expect that people who choose not to share their views would be a statistically significant variable. The sign of the coefficient on the parameter for current view favoring endangered species is as expected, but it conflicts with the coefficient on the variable reflecting those who read current news stories and favor endangered species. Willingness to pay values (shown in Table 5.11) change marginally for this specification, with $WTP_{model\ 2} < WTP_{model\ 3} < WTP_{model\ 1}$, while $WTA_{model\ 1} < WTA_{model\ 3} < WTA_{model\ 2}$. Using Hanemann's (1984) now familiar equation to calculate welfare for the multinomial logit specification:

$$W = -\frac{1}{\mu}\left[\ln \sum_{i \in C} e^{Vi0} - \ln \sum_{i \in C} e^{Vi1}\right] \tag{5.1}$$

where μ is interpreted as the marginal utility of income, and V_{i0} and V_{i1} represent the indirect observable utility associated with alternatives 0 and 1, respectively, we are able to estimate the change in welfare when comparing different scenarios.

Accordingly, Table 5.11 presents willingness to pay values for Camp Pendleton as computed from the conditional logit estimation. We describe the utility calculation as a willingness to pay because the coefficient associated with a change in the level of impact on soldier's readiness is positive, while we describe the utility calculation associated with changes in the level of impact on endangered species survival as a willingness to accept, because the coefficient is negative. Calculation of WTP, while remaining consistent with our hypothesis, is accomplished by maintaining a low impact on endangered species while moving from a high to a low impact on soldiers' readiness. This then becomes the ratio between the respective coefficient (or difference between coefficients) and the payment variable. Therefore, welfare calculations for endangered

Table 5.11: Camp Pendleton Conditional Logit WTP Values

		Model 1		
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (18.20)	$ (1.98)	$ (36.28)	$ (17.89)
Medium to High	$ (46.86)	$ (31.89)	$ (66.68)	$ (46.62)
Low to High	$ (65.06)	$ (46.09)	$ (90.29)	$ (65.21)
Soldiers' Readiness				
High to Medium	$ 34.93	$ 72.69	$ 11.34	$ 34.69
Medium to Low	$ 19.94	$ 36.27	$ 7.12	$ 19.83
High to Low	$ 54.87	$ 93.97	$ 29.75	$ 55.12
		Model 2		
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (21.66)	$ (4.61)	$ (38.54)	$ (21.62)
Medium to High	$ (41.21)	$ (27.13)	$ (61.44)	$ (41.51)
Low to High	$ (62.87)	$ (45.44)	$ (86.13)	$ (62.54)
Soldiers' Readiness				
High to Medium	$ 24.08	$ 54.02	$ 4.06	$ 24.72
Medium to Low	$ 18.05	$ 34.01	$ 5.20	$ 18.19
High to Low	$ 42.13	$ 76.73	$ 20.25	$ 42.58
		Model 3		
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (22.19)	$ (4.86)	$ (39.54)	$ (22.68)
Medium to High	$ (42.37)	$ (26.70)	$ (61.91)	$ (41.70)
Low to High	$ (64.56)	$ (46.71)	$ (88.97)	$ (64.04)
Soldiers' Readiness				
High to Medium	$ 26.41	$ 57.18	$ 4.54	$ 26.60
Medium to Low	$ 18.11	$ 33.04	$ 5.47	$ 17.94
High to Low	$ 44.52	$ 78.98	$ 19.38	$ 44.07

species are only used to compare the amount the American public is willing to accept to allow endangered species to become threatened with extinction versus the amount the American public is willing to pay to improve soldiers' readiness. While our thesis holds preservation of endangered species as a preeminent goal, true cost-benefit analysis requires us to acknowledge that people are willing to be compensated to accept a detrimental action.

Table 5.11 shows that WTA values for endangered species are larger than the WTP values for soldiers' readiness. Ninety-five percent confidence intervals were calculated around WTP/WTA values using the Krinsky and Robb procedure, as described in Haab and McConnell (2003).[50] They show a broad range of values for each attribute level. The differential between WTP for the greatest change in soldiers' readiness and WTA for the greatest change in the preservation of endangered species ranged from ($10.19) for model 1 to ($20.74) for model 2, with model 3 in between ($20.04). If individuals favored improving soldiers' readiness more than the preservation of endangered species, this differential would clearly be positive. Therefore, across all three model specifications, we see that for the scenario as described at Camp Pendleton, the average respondent suffers greater disutility from the thought of a higher risk to endangered species than the utility gained from paying to relieve the significant impact on the American soldiers' readiness.

[50] Confidence intervals were also computed using the Delta method referenced in Hanemann (1998). WTP tables with confidence intervals computed using the Delta method are located in Appendix E, on Tables E1.1 - E1.6. The Krinsky and Robb intervals reported throughout this paper are much tighter than those estimated using the Delta method.

5.2.2 Fort Irwin Conditional Logit Results

Similar goodness of fit measures were achieved when fitting the data for Fort Irwin with the conditional logit model (Table 5.12). Adjusted ρ^2 statistics range from .06 to .095 for model's 1 through 3 respectively, with log likelihood values smaller for Fort Irwin than Camp Pendleton. Coefficients on the attributes have the expected signs, with negative coefficients on the variables representing both medium and high impact on critical habitat, while the variables representing both medium and low impact on a facility's ability to train are positive. *A priori*, we would expect any attribute that increases the risk of destruction of critical habitat to contribute negatively to the odds of that alternative being chosen, while reducing the risk of impacting a facility's ability to train would contribute positively to the odds of that alternative being chosen. For both Camp Pendleton and Fort Irwin, our priors are supported by the data.

Looking at model 1, all variables but the constant are statistically significant at the 1% level. In model 2, which adds socioeconomic variables, all but the coefficient on the "C1*Independent" variable are at least significant at the 10% level. The coefficient on the alternative specific constant gained statistical significance and changed sign from negative to positive, although it was not statistically different from zero in model 1 (when it was negative). With the constant significant at the 1% level, the unobserved parameters contribute meaningfully to explaining the choice probability. Model Three, which includes attitudinal variables along with the previously identified variables from model 2, seems to add little explanatory power. These newly added attitudinal variables

Table 5.12: Fort Irwin Conditional Logit Results

	Model 1			*Model 2*			*Model 3*		
Variable	***Coefficient***		***Std. Error***	***Coefficient***		***Std. Error***	***Coefficient***		***Std. Error***
Payment	-0.0449	***	0.0079	-0.0470	***	0.0086	-0.0494	***	0.0088
Constant (C1)	-0.0630		0.1951	1.1268	***	0.3247	0.9775	***	0.3504
Species_Medium	-0.2917	***	0.1062	-0.2674	**	0.1159	-0.2493	**	0.1183
Species_High	-0.7871	***	0.1124	-0.7960	***	0.1228	-0.7864	***	0.1253
Soldiers_Low	0.7462	***	0.1290	0.7038	***	0.1388	0.7049	***	0.1412
Soldiers_Medium	0.4800	***	0.1314	0.4504	***	0.1411	0.4495	***	0.1437
C1*Age				-0.0137	***	0.0038	-0.0150	***	0.0040
C1*Income				-0.00001	***	0.00000	0.00000	***	0.00000
C1*Sex				-0.6520	***	0.1341	-0.4583	***	0.1468
C1*Less than Bachelor				-0.2635	*	0.1532	-0.4208	***	0.1571
C1*Postgraduate				0.5552	***	0.1860	0.6178	***	0.1896
C1*Democrat				0.5068	***	0.1377	0.5436	***	0.1498
C1*Independent				-0.1103		0.1534	0.0575		0.1717
C1*Green				0.6650	*	0.4019	0.1146		0.4362
C1*News_Species							0.1534		0.2685
C1*News_Equal							0.4982	***	0.1718
C1*News_Other							0.6677	***	0.2077
C1*Current View_Species							-0.5766	***	0.2105
C1*Current View_Other							-0.1420		0.2003
Model Statistics									
Log L	-1623.23			-1371.308			-1323.819		
adj. Rho-square (%)	0.06			0.083			0.095		

*** - significant at 1%, ** - significant at 5%, * - significant at 10% level respectively

demonstrated mixed statistical significance. Coefficients for "C1*News_Habitat" and "C1*Current View_Other" are not statistically different from zero, while the remaining attitudinal coefficients are significant at the 1% level.

Willingness to pay values for Fort Irwin exhibit the same pattern as WTP values for Camp Pendleton (see Table 5.13). Overall, survey respondents still experience more negative utility from a change in impact on critical habitat from low to high than the positive utility that they experience from a positive change in the ability of a training facility to conduct realistic combat training. The difference in WTP amounts and WTA amounts ranges from $.91 for model 1 to $1.96 for model 2, with model 3 in between. Some interesting information is uncovered when you decompose the two utility measures into their incremental values. Here we see that individuals are willing to pay a greater amount to improve a base from a level that will support some wartime missions to a base that will support most wartime missions, while placing a lower value on improving a base from being able to support most wartime missions to supporting all wartime missions. When compared to critical habitat, the opposite is true; respondents place a lower value on the move from no affect on critical habitat to affected critical habitat, while placing a much higher value on the move from affected critical habitat to the destruction of critical habitat. This is not unexpected; perceived incremental gains are expected to be largest when moving from the attribute level that causes the largest disutility. Therefore, movement associated from high levels for either survival of species (critical habitat) or soldiers' readiness (facility's ability to train) is valued higher than the incremental

Table 5.13: Fort Irwin Conditional Logit WTP Values

		Model 1		
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (6.50)	$ (2.35)	$ (11.92)	$ (6.43)
Medium to High	$ (11.04)	$ (6.99)	$ (17.38)	$ (11.00)
Low to High	$ (17.53)	$ (12.08)	$ (26.60)	$ (17.58)
Soldiers' Readiness				
High to Medium	$ 10.69	$ 23.18	$ 4.03	$ 10.65
Medium to Low	$ 5.93	$ 10.97	$ 2.45	$ 5.90
High to Low	$ 16.62	$ 31.10	$ 8.99	$ 16.61
		Model 2		
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (5.69)	$ (1.16)	$ (10.58)	$ (5.68)
Medium to High	$ (11.24)	$ (6.96)	$ (18.81)	$ (11.29)
Low to High	$ (16.93)	$ (11.78)	$ (25.42)	$ (16.90)
Soldiers' Readiness				
High to Medium	$ 9.58	$ 20.16	$ 3.63	$ 9.69
Medium to Low	$ 5.39	$ 10.39	$ 1.87	$ 5.44
High to Low	$ 14.97	$ 28.05	$ 8.22	$ 15.13
		Model 3		
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (5.05)	$ (0.58)	$ (9.78)	$ (5.16)
Medium to High	$ (10.88)	$ (6.58)	$ (17.36)	$ (10.70)
Low to High	$ (15.93)	$ (11.11)	$ (23.80)	$ (15.79)
Soldiers' Readiness				
High to Medium	$ 9.11	$ 19.32	$ 2.77	$ 9.04
Medium to Low	$ 5.17	$ 9.65	$ 1.92	$ 5.12
High to Low	$ 14.28	$ 25.79	$ 7.07	$ 14.03

gain from the next “move”. This is reassuring because the data shows diminishing marginal utility for both attributes across both surveys, as expected.

In both surveys, definitions for the attributes were more explicit regarding the negative effects on both endangered species and its critical habitat then the negative effects to either a soldiers’ readiness or a facility's ability to train. This may help to explain the differences in WTP and WTA values that we observe in the results. The attribute categories were intentionally written in such a way as to try to avoid any direct comparisons of the value of an American soldier's life versus the life of any endangered species. We felt this comparison would be too obvious for most respondents and would lead to predetermined and unsurprising results. Thus, the survey was designed to try and determine the public's level of understanding regarding the deleterious results that lower levels of readiness have on a soldier’s mortality, and how much they value any improvement in this situation. Some respondents provided comments that indicated their preference for military training, even if it meant the continued existence of endangered species might be in jeopardy. These statements were not supported by the data, however, which may be indicative of problems with either the survey instrument or the model fit. Conditional logit models are known to suffer from problems associated with the IIA assumption. Testing for violations of this assumption and corrections, where necessary, may alter the reported results.

The conditional logit procedure used above is based on an assumption that the error term across each respondent is independently and identically distributed (IID) and that the experiment does not violate the IIA assumption. Hausman and McFadden (1984)

advocate a test to determine whether the model satisfies the IIA assumption. Essentially, the Hausman and McFadden procedure entails removing one of the alternatives that was previously estimated and noting any changes in the ratio of the remaining alternatives. By comparing the parameter estimates from the two different specifications, we can conclude that the multinomial logit model is appropriate to use if the difference between the parameters is statistically insignificant. The Hausman test uses the coefficient estimates (b) and the estimated covariance (V) matrices from the restricted and unrestricted models to compute the actual test statistic, which has a chi-square distribution. The test statistic is

$$H_{IIA} = \left[\hat{b}_r - \hat{b}_u\right]' \left[\hat{V}_r - \hat{V}_u\right]^{-1} \left[\hat{b}_r - \hat{b}_u\right], \tag{5.2}$$

where u is the unrestricted estimation and r is the restricted estimation (Long 1997). Significant values of H_{IIA} indicate that the IIA assumption has been violated.

The null hypothesis of the Hausman test is that there is no systematic difference between the coefficients estimated in the unrestricted and restricted models. Table 5.14 reports IIA test results for both Fort Irwin and Camp Pendleton. Model one for Fort Irwin violated the IIA assumption at the 5% and 10% level when dropping either alternative A or B, respectively. However, model one for Camp Pendleton failed to significantly reject the IIA assumption. This is somewhat surprising because the underlying experimental design is the same for both surveys and the respondents were randomly selected from the same sample population, only the descriptions of the attributes themselves changed. Noting this apparent contradiction, we then introduced

Table 5.14: IIA Test Results - Model 1

Fort Irwin Model 1			
Alternative Dropped	**chi-square**	**Degrees of Freedom**	**Prob.**
A	14.6643	6	0.0230
B	11.7555	6	0.0677

Camp Pendleton Model 1			
Alternative Dropped	**chi-square**	**Degrees of Freedom**	**Prob.**
A	2.485	6	0.8701
B	6.3096	6	0.3894

socioeconomic and attitudinal variables. Adding these variables changed the results, as seen in Tables 5.15 and 5.16. Camp Pendleton failed to reject the IIA assumption for both models when alternative A is dropped but violated the IIA assumption at the 1% significance level when alternative B was dropped. Fort Irwin rejected the IIA assumption irrespective of which alternative was dropped or which model was tested. With a large number of test statistics indicating either IIA violations or potential IIA violations across our model specifications, prudence dictated that we look to other models that relax the IIA assumption. Some of these models completely eliminate concerns associated with the assumption of IIA and even allow for random taste parameters across each individual.

5.3 Nested Logit

There are benefits to using CL models when the structure of the data is such that no violations of the underlying assumptions occur, because CL models are both easy to estimate and easy to interpret. Notwithstanding its ease of use, Train (2003) identifies three limitations of logit models: 1) CL is unable to capture random variations in taste,

Table 5.15: IIA Test Results - Model 2

Fort Irwin Model 2			
Alternative Dropped	**chi-square**	**Degrees of Freedom**	**Prob.**
A	23.9508	14	0.0465
B	21.3258	14	0.0936

Camp Pendleton Model 2			
Alternative Dropped	**chi-square**	**Degrees of Freedom**	**Prob.**
A	9.7449	14	0.7806
B	30.5197	14	0.0065

Table 5.16: IIA Test Results - Model 3

Fort Irwin Model 3			
Alternative Dropped	**chi-square**	**Degrees of Freedom**	**Prob.**
A	36.4318	19	0.0093
B	28.9286	19	0.0671

Camp Pendleton Model 3			
Alternative Dropped	**chi-square**	**Degrees of Freedom**	**Prob.**
A	11.824	19	0.8930
B	40.9065	19	0.0025

2) IIA must hold to prevent misspecification, 3) CL is unable to handle situations where unobserved factors that affect utility are correlated over time. The second limitation appears to have manifested itself in our dataset given the number of potential IIA violations identified by the Hausman and McFadden test for all three models. One modeling technique used to correct this situation is to fit the data using a nested logit (NL) approach. The nested logit approach identifies branches (the first level at which a decision is made) and then assigns alternatives to nests that are created by the branching structure. Each previously assigned alternative, which represents the last decision-making level, is referred to as a "twig".

To be more specific, the nested logit specification is one of a class of models known as the Generalized Extreme Value (GEV) models. Ortuzar (2001) credits Ben-Akiva (1974) with the first application of the nested logit model, while he credits the theoretical derivation of the nested logit to two papers, Williams (1977) and Daly and Zachary (1978). Ortuzar acknowledges McFadden (1978) as the individual who extended the generalization of GEV to the nested logit model. As noted by Louviere *et al.* (2000), GEV models allow many different sets of substitution patterns across alternatives that remain consistent with utility maximization theory.[51]

Following Train (2003), we see that GEV in general, and NL in particular, rest upon two assumptions. First, the utility from all alternatives that is unobserved by the researcher has a joint distribution that is generalized extreme value. As it applies to the NL model, this specification, shown subsequently, allows correlation to exist across

[51] Train (2003) points out that the authors typically cited in reference to the nested logit model, McFadden, Daly and Zachary, and Williams all independently and with differing proofs, proved the consistency of the NL model with utility maximization.

certain alternatives. If correlation does not exist between any alternatives, then the GEV specification collapses to a standard logit specification. The second assumption deals with substitution patterns. The NL model holds when the entire set of alternatives can be subdivided into nests, so that IIA holds for all alternatives within a nest but does not hold for alternatives across nests.

Continuing with Train (2003), we partition the set of alternatives *j* into *k* non-overlapping nests, labeled B_1, ..., B_k. Person *n* derives the same utility from alternative *j* in nest B_k as we previously identified for the conditional logit model, $U_{nj} = V_{nj} + \varepsilon_{nj}$. To obtain the NL model, we assume that the vector of unobserved utility has the following cumulative distribution:

$$\exp\left(-\sum_{k=1}^{K}\left(\sum_{j\in B_k} e^{-\varepsilon_{nj}/\lambda_k}\right)^{\lambda_k}\right) \tag{5.3}$$

For this GEV distribution, each ε_{nj} has a marginal distribution that is univariate extreme value, with ε_{nj}'s correlated within nests but uncorrelated for alternatives between nests. The NL model allows us to approximate the level of independence in unobserved utility between alternatives that share the same nest using the parameter λ_k. The greater the value of λ_k, the less the correlation, with the obvious result that λ_k=1 indicates complete independence. Likewise, the lower the value, the greater the correlation, which implies the chosen tree structure is most likely appropriate for the specification, assuming positive confirmation from other goodness of fit measures. λ_k is also identified as the coefficient of the inclusive value and it must lie within the unit interval ($0 < \lambda_k < 1$) to be globally consistent with utility maximization (McFadden 1981).

It has been shown that assuming the above distribution for ε yields a probability of choosing *i* in nest B_k as follows:

$$P_{ni} = \frac{e^{V_{ni}/\lambda_k}\left(\sum_{j\in B_k} e^{V_{nj}/\lambda_k}\right)^{\lambda_k - 1}}{\sum_{l=1}^{K}\left(\sum_{j\in B_l} e^{V_{nj}/\lambda_l}\right)^{\lambda_l}} \tag{5.4}$$

It follows from this specification that IIA holds within nests but not between nests. For alternative *i* which is an element of B_k and alternative *m* which is an element of B_l, then the ratio of probabilities between the two alternatives is:

$$\frac{Pni}{Pnm} = \frac{e^{V_{ni}/\lambda_k}\left(\sum_{j\in B_k} e^{V_{nj}/\lambda_k}\right)^{\lambda_k - 1}}{e^{V_{nm}/\lambda_l}\left(\sum_{j\in B_l} e^{V_{nj}/\lambda_l}\right)^{\lambda_l - 1}} \tag{5.5}$$

Note that when $k=l$, indicating two alternatives share the same nest, the expressions within the parentheses cancel, leaving the choice probability a function of the two attributes within the nests. However, when $k \neq l$, the expressions do not cancel and the probabilities depend on all the alternatives within the two nests. Train (2003) describes this as a loose form of IIA that he calls Independence of Irrelevant Nests (IIN), because only the two nests containing alternatives *i* and *m* affect the choice probability.

It is possible to decompose the NL model into the product of two standard logits (see Train (2003) or Louviere *et al.* (2000)). Doing this demonstrates how information from the subset of alternatives that are grouped into nests is incorporated in the choice

between branches. It then becomes clear that the probability of choosing a particular nest depends upon two things, the utility the person expects to receive regardless of the alternative that is selected within the nest, as well as the expected utility the individual receives from being able to choose the best alternative within the chosen nest. Using the approach of Blamey *et al.* (2000), we created two branches for our model. Figure 5.1 graphically depicts our chosen nesting structure. One branch is identified as the "do something" branch. It includes options A and B, which represent some action other than the status quo. The "do nothing" branch is a degenerate branch that only contains option C, which is a choice to maintain the status quo.[52] The NL models for both Camp

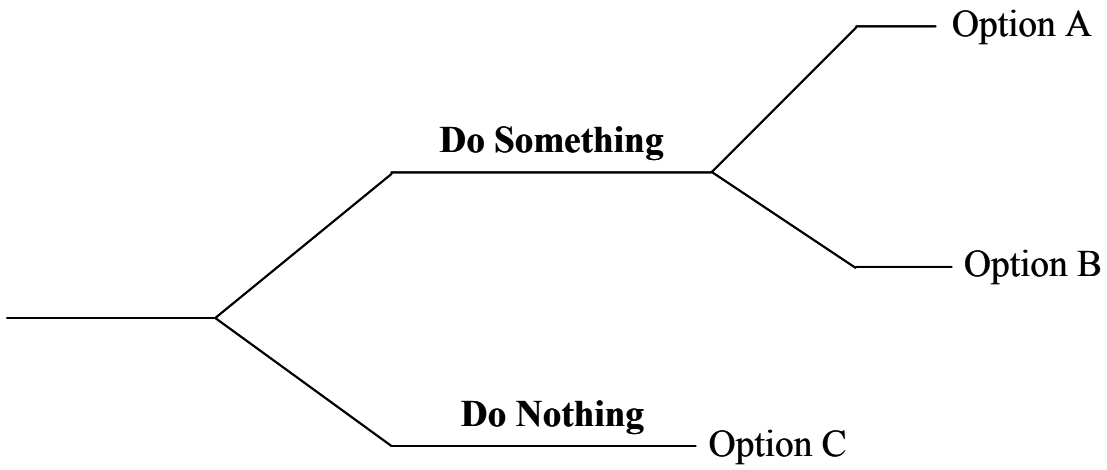


Figure 5.1: Nesting Structure

[52] Degenerate branches are computationally different than branches with more than one alternative. Essentially, λ_k, which estimates the level of independence, becomes irrelevant because a degenerate nest only has one alternative, so it is by definition completely independent from all other alternatives. Hensher and Greene (2000) propose several methods of normalization that compute an IV parameter of 1 for any degenerate nests. See their paper for a full exposition of normalization. We used the method they call Random Utility 2 (RU2), which normalizes the parameters in the upper levels and allows the lower level parameters to be free (which is consistent with the assumptions of the GEV nested logit specification.)

Pendleton and Fort Irwin follow this pattern.

5.3.1 Nested Logit Results for Camp Pendleton

Table 5.17 reports the nested logit results for Camp Pendleton for the same three models previously estimated using a conditional logit model. The first thing that we notice is the adjusted ρ^2 for all three nested logit models improves over the results as reported from the conditional logit model, although not as much as we had anticipated. Model's 1, 2 and 3 improve from a range of .062 - .108 to a range of .087 - .145. Other goodness of fit measures include the coefficients of the inclusive values and their significance. As explained in the previous section, inclusive value parameters are expected to lie within the unit interval if the nested logit model is expected to be consistent with a random utility specification. All three models exhibit highly significant inclusive values that are less than one for the nest "choose".[53] The nest "status quo" is defined as a degenerate nest. A degenerate nest is a nest that contains only one alternative and its inclusive value is normalized to one, by definition.

Coefficients in all three models maintain the same sign and statistical significance (albeit not always at the same level as before) if they were significant in the conditional

[53] While our final specification is consistent with our theoretical predictions, for robustness we attempted to let the data determine the "best" nesting structure by checking all 3 nesting options {(AB,C), (AC,B), and (BC,A)}. IV values for the non-degenerate nest were lowest for our original specification.

Table 5.17: Nested Logit Results for Camp Pendleton

	Model 1			*Model 2*			*Model 3*		
Variable	***Coefficient***		***Std. Error***	***Coefficient***		***Std. Error***	***Coefficient***		***Std. Error***
Payment	-0.0086	***	0.0024	-0.0100	***	0.0029	-0.0101	***	0.0030
Constant (C1)	0.4468	**	0.1874	1.5582	***	0.3675	1.2695	***	0.4291
Species_Medium	-0.1957	**	0.0916	-0.2609	**	0.1088	-0.2626	**	0.1132
Species_High	-0.5636	***	0.1638	-0.6397	***	0.1845	-0.6645	***	0.1951
Soldiers_Low	0.3945	**	0.1726	0.3468	**	0.1770	0.3895	**	0.1951
Soldiers_Medium	0.2130		0.1367	0.1601		0.1415	0.1985		0.1571
C1*Age				-0.0196	***	0.0049	-0.0219	***	0.0054
C1*Income				0.00001	***	0.00000	0.00001	***	0.00000
C1*Sex				0.3590	**	0.1519	0.2990	*	0.1688
C1*Less than Bachelor				-0.3089	*	0.1652	-0.2665		0.1751
C1*Postgraduate				0.5818	**	0.2310	0.8325	***	0.2638
C1*Democrat				-0.3055	**	0.1501	-0.4157	***	0.1590
C1*Independent				-0.3669	**	0.1759	-0.3781	*	0.1953
C1*Green				-1.5860	***	0.4270	-1.6305	***	0.4852
C1*News_Species							0.5081		0.3889
C1*News_Equal							0.5475	***	0.1793
C1*News_Other							0.1236		0.2042
C1*Current View_Species							-0.0362		0.2061
C1*Current View_Other							0.6377	**	0.2576
Inclusive Values (IV)									
Choose	0.6016	***	0.1878	0.6655	***	0.2132	0.6985	***	0.2277
Status Quo	1.0000		……	1.0000		…….	1.0000		…….
Model Statistics									
Log L	-1404.372			-1187.692			-1145.935		
adj. Rho-square (%)	0.087			0.128			0.145		

*** - significant at 1%, ** - significant at 5%, * - significant at 10% level respectively

logit specification, except for the variable representing medium impact on soldiers' readiness. The coefficients on this variable, which were highly significant under the CL specification, inexplicably drop their significance in the NL specification. So, the model exhibits consistent coefficients with a better fit, but how does this affect our utility calculations?

Looking at Table 5.18, we see subtle changes in the levels of utility when compared to the results from the conditional logit estimation. WTP values for soldiers' readiness decreased from the conditional logit to the nested logit specification, while the WTA values for species survival increased marginally. Diminishing marginal returns are not replicated across all three models, with model 2 showing that respondents valued the change from medium to low more than they valued the change from high to medium. By using the nested logit specification, we see that the utility differential between WTA and WTP increased. Model 2 exhibited a ($20.74) differential between the WTA and WTP values in the conditional logit specification; when estimated using the nested logit specification, this differential grows to ($29.36), a 41% increase. Model 2 exhibited the midpoint of differential increase growth, with NL model 1 showing a 94% increase and NL model 3 showing a 35% increase. These results indicate that with respect to Camp Pendleton, the American public (as represented by our sample) still places a higher value on endangered species preservation than the value they place on increasing soldiers' readiness, whether we used the CL or NL specification.

Table 5.18: Nested Logit WTP Values for Camp Pendleton

	Model 1			
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (22.83)	$ (0.98)	$ (36.00)	$ (16.90)
Medium to High	$ (42.92)	$ (26.90)	$ (61.58)	$ (41.31)
Low to High	$ (65.75)	$ (38.82)	$ (85.50)	$ (59.09)
Soldiers' Readiness				
High to Medium	$ 24.86	$ 66.98	$ 7.34	$ 30.12
Medium to Low	$ 21.17	$ 34.11	$ 5.46	$ 17.80
High to Low	$ 46.02	$ 88.91	$ 23.56	$ 48.18
	Model 2			
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (26.15)	$ (4.06)	$ (39.02)	$ (21.35)
Medium to High	$ (37.98)	$ (25.03)	$ (62.16)	$ (39.95)
Low to High	$ (64.13)	$ (42.59)	$ (87.68)	$ (61.37)
Soldiers' Readiness				
High to Medium	$ 16.05	$ 54.13	$ 2.52	$ 23.01
Medium to Low	$ 18.72	$ 33.82	$ 4.00	$ 17.70
High to Low	$ 34.77	$ 76.96	$ 18.94	$ 40.94
	Model 3			
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (25.88)	$ (3.91)	$ (39.58)	$ (22.16)
Medium to High	$ (39.60)	$ (25.96)	$ (64.23)	$ (40.16)
Low to High	$ (65.47)	$ (44.60)	$ (88.85)	$ (62.88)
Soldiers' Readiness				
High to Medium	$ 19.56	$ 58.47	$ 3.05	$ 25.32
Medium to Low	$ 18.82	$ 34.89	$ 4.31	$ 17.97
High to Low	$ 38.38	$ 78.16	$ 18.85	$ 43.29

5.3.2 Nested Logit Results for Fort Irwin

As with Camp Pendleton, Table 5.19 reports the results from estimating our three models using the nested logit specification. The nested logit specification did not improve the model fit as much as it did for Camp Pendleton. For model 1, the adjusted ρ^2 value increased marginally, from .06 to .068. This phenomenon repeated itself for model 2, moving from .083 to .091, although model 3 did not show any improvement in the adjusted ρ^2 values. These results were interesting, to say the least, because the Fort Irwin model consistently rejected the IIA assumption using the Hausman and McFadden specification test. Based upon those results, we would have expected an improvement equal to or greater than that demonstrated by Camp Pendleton, not less. One possible reason we will explore is that the Hausman and McFadden test detected a different misspecification issue, such as a failure of the IID assumption. We examine this possibility in the next section by estimating a mixed logit model. Finally, inclusive values for all 3 models lie within the unit interval and are statistically significant at the 1% level.[54]

Regarding model 1, the estimated coefficients still retain the same signs as previously estimated using the CL model except for the constant, which changed from negative under the CL model to positive, while remaining not statistically different from zero for model 1. The significance levels for the medium impact on both facilities and

[54] Checking robustness for Fort Irwin produced interesting results. The results for model 1 were similar to Camp Pendleton, with our original specification producing the lowest IV values. For model's 2 and 3, the specification of {(BC,A)} produced marginally lower IV coefficients than our chosen specification of {(AB,C)}. We decided not to use the alternate specification for model's 2 and 3 because the difference was not meaningful and we wanted to maintain continuity with the Camp Pendleton methodology.

Table 5.19: Nested Logit Results for Fort Irwin

	Model 1			Model 2			Model 3		
Variable	***Coefficient***		***Std. Error***	***Coefficient***		***Std. Error***	***Coefficient***		***Std. Error***
Payment	-0.0351	***	0.0102	-0.0425	***	0.0119	-0.0466	***	0.0125
Constant (C1)	0.1441		0.2292	1.2084	***	0.3741	1.0242	**	0.4083
Species_Medium	-0.2418	**	0.0976	-0.2449	**	0.1132	-0.2371	**	0.1174
Species_High	-0.6037	***	0.1716	-0.7109	***	0.1977	-0.7378	***	0.1984
Soldiers_Low	0.5183	**	0.2092	0.6094	**	0.2419	0.6508	***	0.2505
Soldiers_Medium	0.3032	*	0.1683	0.3763	*	0.2037	0.4068	*	0.2138
C1*Age				-0.0137	***	0.0039	-0.0149	***	0.0041
C1*Income				-0.00001	***	0.00000	0.00000	***	0.00000
C1*Sex				-0.6500	***	0.1347	-0.4577	***	0.1478
C1*Less than Bachelor				-0.2627	*	0.1528	-0.4200	***	0.1610
C1*Postgraduate				0.5541	***	0.1863	0.6171	***	0.1909
C1*Democrat				0.5052	***	0.1358	0.5427	***	0.1473
C1*Independent				-0.1102		0.1566	0.0573		0.1729
C1*Green				0.6619	*	0.4014	0.1136		0.4681
C1*News_Species							0.1532		0.2788
C1*News_Equal							0.4972	***	0.1789
C1*News_Other							0.6667	***	0.2257
C1*Current View_Species							-0.5755	**	0.2263
C1*Current View_Other							-0.1421		0.2162
Inclusive Values (IV)									
Choose	0.7081	***	0.2203	0.8686	***	0.2625	0.9241	***	0.2689
Status Quo	1.0000		…….	1.0000		…….	1.0000		…….
Model Statistics									
Log L	-1623.23			-1371.308			-1323.776		
adj. Rho-square (%)	0.068			0.09			0.098		

*** - significant at 1%, ** - significant at 5%, * - significant at 10% level respectively

critical habitat declined to 5% and 10%, respectively. Closer inspection of the coefficients for model's 2 and 3 show very similar patterns to the Camp Pendleton model, where the socioeconomic and attitudinal coefficients vary little from those estimated using the CL model. While some coefficients decline in significance when estimated using the NL model, all variables that were significant using the CL model remain at least significant at the 10% level when estimated using the NL model. This pattern differed from the Camp Pendleton estimation results, where one coefficient that was significant using the CL estimation lost its significance when estimated using an NL specification.

Willingness to accept values for the Fort Irwin nested logit model varied less than the willingness to pay values. Table 5.20 shows the same calculations as presented for the conditional logit model. Here again the Fort Irwin specification does not exhibit the magnitude of the changes that we saw for Camp Pendleton. In all three Camp Pendleton models, the WTP associated with a change from high to low for soldiers' readiness experienced a large decline, while the WTA a change from low to high for species survival increased for almost all three models. Using the same utility differential that we used for Camp Pendleton, the percent increase for model 1 is much larger than Camp Pendleton but model's 2 and 3 exhibit a smaller percentage increase. What does remain is the fact that Fort Irwin respondents place a higher value on the disutility associated with the destruction of critical habitat than the utility they associated with increasing a facility's ability to train.

Table 5.20: Nested Logit WTP Values for Fort Irwin

	Model 1			
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (6.89)	$ (1.52)	$ (10.75)	$ (5.63)
Medium to High	$ (10.31)	$ (4.70)	$ (13.40)	$ (8.19)
Low to High	$ (17.20)	$ (8.92)	$ (21.42)	$ (14.04)
Soldiers' Readiness				
High to Medium	$ 8.64	$ 18.97	$ 1.99	$ 7.90
Medium to Low	$ 6.13	$ 8.95	$ 1.47	$ 4.58
High to Low	$ 14.77	$ 24.90	$ 5.94	$ 12.54
	Model 2			
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (5.77)	$ (0.47)	$ (10.16)	$ (5.07)
Medium to High	$ (10.98)	$ (5.45)	$ (16.14)	$ (9.41)
Low to High	$ (16.74)	$ (9.49)	$ (22.48)	$ (14.51)
Soldiers' Readiness				
High to Medium	$ 8.86	$ 17.81	$ 2.28	$ 7.86
Medium to Low	$ 5.49	$ 9.25	$ 1.04	$ 4.55
High to Low	$ 14.35	$ 24.65	$ 6.00	$ 12.48
	Model 3			
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (5.09)	$ 0.05	$ (9.55)	$ (4.73)
Medium to High	$ (10.75)	$ (5.74)	$ (16.39)	$ (9.66)
Low to High	$ (15.84)	$ (9.48)	$ (21.71)	$ (14.34)
Soldiers' Readiness				
High to Medium	$ 8.73	$ 17.05	$ 2.09	$ 8.15
Medium to Low	$ 5.24	$ 9.61	$ 1.21	$ 4.64
High to Low	$ 13.97	$ 24.87	$ 6.05	$ 12.61

We were disappointed in the improvement in the goodness of fit measures when we re-estimated using the NL specification. Given the IIA test results, we fully expected the NL model would generate adjusted ρ^2 values within the .2 to .4 range, identified earlier as indicative of good fit with the data. With the NL model failing to significantly improve the Fort Irwin data given its repeated indications of violating the IIA assumption, it seemed prudent to investigate any other potential improvements from fitting the data with a mixed logit specification. To that end, we briefly review the mixed logit model and then present the results of our estimations.

5.4 Mixed Logit

The mixed logit model (Train 2003) obviates the 3 main limitations from using the standard logit model, because it can accommodate random variations in taste, allow unrestricted substitution patterns and allow correlation in the unobserved factors over time. The drawback to using mixed logit is the computational time required for estimation. As will be discussed shortly, estimation requires mathematical simulation techniques to compute the final probabilities of choice. While this computational burden is intense, most computers in use today can compute fairly sophisticated specifications measured in hours versus days, making the mixed logit a more attractive tool for use. Even still though, use of the CL or NL methodology is preferable if it accurately models the data. In our case, it would seem that neither of these models does a particularly good job of representing the choice probabilities.

Compiling from Train (1998, 2003) and Revelt and Train (1998) to derive the mixed logit model, we start from the common basis for all random utility models, which

is the assumption that person *n* picks an alternative *j* because she experiences the greatest utility from this selection:

$$U_{njt} = \mathrm{B}'_n x_{njt} + \varepsilon_{njt} \tag{5.6}$$

As with CL, x_{njt} includes all observed characteristics, including those for attributes that underlie the alternatives, socioeconomic characteristics of the decision-maker, etc. The mixed logit model varies from the CL model in that the coefficient vector β_n is stochastic across all *n* and varies with density $f(\beta|\theta^*)$. Here θ^* represents the true parameters of the distribution (such as mean, covariance and actual shape of the distribution). The random error term, ε_{njt}, is distributed IID extreme value 1. Once again, person *n* chooses alternative *i* if $U_{ni} > U_{nj} \ (i \neq j)$. The analyst observes the vector of *x's* associated with this distribution, but not the β_n's or the ε_{nj}'s. Since both terms are unobserved, the standard logit equation for choice probabilities now becomes the integral of the logit probabilities weighted by the density function (mixing distribution) $f(\beta|\theta^*)$:

$$P_{ni} = \int \left(\frac{e^{\beta' x_{ni}}}{\sum_j e^{\beta' x_{nj}}} \right) f(\beta) d\beta \,. \tag{5.7}$$

Standard logit can be obtained from this specification by setting the mixing distribution equal to 1 when β equals the fixed parameters *b* and setting the mixing distribution equal to 0 otherwise.

Where individuals face repeated choices (such as stated preference surveys), the model changes slightly to reflect the fact that the probability that person *n* makes the sequence of choices as reflected in the data now becomes a product of logit formulas:

$$L_{ni}(\beta) = \prod_{t=1}^{T} \left[\frac{e^{\beta_n' x_{nit}}}{\sum_j e^{\beta_n' x_{njt}}} \right], \tag{5.8}$$

and thus equation 5.8 (the unconditional probability of choosing *i*) becomes:

$$P_{ni} = \int L_{ni}(\beta) f(\beta) d\beta . \tag{5.9}$$

The difference reflects the fact that choices are made over time (or that there are repeated choices by the same individual), so equation 5.9 allows the coefficients to vary over each person *n* but remain constant across the sequence of choices. This seems to be a reasonable assumption for stated preference data, whereas it may not be as reasonable if we were estimating travel costs for trips that were taken over a number of years (where tastes may change even for specific individuals over time).

In both mixed logit specifications, the integral does not have a closed-form solution, requiring simulation to estimate its solution. As we alluded to above, mixed logit estimation (and the corresponding simulation procedures) requires the analyst to choose the distribution for the estimated coefficients and then estimate the parameters of that distribution. In recent work, researchers have chosen any number of distributions including normal, lognormal, uniform or triangular, with normal and lognormal being the most chosen. Each random coefficient can be assigned its own distribution. Typically, the lognormal distribution is used for coefficients that are known to have a particular sign that stays constant across all *N* persons, such as a price coefficient. Continuing from Train (2003), no matter the distribution selected, simulation occurs by drawing a value from the function $f(\beta|\theta)$, call it β^r where *r* indexes the number of draws, and calculating the logit probability ($L_{ni}(\beta^r)$). This step is repeated *R* times and then averaged:

$$\breve{P}_{ni} = \frac{1}{R}\sum_{r=1}^{R} L_{ni}\left(\beta^{r}\right). \tag{5.10}$$

$\breve{P}_{ni}$ is an unbiased estimator of P_{ni} whose variance decreases as R increases. Its properties are such that $ln\ P_{ni}$ is used to approximate the true log likelihood function as:

$$SLL = \sum_{r=1}^{R}\sum_{j=1}^{J} d_{nj} \ln P_{nj}\ , \tag{5.11}$$

with $d_{nj} = 1$ if person n chose alternative j and $d_{nj} = 0$ otherwise.

Our mixed logit specification followed this basic construct, however we chose to specify the payment coefficient as constant versus either lognormal or normal. Hensher and Greene (2001), as well as Train (2003), note that both the normal and lognormal distributions have very long tails, which can provide distorted estimates when used to compute WTP values. While fixing the payment variable assumes the effect is constant over all individuals (as in CL), we have previously accepted the fact that individuals universally react negatively to increases in price (hence other author's use of the lognormal distribution). Our assumption restricts the magnitude of this reaction to be constant across all individuals. Revelt and Train (1998) fix the price coefficient in their study of household appliance efficiency and note that this specification actually helps the simulation to converge, while providing the added bonus that WTP is easier to calculate. Therefore, we chose to fix the coefficient on price across individuals. Each mixed logit model was estimated with the assumption that alternative selections are correlated across

individuals. Finally, the number of repetitions chosen for the simulation was 1,000, using a Halton number sequence to generate the random draws.[55]

5.4.1 Mixed Logit Results for Camp Pendleton

Upon inspection of the results of a mixed logit estimation on the Camp Pendleton data, we were immediately drawn to the vast improvement in the goodness of fit demonstrated in even the simplest of models. Heretofore, the adjusted ρ^2 for our best model specification was .148; this value climbed to .434 for our most basic mixed logit model which included just the attributes and a constant. This statistic indicates almost a three-fold improvement in model fit and easily surpasses the level identified by Hensher and Green (1981) as indicative of an extremely good fit. The simulated log likelihood value for the mixed logit at convergence was an impressive -845.224 versus -1406.246 for the same specification in the CL model and -1404.372 in the NL model. Table 5.21 reports the results for both model specifications for Camp Pendleton. Only two models were estimated using the mixed logit model due to the small improvements demonstrated with additional specifications that included various combinations of socioeconomic and attitudinal variables. While the improvements were small, the increase in computing time was not, and with little gain, there was no compelling reason to continue with the pattern set previously by estimating all 3 models. Similarly, education no longer enters the model as a parameter. Education as a parameter was not statistically significant no matter how it was specified, so it was dropped from the mixed logit models to decrease

[55] See Train (2003), Train (1999) and Bhat (2000) for the benefits of Halton number sequences vs. random numbers.

Table 5.21: Mixed Logit Results for Camp Pendleton

		Model 1			Model 2		
Variable		*Estimate*		*Std Error*	*Estimate*		*Std Error*
Payment	Coefficient	-0.0317	***	0.0027	-0.0336	***	0.0032
Constant (C1)	Mean Coefficient	0.9611		0.9658	3.7546		2.5054
	Std Dev of Coefficient	7.7725	***	1.3603	5.4069	***	1.8220
Species_Medium	Mean Coefficient	-0.2590		0.3937	-0.5728		0.4926
	Std Dev of Coefficient	2.1339	***	0.5156	2.1157	***	0.4505
Species_High	Mean Coefficient	-1.6659	***	0.4914	-2.0395	***	0.5909
	Std Dev of Coefficient	3.2491	***	0.4450	3.4825	***	0.5202
Soldiers_Low	Mean Coefficient	1.6283	***	0.6067	1.9668	**	0.7855
	Std Dev of Coefficient	4.1100	***	0.4403	4.9370	***	0.6537
Soldiers_Medium	Mean Coefficient	1.4094	***	0.5054	1.5328	**	0.6383
	Std Dev of Coefficient	2.7735	***	0.4671	3.2441	***	0.7113
C1*Age	Mean Coefficient				-0.0903	**	0.0413
	Std Dev of Coefficient				0.0947	***	0.0224
C1*Income	Mean Coefficient				-0.00003	*	0.00001
	Std Dev of Coefficient				0.00002		0.00002
C1*Sex	Mean Coefficient				1.9302		1.2817
	Std Dev of Coefficient				3.6836	*	2.1431
Model Statistics							
Log L		-845.224			-759.0164		
adj. Rho-square (%)		0.43367			0.4376		

*** - significant at 1%, ** - significant at 5%, * - significant at 10% level respectively

the model complexity. The coefficients for payment, species_medium and species_high are all negative, while the remaining coefficients are positive, which matches our expectations.

Using the mixed logit model allows us to extract more information than when using either the CL or NL model. Given an assumed distribution for the variables, we are able to use the estimated standard deviation for a specific variable and its estimated mean to determine how the respondents are distributed for that specific variable. All our attributes were distributed normally, except for the payment attribute that was fixed, so the following calculations are based on the cumulative normal distribution. Fifty-five percent of respondents were opposed to any option that has a medium impact on endangered species survival, while 69% of people favor any option having a medium impact on soldiers' readiness. When looking at the two biggest changes in impact regarding both endangered species and soldiers' readiness, we now see the number of people opposed to any option that highly impacts endangered species climb to 70%, while the number of people who favor any option where there is a low impact on soldiers' readiness falls to 65%. This is one indication that the respondents may be unwilling to pay the high costs associated with achieving a low impact on soldiers' readiness.

Looking at model 2, there is hardly any improvement by including socioeconomic variables. The simulated log likelihood value increases from -845.224 to -759.016 but the adjusted ρ^2 barely moves, increasing from .434 to .437.[56] The coefficients for the age

[56] For Camp Pendleton model 2, several different numbers of Halton replications were tried to test sensitivity. Coefficients significantly varied when 10, 25, 50 and 100 Halton replications were tried but

and income parameters interacted with the constant are significant at the 5% and 1% levels respectively, with the estimated standard deviation for the interacted coefficient for sex also significant at the 10% level. Inclusion of socioeconomic variables marginally increased the percentage of respondents who were opposed (from 70% to 72%) to any option that highly impacted the survival of endangered species, while holding the percentage of those who favored any option that had a low impact on soldiers' readiness steady at 65%.

Estimated values of utility changed considerably when calculated for Camp Pendleton using the mixed logit model. Looking first at WTA for endangered species in Table 5.22, the estimate has decreased from the CL and NL estimations, especially when estimated using the specification for model 1. Confidence intervals as estimated by the Krinsky and Robb procedure are wider than those intervals calculated using either the CL or NL models. This is more than likely a function of the random estimation process whereby each individual parameter has its own random term, thus transferring some of the "randomness" that is usually captured by the constant term to the specific parameter estimates. The constant does not enter the WTA or WTP calculations for our specifications, so additional randomness in the estimated coefficients for the attributes

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they began to converge at 500 Halton replications. The marginal benefit from increasing Halton replications from 1000 to 2500 did not justify the marginal cost associated with the extra computing time. 1000 replications typically averaged 4 ¼ hours, while the single 2500 replication estimation we tried took over 11 hours.

Table 5.22: Mixed Logit WTP Results for Camp Pendleton

	Model 1			
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (8.16)	$ 19.83	$ (30.38)	$ (8.22)
Medium to High	$ (44.33)	$ (29.27)	$ (60.28)	$ (44.43)
Low to High	$ (52.49)	$ (18.95)	$ (78.89)	$ (52.55)
Soldiers' Readiness				
High to Medium	$ 44.41	$ 82.57	$ 12.89	$ 45.60
Medium to Low	$ 6.90	$ 23.69	$ (9.24)	$ 7.41
High to Low	$ 51.31	$ 94.03	$ 15.73	$ 52.79
	Model 2			
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (17.05)	$ 14.37	$ (45.42)	$ (16.59)
Medium to High	$ (43.65)	$ (27.04)	$ (61.17)	$ (44.07)
Low to High	$ (60.70)	$ (24.05)	$ (92.84)	$ (60.71)
Soldiers' Readiness				
High to Medium	$ 45.62	$ 85.54	$ 8.07	$ 45.90
Medium to Low	$ 12.92	$ 33.46	$ (4.51)	$ 12.78
High to Low	$ 58.54	$ 111.64	$ 12.23	$ 59.10

leads to a larger confidence interval. The net differences between WTA and WTP amounts for the mixed logit model have decreased dramatically. Previous differential amounts in the CL and NL models ranged from approximately ($10.00) to ($30.00). Under the mixed logit model, net differences are ($1.18) for model 1 and ($2.16) for model 2. Where before we estimated the value of endangered species to be much greater than soldiers' readiness, we now see the two are almost equal.

If we assume that the increased goodness of fit measures indicate the mixed logit model more accurately "fits" the data, then it would seem that our earlier models were ill-equipped to correctly estimate the actual WTP for improving soldiers' readiness. This means our earlier models, which produced surprising results, may have been more a

function of misspecification than actual estimated value. Using model 2 as our preferred model (because it controls for some socioeconomic characteristics), we see that aggregating our mean WTP across all U.S. households gives us a total WTP of $6.174 billion versus an estimated cost of $4.804 billion. Regarding our first question which concerned the willingness of the American public to pay to alleviate encroachment impacts at Camp Pendleton, the answer appears to be yes, the public is willing. This indicates the Federal government should consider developing a viable alternative for peaceful co-existence at Camp Pendleton and then allocate funding for implementation. Interestingly enough, if the question had pitted soldiers' readiness against species survival, our analysis indicates the public values endangered species more than improving soldiers' readiness. While some survey respondents replied that the animals were worthless without the protection offered by soldiers, that is clearly not the opinion of the majority of the respondents. Let us now look at how the mixed logit model changed the picture at Fort Irwin.

5.4.2 Mixed Logit Results for Fort Irwin

We observed improvements in model fit for Fort Irwin similar to those achieved for Camp Pendleton. Table 5.23 presents the Fort Irwin results. Simulated log likelihood values increased to -970.6490, while the best actual log likelihood value realized by the other two Fort Irwin models was -1323.776. The adjusted ρ^2 again showed impressive gains, increasing from a high of .098 under previous specifications to a high of .437, almost a five-fold increase. As with Camp Pendleton, all coefficients exhibit the

Table 5.23: Mixed Logit Results for Fort Irwin

		Model 1			Model 2		
Variable		***Estimate***		***Std Error***	***Estimate***		***Std Error***
Payment	Coefficient	-0.1129	***	0.0126	-0.1167	***	0.0135
Constant (C1)	Mean Coefficient	-0.2224		1.0780	4.5404	**	2.1638
	Std Dev of Coefficient	8.7952	***	1.6000	6.5628	***	1.4322
Species_Medium	Mean Coefficient	-0.5745		0.3505	-0.5181		0.3755
	Std Dev of Coefficient	1.9966	***	0.6178	1.9307	***	0.5283
Species_High	Mean Coefficient	-1.8090	***	0.4304	-1.9426	***	0.5122
	Std Dev of Coefficient	3.3073	***	0.4517	3.5473	***	0.3985
Soldiers_Low	Mean Coefficient	2.6612	***	0.7152	2.3625	***	0.6396
	Std Dev of Coefficient	3.5269	***	0.6236	3.5224	***	0.5203
Soldiers_Medium	Mean Coefficient	2.2556	***	0.7026	2.0072	***	0.5907
	Std Dev of Coefficient	2.6697	***	0.7771	2.4890	***	0.5722
C1*Age	Mean Coefficient				-0.0502		0.0317
	Std Dev of Coefficient				0.0521	**	0.0264
C1*Income	Mean Coefficient				-0.00002	*	0.00001
	Std Dev of Coefficient				0.00003		0.00002
C1*Sex	Mean Coefficient				-2.3513	**	1.1774
	Std Dev of Coefficient				0.8864		2.0085
Model Statistics							
Simulated Log L		-970.649			-893.915		
adj. Rho-square (%)		0.43563			0.43318		

*** - significant at 1%, ** - significant at 5%, * - significant at 10% level respectively

expected sign, with the exception of the constant term. The coefficient for the constant had a negative sign for model 1 but it was not significantly different from zero. When estimated for model 2, the coefficient switched signs, became positive and became statistically significant at the 5% level. When compared against the mixed logit model for Camp Pendleton, the constant did not change signs; it did exhibit, however, this sign-switching pattern when estimated using the CL and NL models for Fort Irwin. A positive and significant constant is indicative of a preference to act, whereas a negative coefficient would indicate a preference for the status quo. We have no priors regarding the "true" sign of the constant; the literature has recognized the potential for a status quo bias, but our status quo is not just interpreted as a vote for inaction, it is also a vote for endangered species (or its habitat), so we made no assumptions regarding its predicted sign. Finally, the estimated standard deviations for all parameters are statistically significant, which is an indication that the parameters do vary significantly across the population and are important to the decision-making process (Train 1998). A coefficient on a parameter that is not statistically different from zero may actually be masking a situation where people feel strongly on both sides of the issue, thereby negating the other side's opinion. A large and significant estimated standard deviation on the coefficient is an indication that this is happening (Train 1998). This situation goes undetected when using a CL or NL specification by assumption.

Looking closer at model 1, we calculated that 71% of the people are opposed to any option that highly impacts the critical habitat (the worst category in terms of this survey). We also see that 77% of the people favor any option that has a low impact on the facility's ability to train. Similar numbers are calculated for model 2, 71% and 75%,

respectively. While these results are unsurprising, they are curious when compared to the fact that, using the same specification for Camp Pendleton, only 70% were opposed to highly impacting endangered species, while 65% were in favor of any option that imposed a low impact on a soldier's readiness. If anything, we expected these results to be reversed, with animals having "marquee" appeal, while habitat has a more humble, much lower ranking in the order of importance. We can only guess that any difference between the percentages for soldier's readiness and a facility's ability to train is a reflection of the larger costs associated with achieving a low impact on soldiers' readiness at Camp Pendleton.

Our next deviation from the Camp Pendleton results occurs when we compare the estimated WTP and WTA values. Table 5.24 shows the calculations for model's 1 and 2, with 95% confidence intervals using the Krinsky and Robb procedure. We now see that WTP to improve the facility's ability to train is valued higher than the WTA harm to the critical habitat associated with endangered species. Model 1 shows the largest disparity, where the net differential equals $7.03. Inclusion of socioeconomic variables slightly increases the WTA value associated with the impact on critical habitat while lessening the WTP for an improvement at Fort Irwin, for a net differential equal to $3.60. Regardless of the specification, though, respondents value the improvement more than they value the negative impact. While Camp Pendleton's model 2 results were quite close in value, our survey respondents have demonstrated that they value Fort Irwin's ability to train more than they do the critical habitat at Fort Irwin.

Table 5.24: Mixed Logit WTP Results for Fort Irwin

	Model 1			
Critical Habitat	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (5.09)	$ 0.32	$ (10.84)	$ (4.98)
Medium to High	$ (10.93)	$ (6.80)	$ (15.83)	$ (10.95)
Low to High	$ (16.02)	$ (9.11)	$ (22.97)	$ (16.06)
Facility				
High to Medium	$ 19.98	$ 39.03	$ 6.77	$ 20.12
Medium to Low	$ 3.59	$ 7.23	$ 0.10	$ 3.53
High to Low	$ 23.57	$ 41.80	$ 10.70	$ 23.64
	Model 2			
Critical Habitat	**Mean WTP**	**95% Upper**	**95% Lower**	**K&R Median**
Low to Medium	$ (4.44)	$ 2.47	$ (10.21)	$ (4.39)
Medium to High	$ (12.21)	$ (7.10)	$ (18.25)	$ (12.37)
Low to High	$ (16.65)	$ (7.88)	$ (24.74)	$ (16.74)
Facility				
High to Medium	$ 17.20	$ 31.72	$ 6.22	$ 17.17
Medium to Low	$ 3.05	$ 7.36	$ (1.06)	$ 3.02
High to Low	$ 20.25	$ 35.57	$ 8.18	$ 20.29

Our survey was designed to determine if the American public, as represented by our random sample, is willing to pay to offset the impacted training at Fort Irwin. As a reminder, the National Training Center is located at Fort Irwin and it is currently unable to conduct realistic armored training due to the presence of critical habitat associated with the desert tortoise. Using model 2 from the mixed logit specification and aggregating the mean WTP values across all American households, we see that for Fort Irwin the American public is willing to pay $2.1 billion dollars to alleviate the encroachment issue. This is 200% of the amount that we calculated is necessary to purchase the requested private lands at Fort Irwin. From a public policy perspective, the American government should carefully consider fully funding the private land buyout.

5.5 Comparison of Willingness to Pay Values by Survey Type

As discussed in Section 4.3.5, a secondary goal of this research project was to quantify the ability of the American public to accurately assess the value of upstream inputs to downstream production. In this case, our upstream inputs are the actual lands occupied by either the endangered species or the training grounds or both simultaneously, which happens to be the case in both of our scenarios. Evidence that the public can perceive these nuances will include WTP and WTA values that are different only by the relative scale of their payment values. There is no doubt that some researchers will give limited credence to any findings from the simplistic comparisons that follow, no matter the result. We argue that such attempts are necessary, however simple they may seem, because a positive result lends credibility to the entire issue of choice modeling as a contingent valuation technique. We say this because choice modeling is predicated on the respondent's ability to value goods by analyzing all relevant information provided and then accurately assessing their willingness to pay to avoid, or their willingness to accept compensation to allow the imposition of a harmful action. If people are unable to accurately assess the importance of critical habitat, for instance, and they fail to draw the connection between the necessity of critical habitat and further survival of endangered species, then any other information provided from this exercise may be suspect.

Looking at the WTP and WTA values for the first mixed logit model, we see that respondents are willing to pay $23.57 for the greatest improvement (lessening of impact) on Fort Irwin's ability to conduct training. At Camp Pendleton, respondents are only willing to pay $51.31 to improve readiness, which is clearly less than the factor of 5 for which we were looking for. In fact, respondents are barely more than twice as willing to

pay for improving soldiers' readiness as they are willing to pay for improving the facility's ability to train. The disparity is not as large when comparing the willingness to accept associated with endangered species and critical habitat. If respondents are to accept a high probability of losing an endangered species, they must be paid three times more than the amount they expect to accept the possible destruction of critical habitat.

Are these conflicting values an indictment of the choice modeling approach? Taken in isolation, this is little more than a simple comparison designed to assess survey respondents' awareness of the possible subtleties that choice modeling attempts to capture. We make this comparison because the underlying survey design and pool from which the sample is drawn are identical. Thus, deviations from value may indicate either people have not given much thought to the subject or they are unable to establish the cause and effect link. What other reasons could cause the noted disparity above? Price may be an issue with the Camp Pendleton survey. Recall that payment amounts ranged from $0 to $75 at Camp Pendleton versus $0 to $15 for Fort Irwin. So, while we did not include a universal choke price in the experiment, people may be unwilling to "pay up" for a government entity that, especially in light of recent events, seems fully funded for whatever contingencies it may experience. This answer certainly seems plausible and may cast doubt on our survey design, not the methodology. Another possibility is that the description for the impact on soldiers' readiness was too nebulous and should have been more definitive, similar to the description of the effects on endangered species. While we purposely shied away from the comparison of soldiers' lives versus the lives of animals, we may have been able to develop a description that talks about the impacts in

terms of increased casualties, where casualty refers not to death, but increased injuries, risk of internment, etc.

We consider the fact that the two surveys did not return the same relative values to be a mark on the wall for future research. The difference in values may be a result of flaws in the construction of the survey, the large disparity in the cost of the remedies for the two scenarios, or other reasons, included those listed above. Only through continued research along these same lines will we be able to decipher the true meaning, if any, associated with these preliminary results.

6. Conclusions

We started this project with the desire to accomplish several goals. Our first goal was to place a value on realistic, combat training by juxtaposing it against the survival of endangered species. Secondly, we wanted to compare the estimated values for endangered species survival and soldiers' readiness against those values associated with critical habitat and the training facilities. Thirdly, we wanted to try a choice modeling survey across two different media, mail and Internet, with the idea of comparing the results for consistency. The study was successful, in some shape or form, in two of the three goals, while the attempt to conduct a choice model experiment by using the Internet was not.

6.1 Extensions

One interesting extension would be to attempt to weight the survey so that it more closely matches its target demographics. It would definitely be interesting to compare how the results may change once the sample mirrors the population. Clearly, having a 71% response rate from men has had an effect on our results. Hazarding a guess as to how, it would seem that the value associated with soldiers' readiness might be overestimated. This cannot be known for sure, though, without further research. Other areas that seem ripe for these same types of valuation questions include any potential land-use limitations. The problems at Camp Pendleton exist because of the urban sprawl associated with San Diego and Los Angeles. The ESA carries the most weight when applied to Federal entities but will we see future clashes between business or residential

developers and environmentalists. If so, choice modeling may help identify how the public values each side of the argument.

Extensions on the use of choice modeling are as varied as the imagination of the researcher. Some easy topics that come to mind include the gathering of information regarding current topics, such as the National Aeronautical and Space Administration's decision to let the Hubble telescope expire without performing the required maintenance and upgrades needed to extend its life. Another interesting use of the choice modeling approach that is germane to the American public today is high gas prices. How much value does the public place on the Alaskan National Wildlife Refuge (ANWR)? Are we willing to pay higher gasoline prices because of stringent environmental regulations that govern new construction of gasoline refineries and/or offshore drilling? This question seems especially applicable to choice modeling because of the different alternatives, such as more fuel-efficient vehicles, investments in alternative fuels, etc. that must be considered, as well as the alternative of drilling for more oil. Proper application of choice modeling can help us determine values for many complex scenarios.

6.2 Summary

In summary, the public has indicated a willingness to pay for improvements at both Camp Pendleton and Fort Irwin to ensure realistic combat training can be conducted without interruption from endangered species or its critical habitat. The public has also indicated that, at least at Camp Pendleton, they would not be in favor of allowing the military to train without regard for ensuring the continued survival of any endangered

species. While this was never directly proposed for consideration, this value is easily calculated from the estimated parameters.

Our results indicate the public may be less likely to notice the subtleties associated with choice modeling. Neither soldiers' readiness nor endangered species can survive and grow without having access to the necessary space. It was disappointing, yet not wholly surprising, that the two surveys arrived at different relative values. The public did place a high enough value on both soldiers' readiness and training facilities to pay to alleviate the current conflicts regarding the use of space at Camp Pendleton and Fort Irwin. Attention should now be turned to developing the best alternative and funding its implementation.

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APPENDICES

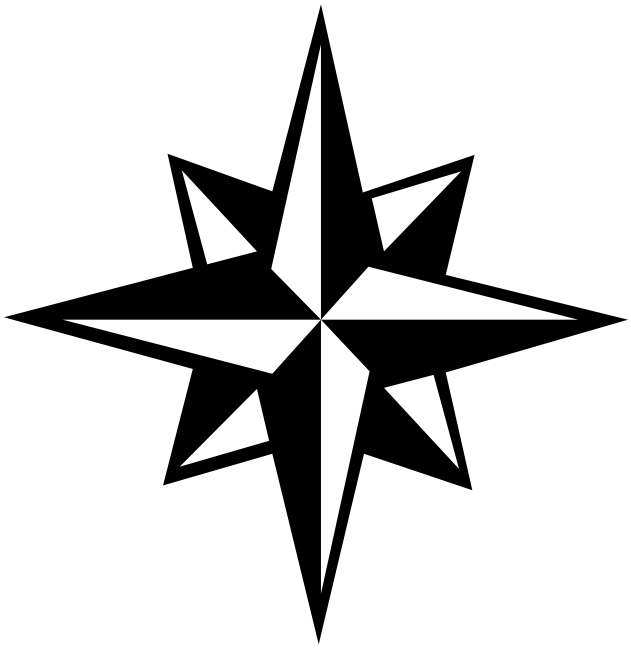
Appendix A

Table A1.1: Sample Distribution and Proportional Split between Media

	Sample Size	Mail	Internet
California	560	280	280
Washington	96	48	48
Oregon	56	28	28
Arizona	108	54	54
Colorado	96	48	48
Utah	62	31	31
Nevada	58	29	29
New Mexico	54	27	27
Idaho	46	23	23
Montana	40	20	20
Wyoming	32	16	16
Illinois	204	102	102
Ohio	186	93	93
Michigan	164	82	82
Indiana	100	50	50
Missouri	92	46	46
Wisconsin	88	44	44
Minnesota	80	40	40
Iowa	48	24	24
Kansas	44	22	22
Nebraska	28	14	14
South Dakota	12	6	6
North Dakota	10	5	5
Florida	262	131	131
Georgia	134	67	67
North Carolina	132	66	66
Virginia	116	58	58
Tennessee	94	47	47
Maryland	88	44	44
Alabama	72	36	36
Kentucky	66	33	33
South Carolina	66	33	33
Mississippi	47	24	23
West Virginia	30	15	15
District of Columbia	8	4	4
Delaware	13	7	6
Texas	343	171	172
Louisiana	80	40	40
Oklahoma	57	28	29
Arkansas	48	24	24
New York	312	156	156
Pennsylvania	202	101	101
New Jersey	138	69	69
Massachusetts	104	52	52
Connecticut	56	28	28
Maine	21	11	10
New Hampshire	20	10	10
Rhode Island	17	8	9
Vermont	10	5	5

Appendix B

Camp Pendleton Survey (Block 1)



A Survey Regarding Endangered Species and Military Training - What's the Value?

Please return your completed questionnaire in the enclosed envelope to:

The Department of Economics
University of Tennessee
505 Stokely Management Center, UT, Knoxville TN 37996

Block 1

SECTION A: SOME GENERAL ISSUES

First, we would like to find out what you think about some general issues that Americans face today.

Question 1

Below is a list of areas that compete for funding within the Federal government. Please rank these five areas by placing the numbers 1 (most deserving of continued funding) to 5 (least deserving of continued funding) in the following boxes:

Education	
The Environment	
National Defense	
Health Care	
Unemployment	

Question 2

One of the areas mentioned in Question 1 was "The Environment". Please rank the following five environmental goals by placing the numbers 1 (most deserving of funding) to 5 (least deserving of funding) in the following boxes:

Increasing water quality	
Increasing air quality	
Increasing the rate of survival of endangered species	
Increasing conservation of wetlands	
Increasing the use of recycling	

SECTION B: ENDANGERED SPECIES AND DOD READINESS

Camp Pendleton and its Surrounding Region

Camp Pendleton is the Marine Corps' only West Coast amphibious assault training center. It occupies approximately 125,000 acres and has 17 miles of beaches in coastal Southern California in the NW corner of San Diego County. The mission of Camp Pendleton is to "operate an amphibious training base that trains Marines for combat." Nearly 60,000 Marines train at Camp Pendleton annually.

Camp Pendleton also occupies some of the last significant open space and wildlife habitat in coastal areas of Southern California. The terrain is varied, including sandy shores and seaside cliffs, coastal plains and rolling hills, canyons and mountains rising to 2,700 feet. The prevailing climate is semiarid Mediterranean, with warm, dry summers and mild, wet winters. This diverse habitat contains over 800 plant species, hundreds of invertebrates, and more than 50 mammals, 30 reptiles, 10 amphibian, 300 bird and 60 fish species. Eighteen (18) federally listed threatened or endangered species are found on, or pass through, Camp Pendleton.

The land surrounding Camp Pendleton is mixed use, consisting of urban development, rural residential development, farming and ranching. The region surrounding Camp Pendleton has been shaped by rapid population growth and increasing urbanization and development. San Diego County is one of the top 5 fastest growing counties in California. This trend tends to decrease the amount of open spaces, increase fragmented habitat, and increase the number of native species and habitats that are becoming threatened with extinction. San Diego County leads the continental U.S. in the numbers of rare/federally listed threatened and endangered species.

The Issue

Camp Pendleton has approximately 45,000 training events scheduled every year. The capability to move Marine combat elements from sea to a military objective ashore is essential to combat capability, readiness, and national security. A recent assessment determined that a Battalion Landing Team (BLT) training on Camp Pendleton in a realistic, amphibious assault is able to complete required tasks to less than 68 percent of the Marine Corps standard. In general, the larger the unit involved and the more complex the training, the greater the impact of endangered species habitat.

One example of an impact is the reduced availability of Camp Pendleton's beaches. Even though Camp Pendleton consists of 17 miles of beachfront, various restrictions and competing land uses limit the availability of this beach area for amphibious training to approximately one mile (known as Red Beach). Additional restrictions at Red Beach, due to the requirements to protect endangered species, include reducing the number of landing craft on the beach at the same time and the inability to dig fighting holes. Digging a fighting hole on the beach is a force protection measure considered critical by the Marine Corps.

The purpose of this survey is to learn about the public views on possible management options for balancing the preservation of endangered species and military training.

Training Impacts from the Presence of Endangered Species

Training has an impact on endangered species and vice versa. Consider each of the following impacts in turn. These will be used in the choices that follow.

A. Impact on soldiers' readiness

Many experts have testified that a reduction in realistic training will lead to a decline in the combat readiness of the soldier. Please consider the following alternative possibilities:

High: Likely that the soldier will suffer a significant decline in combat readiness.

Medium: Likely that the soldier will suffer some decline in combat readiness.

Low: Likely that there will be no decline in combat readiness.

The current status implies that soldiers will suffer significant declines in readiness.

B. Impact on endangered species survival

Currently, in accordance with the Endangered Species Act, a species is listed as endangered based upon a determination by the Secretary of Interior. After a species is listed, federal agencies must consult with the US Fish and Wildlife Service (FWS) to ensure minimum adverse impact to the species. Different training levels correspond to differing levels of risk to endangered species that may be present.

High: Likely that an endangered species will become extinct in this region.

Medium: Likely that an endangered species will experience a further decline in this region.

Low: Likely that no affected species will become extinct.

The current status is that no affected species will become extinct.

C. Alternatives and the cost

There are alternatives for the military mission to continue realistic combat training. The options would include providing alternative habitat for the endangered species or establishing alternative training facilities. These options are costly and are not currently in the Federal budget. Implementation of these options would require a one-time levy on each U.S. household, which could be collected with the payment of the Federal income tax. The possible amounts to consider are **none, $25, $50 and $75**.

The current status is that no payment is made to resolve this issue.

This subsection will present various combinations of the previously identified attributes that are considered most important to determining the balance between preserving endangered species and conducting military training. Over the next nine questions, you are asked to consider each set of attributes within an option, and then choose the option that most closely matches your choice. Choosing to fund an alternative may reduce your available household income. ***While certain options may appear to contain attribute levels which do not make sense, the specific design of the questions is required to ensure statistical accuracy.*** *Likewise, e****ven though certain options may look similar, please make sure you give each question your full attention.***

Next is a sample question similar to the nine questions that you will be asked to answer. To indicate your selection, place an "X" in the box that corresponds to your answer. Here is an example:

Sample Question

Suppose the following three options were the only options available for managing the balance between endangered species encroachment and the DOD training mission. Please indicate which option you prefer by placing an "X" in one of the boxes below.

Feature	Option A	Option B	Option C: Current Status
Payment per household	$50	$25	None
Impact on species survival	Medium	Low	Low
Impact on soldiers' readiness	Low	Medium	High

If you choose option A, indicate this with an "X" as shown below:

☒ I would choose A

☐ I would choose B

☐ I would choose C

Question 3

Suppose the following three options were the only options available for managing the balance between endangered species encroachment and the DOD training mission. Please indicate which option you prefer by placing an "X" in one of the boxes below.

Feature	Option A	Option B	Option C: Current Status
Payment per household	$50	None	None
Impact on species survival	High	Medium	Low
Impact on soldiers' readiness	High	Medium	High

☐ I would choose A

☐ I would choose B

☐ I would choose C

Question 4

Suppose the following three options were the only options available for managing the balance between endangered species encroachment and the DOD training mission. Please indicate which option you prefer by placing an "X" in one of the boxes below.

Feature	Option A	Option B	Option C: Current Status
Payment per household	None	$25	None
Impact on species survival	High	Medium	Low
Impact on soldiers' readiness	Low	High	High

☐ I would choose A

☐ I would choose B

☐ I would choose C

Question 5

Suppose the following three options were the only options available for managing the balance between endangered species encroachment and the DOD training mission. Please indicate which option you prefer by placing an "X" in one of the boxes below.

Feature	Option A	Option B	Option C: Current Status
Payment per household	$50	$75	None
Impact on species survival	High	Medium	Low
Impact on soldiers' readiness	Medium	Low	High

☐ I would choose A

☐ I would choose B

☐ I would choose C

Question 6

Suppose the following three options were the only options available for managing the balance between endangered species encroachment and the DOD training mission. Please indicate which option you prefer by placing an "X" in one of the boxes below.

Feature	Option A	Option B	Option C: Current Status
Payment per household	$50	$25	None
Impact on species survival	Medium	Low	Low
Impact on soldiers' readiness	High	Low	High

☐ I would choose A

☐ I would choose B

☐ I would choose C

Question 7

Suppose the following three options were the only options available for managing the balance between endangered species encroachment and the DOD training mission. Please indicate which option you prefer by placing an "X" in one of the boxes below.

Feature	Option A	Option B	Option C: Current Status
Payment per household	$25	$75	None
Impact on species survival	Medium	High	Low
Impact on soldiers' readiness	Medium	Low	High

☐ I would choose A

☐ I would choose B

☐ I would choose C

Question 8

Suppose the following three options were the only options available for managing the balance between endangered species encroachment and the DOD training mission. Please indicate which option you prefer by placing an "X" in one of the boxes below.

Feature	Option A	Option B	Option C: Current Status
Payment per household	$50	None	None
Impact on species survival	Low	Medium	Low
Impact on soldiers' readiness	Medium	Low	High

☐ I would choose A

☐ I would choose B

☐ I would choose C

Question 9

Suppose the following three options were the only options available for managing the balance between endangered species encroachment and the DOD training mission. Please indicate which option you prefer by placing an "X" in one of the boxes below.

Feature	Option A	Option B	Option C: Current Status
Payment per household	$25	$50	None
Impact on species survival	High	Low	Low
Impact on soldiers' readiness	High	Medium	High

☐ I would choose A

☐ I would choose B

☐ I would choose C

Question 10

Suppose the following three options were the only options available for managing the balance between endangered species encroachment and the DOD training mission. Please indicate which option you prefer by placing an "X" in one of the boxes below.

Feature	Option A	Option B	Option C: Current Status
Payment per household	None	$75	None
Impact on species survival	High	Low	Low
Impact on soldiers' readiness	Low	Medium	High

☐ I would choose A

☐ I would choose B

☐ I would choose C

Question 11

Suppose the following three options were the only options available for managing the balance between endangered species encroachment and the DOD training mission. Please indicate which option you prefer by placing an "X" in one of the boxes below.

Feature	Option A	Option B	Option C: Current Status
Payment per household	$75	$50	None
Impact on species survival	High	Medium	Low
Impact on soldiers' readiness	Medium	Low	High

☐ I would choose A

☐ I would choose B

☐ I would choose C

SECTION C: YOU AND YOUR BACKGROUND

In this section of the questionnaire, we would like to ask you a few questions about yourself and your family background to make sure the people we are surveying are representative of the full range of Americans.

Question 12

Recently, there have been several news stories and Congressional debate about the growing conflict between endangered species and the Department of Defense training mission. When you hear about these stories, do you tend to favor (place an "X" in one of the boxes):

Preservation of endangered species more frequently ☐

The military training mission more frequently ☐

Military training and endangered species preservation equally ☐

Don't know, or haven't heard about this issue ☐

Question 13

The following two statements have been made when discussing this issue. Which of these statements comes closest to representing your current view (place an "X" in one of the boxes)?

Protection of endangered species should be given priority, even at the risk of better military training opportunities ☐

Military training should be given priority, even if the preservation of endangered species suffers to some extent ☐

Don't know, or haven't thought much about it ☐

Question 14

What is your age? _____

Question 15

What is your gender?

☐ Male ☐ Female

Question 16

If you are a registered voter, is your political affiliation:

Democrat ☐ Green Party ☐

Republican ☐ Independent ☐

Other _____

Question 17

What is the highest level of education you have completed?

Elementary or some High School ☐

High School Graduate/GED ☐

Trade or Vocational Certification ☐

Some College/Associate Degree ☐

College Graduate ☐

Post-Graduate Degree ☐

Question 18

What is your race?

Asian	☐	Hispanic	☐
Black	☐	White	☐

Other (please specify) _____

Question 19

What is your current marital status?

☐	Married	☐	Single
☐	Divorced	☐	Widow(er)

Question 20

About how much was your gross household income in 2003?

Less than $20,000	☐	$20,000 to $39,999	☐
$40,000 to $59,999	☐	$60,000 to $79,999	☐
$80,000 to $99,999	☐	$100,000 to $199,999	☐
More than $200,000	☐		

Question 21

Please fill-in the date on which you completed this survey.

_____

Question 22

Do you now, or have you ever belonged to a group that advocates/promotes environmental causes?

☐ ☐ No

Question 23

Are you now, or have you ever been a member of the Armed Forces?

☐ Yes ☐ No

Question 24

Do you have an immediate family member, defined as a parent, spouse, sibling or child, currently serving in the military?

☐ Yes ☐ No

Question 25 (If you answered yes to question 24)

Is the immediate family member identified in question 24 currently serving in the Middle East, specifically either Afghanistan or Iraq?

☐ Yes ☐ No

Question 26

Please list the state where you received this survey

_____

<u>Your comments will be appreciated, either here or in a separate envelope.</u>

All your answers will be kept strictly confidential

<u>Thank you for your time.</u>

Please return your questionnaire in the enclosed envelope to:

The Department of Economics
University of Tennessee
505 Stokely Management Center
Knoxville TN 37996

Choice Set Values for Camp Pendleton Survey (Block 2)

Question 3

Feature	Option A	Option B	Option C: Current Status
Payment per household	$50	$75	None
Impact on species survival	High	Medium	Low
Impact on soldiers' readiness	Low	Medium	High

Question 4

Feature	Option A	Option B	Option C: Current Status
Payment per household	$50	$25	None
Impact on species survival	High	Medium	Low
Impact on soldiers' readiness	Medium	Low	High

Question 5

Feature	Option A	Option B	Option C: Current Status
Payment per household	$25	$50	None
Impact on species survival	High	Low	Low
Impact on soldiers' readiness	High	Low	High

Question 6

Feature	Option A	Option B	Option C: Current Status
Payment per household	$75	$25	None
Impact on species survival	Medium	High	Low
Impact on soldiers' readiness	Low	Medium	High

Question 7

Feature	Option A	Option B	Option C: Current Status
Payment per household	None	$25	None
Impact on species survival	Medium	Low	Low
Impact on soldiers' readiness	Medium	Low	High

Question 8

Feature	Option A	Option B	Option C: Current Status
Payment per household	None	$50	None
Impact on species survival	High	Medium	Low
Impact on soldiers' readiness	Medium	High	High

Question 9

Feature	Option A	Option B	Option C: Current Status
Payment per household	$75	$25	None
Impact on species survival	Medium	Low	Low
Impact on soldiers' readiness	High	Low	High

Question 10

Feature	Option A	Option B	Option C: Current Status
Payment per household	$50	$75	None
Impact on species survival	High	Low	Low
Impact on soldiers' readiness	High	Medium	High

Question 11

Feature	Option A	Option B	Option C: Current Status
Payment per household	$25	$75	None
Impact on species survival	Medium	High	Low
Impact on soldiers' readiness	Medium	Low	High

Appendix C

Descriptive Elements of Fort Irwin Survey

Fort Irwin and its Surrounding Region

The National Training Center (NTC) at Fort Irwin, California, is the only instrumented training area in the world suitable for force-on-force and live fire training of heavy brigade-sized military forces. The mission is to provide realistic combat training. Technological advances, both in equipment and tactics, require an expansion of this training facility. This expansion covers 132,000 acres. 110,000 acres are new acquisitions from the Bureau of Land Management. They will be combined with 22,000 acres currently designated off-limits due to environmental concerns. Utilization of these expansion lands has been delayed to prevent any adverse environmental impacts.

The desert tortoise is a large, plant-eating reptile that can reach 15 inches in length. In California, the desert tortoise occurs primarily within the creosote, shadscale, and Joshua tree series of Mojave Desert scrub. Desert tortoises breed between 15 and 20 years of age; however, only 2 percent of tortoises reach reproductive age. As a result of several factors, some due to humans, a pattern of widespread decline in the number of desert tortoises in the western Mojave Desert has become evident.

On April 2, 1990, the U.S. Fish and Wildlife Service (FWS) listed the desert tortoise after determining that it was threatened due to the destruction of habitat caused by human activities, including urbanization, agricultural development, military training, etc. In 1994, the FWS designated substantial tracts of lands on and around Fort Irwin as critical habitat. A desert tortoise recovery plan recommends prohibition of several activities, such as off-highway vehicle (OHV) activity, habitat-destructive military maneuvers, grazing, etc.

The Issue

Fort Irwin was activated in 1980 based on tactics available at that time. Now, the Army engages at ranges up to 60 miles away and at speeds of 25 mph. To ensure that realistic training can be conducted, the Army must establish a second maneuver corridor, 55 miles in depth and 9-25 miles wide, that is capable of supporting a free-flowing, brigade-sized exercise.

Force-on-force training will occur in the new training corridor, with the FWS projecting that desert tortoises will be eliminated from all areas used by wheeled and tracked vehicles. This type of training will also result in long-term loss of desert tortoise habitat, which is crucial for its survival, because it provides shrub cover from the sun and predators. The expansion plan identified several conservation measures needed to offset

the effects of this expansion, including: contributing offsetting lands to Desert Wildlife Management Areas (DWMA), which are managed to promote recovery of the desert tortoise; constructing barriers and fences that are designed to conserve the endangered or threatened species and their habitat; and acquiring private lands to add to the proposed DWMA areas.

The purpose of this survey is to learn about public views on some possible management options for balancing the preservation of critical habitat and military training lands.

Training Impacts from the Presence of Endangered Species

Training has an impact on the critical habitat for endangered species and vice versa. Consider each of the following impacts in turn. These will be used in the choices that follow.

A. Impact on a facility to conduct training

Currently, the presence of endangered species and its critical habitat causes a reduction in training opportunities, as previously illustrated. Please consider the following alternative training levels:

High: The presence of endangered species and its critical habitat has a substantial impact on the ability of the base to provide training. The facilities are "capable of supporting training for some wartime missions."

Medium: The presence of endangered species and its critical habitat has a moderate impact on the ability of the base to provide training. The facilities are "capable of supporting training for most wartime missions."

Low: The presence of endangered species and its critical habitat has no impact on the ability of the base to provide training opportunities.

The current status is that Fort Irwin suffers a substantial impact on the ability of the base to provide training.

B. Impact on the critical habitat

Currently, in accordance with the Endangered Species Act, once a species is listed as endangered, a critical habitat is designated, unless the Secretary of Interior grants a waiver. After critical habitat is designated, all federal entities affected must consult with the US Fish and Wildlife Service to ensure minimum adverse impact to the critical habitat. Different training levels correspond to differing levels of risk to endangered species that may be present.

High: Likely that critical habitat will be destroyed in this region.

Medium: Likely that critical habitat will be damaged in this region.

Low: Likely that critical habitat will be unaffected in this region.

The current status is that critical habitat is unaffected in this region.

C. Alternatives and the cost

There are alternatives for the military mission to continue realistic combat training. The options would include providing an alternative habitat for the endangered species or establishing alternative training facilities. These options are costly and are not currently in the Federal budget. Implementation of these options would require a one-time levy on each U.S. household, which could be collected with the payment of the Federal income tax. The possible amounts to consider are **none, $5, $10 and $15**.

The current status is that no payment is made to resolve this issue.

Choice Set Values for Fort Irwin Survey (Block 1)

Question 3

Feature	Option A	Option B	Option C: Current Status
Payment per household	$15	None	None
Impact on critical habitat	High	Medium	Low
Impact on training opportunities	High	Medium	High

Question 4

Feature	Option A	Option B	Option C: Current Status
Payment per household	None	$5	None
Impact on critical habitat	High	Medium	Low
Impact on training opportunities	Low	High	High

Question 5

Feature	Option A	Option B	Option C: Current Status
Payment per household	$10	$15	None
Impact on critical habitat	High	Medium	Low
Impact on training opportunities	Medium	Low	High

Question 6

Feature	Option A	Option B	Option C: Current Status
Payment per household	$10	$5	None
Impact on critical habitat	Medium	Low	Low
Impact on training opportunities	High	Low	High

Question 7

Feature	Option A	Option B	Option C: Current Status
Payment per household	$5	$15	None
Impact on critical habitat	Medium	High	Low
Impact on training opportunities	Medium	Low	High

Question 8

Feature	Option A	Option B	Option C: Current Status
Payment per household	$10	None	None
Impact on critical habitat	Low	Medium	Low
Impact on training opportunities	Medium	Low	High

Question 9

Feature	Option A	Option B	Option C: Current Status
Payment per household	$5	$10	None
Impact on critical habitat	High	Low	Low
Impact on training opportunities	High	Medium	High

Question 10

Feature	Option A	Option B	Option C: Current Status
Payment per household	None	$15	None
Impact on critical habitat	High	Low	Low
Impact on training opportunities	Low	Medium	High

Question 11

Feature	Option A	Option B	Option C: Current Status
Payment per household	$15	$10	None
Impact on critical habitat	High	Medium	Low
Impact on training opportunities	Medium	Low	High

Choice Set Values for Fort Irwin Survey (Block 2)

Question 3

Feature	Option A	Option B	Option C: Current Status
Payment per household	$10	$15	None
Impact on critical habitat	High	Medium	Low
Impact on training opportunities	Low	Medium	High

Question 4

Feature	Option A	Option B	Option C: Current Status
Payment per household	$10	$5	None
Impact on critical habitat	High	Medium	Low
Impact on training opportunities	Medium	Low	High

Question 5

Feature	Option A	Option B	Option C: Current Status
Payment per household	$5	$10	None
Impact on critical habitat	High	Low	Low
Impact on training opportunities	High	Low	High

Question 6

Feature	Option A	Option B	Option C: Current Status
Payment per household	$15	$5	None
Impact on critical habitat	Medium	High	Low
Impact on training opportunities	Low	Medium	High

Question 7

Feature	Option A	Option B	Option C: Current Status
Payment per household	None	$5	None
Impact on critical habitat	Medium	Low	Low
Impact on training opportunities	Medium	Low	High

Question 8

Feature	Option A	Option B	Option C: Current Status
Payment per household	None	$10	None
Impact on critical habitat	High	Medium	Low
Impact on training opportunities	Medium	High	High

Question 9

Feature	Option A	Option B	Option C: Current Status
Payment per household	$15	$5	None
Impact on critical habitat	Medium	Low	Low
Impact on training opportunities	High	Low	High

Question 10

Feature	Option A	Option B	Option C: Current Status
Payment per household	$10	$15	None
Impact on critical habitat	High	Low	Low
Impact on training opportunities	High	Medium	High

Question 11

Feature	Option A	Option B	Option C: Current Status
Payment per household	$5	$15	None
Impact on critical habitat	Medium	High	Low
Impact on training opportunities	Medium	Low	High

Appendix D

Table D1.1: Variable List with Descriptions

Variable	Description
ID	ID number of respondent
Age	Age of respondent
Income	2003 Household income
Date	Date the survey was completed
Stat_num	Arbitrary number assigned to each state
Region	Corresponding to categories identified earlier
Comments	Whether or not the respondent commented on the questionnaire
Version	Either 1 or 2
newsspec	Respondents who favor endangered species when reading current news stories
newstrain	Respondents who favor military training when reading current news stories
newsequal	Respondents who favor endangered species and military training equally when reading current news stories
newsother	Respondents who didn't know or haven't heard of this issue
curspec	Respondents whose current view favors endangered species
curtrain	Respondents whose current view favors military training
curother	Respondents who didn't know or haven't thought about the issue
male	Number of male respondents
female	Number of female respondents
democrat	Respondents registered as Democratic voters
repub	Respondents registered as Republican voters
green	Respondents registered as Green party voters
indep	Respondents registered as Independent voters
lhs	Respondents with less than a high school education
hs	Respondents with a high school education
trade	Respondents with either a trade or vocational certification
assoc	Respondents with an Associate's degree
bachelor	Respondents with a Bachelor's degree
postgrad	Respondents with a postgraduate degree
asian	Respondents who are Asian
black	Respondents who are Black
hispanic	Respondents who are Hispanic
white	Respondents who are White
married	Respondents who are married
single	Respondents who are single
divorced	Respondents who are divorced

Table D1.1: Continued

Variable	Description
widowed	Respondents who are widow(er)
post	Respondents who completed the survey by mail
Internet	Respondents who completed the survey over the Internet
cp	Respondents who completed the Camp Pendleton survey
irwin	Respondents who completed the Fort Irwin survey
envmbr	Respondents who either currently belong to, or have belonged to an environmental group in the past
military	Respondents who either currently serve in, or have served in the military in the past
fammbr	Respondents who have an immediate family member serving in the military
afghaniraq	Respondents who have an immediate family member currently serving in Afghanistan or Iraq

Appendix E

Table E1.1: Camp Pendleton Conditional Logit WTP Values (Delta Method)

				Model 1		
Endangered Species Survival		**Mean WTP**		**95% Upper**		**95% Lower**
Low to Medium	$	(18.20)	$	4.52	$	(40.92)
Medium to High	$	(46.86)	$	(22.61)	$	(71.11)
Low to High	$	(65.06)	$	(37.33)	$	(92.80)
Soldiers' Readiness						
High to Medium	$	34.93	$	69.71	$	0.16
Medium to Low	$	19.94	$	38.98	$	0.90
High to Low	$	54.87	$	94.56	$	15.19
				Model 2		
Endangered Species Survival		**Mean WTP**		**95% Upper**		**95% Lower**
Low to Medium	$	(21.66)	$	1.24	$	(44.57)
Medium to High	$	(41.21)	$	(18.59)	$	(63.82)
Low to High	$	(62.87)	$	(35.98)	$	(89.77)
Soldiers' Readiness						
High to Medium	$	24.08	$	69.71	$	0.16
Medium to Low	$	18.05	$	38.98	$	0.90
High to Low	$	42.13	$	94.56	$	15.19
				Model 3		
Endangered Species Survival		**Mean WTP**		**95% Upper**		**95% Lower**
Low to Medium	$	(22.19)	$	1.34	$	(45.72)
Medium to High	$	(42.37)	$	(18.86)	$	(65.87)
Low to High	$	(64.56)	$	(36.76)	$	(92.36)
Soldiers' Readiness						
High to Medium	$	26.41	$	60.17	$	(7.35)
Medium to Low	$	18.11	$	37.15	$	(0.94)
High to Low	$	44.52	$	82.68	$	6.35

Table E1.2: Fort Irwin Conditional Logit WTP Values (Delta Method)

		Model 1	
Critical Habitat	**Mean WTP**	**95% Upper**	**95% Lower**
Low to Medium	$ (6.50)	$ (0.52)	$ (12.48)
Medium to High	$ (11.04)	$ (4.06)	$ (18.02)
Low to High	$ (17.53)	$ (9.02)	$ (26.04)
Facility's ability to train			
High to Medium	$ 10.69	$ 11.31	$ 0.55
Medium to Low	$ 5.93	$ 21.00	$ 0.38
High to Low	$ 16.62	$ 28.99	$ 4.25
		Model 2	
Critical Habitat	**Mean WTP**	**95% Upper**	**95% Lower**
Low to Medium	$ (5.69)	$ 0.47	$ (11.85)
Medium to High	$ (11.24)	$ (3.99)	$ (18.49)
Low to High	$ (16.93)	$ (8.35)	$ (25.51)
Facility's ability to train			
High to Medium	$ 9.58	$ 16.24	$ (4.38)
Medium to Low	$ 5.39	$ 16.11	$ 5.27
High to Low	$ 14.97	$ 28.81	$ 4.43
		Model 3	
Critical Habitat	**Mean WTP**	**95% Upper**	**95% Lower**
Low to Medium	$ (5.05)	$ 0.91	$ (11.01)
Medium to High	$ (10.88)	$ (3.97)	$ (17.79)
Low to High	$ (15.93)	$ (7.92)	$ (23.94)
Facility's ability to train			
High to Medium	$ 9.11	$ 18.96	$ (0.74)
Medium to Low	$ 5.17	$ 10.38	$ (0.04)
High to Low	$ 14.28	$ 25.86	$ 2.70

Table E1.3: Nested Logit WTP Values for Camp Pendleton (Delta Method)

		Model 1	
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**
Low to Medium	$ (22.83)	$ 1.91	$ (47.57)
Medium to High	$ (42.92)	$ (19.92)	$ (65.92)
Low to High	$ (65.75)	$ (39.06)	$ (92.44)
Soldiers' Readiness			
High to Medium	$ 24.86	$ 62.06	$ (12.35)
Medium to Low	$ 21.17	$ 39.24	$ 3.10
High to Low	$ 46.02	$ 88.16	$ 3.89
		Model 2	
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**
Low to Medium	$ (26.15)	$ (1.23)	$ (51.07)
Medium to High	$ (37.98)	$ (16.18)	$ (59.78)
Low to High	$ (64.13)	$ (37.73)	$ (90.53)
Soldiers' Readiness			
High to Medium	$ 16.05	$ 50.44	$ (18.34)
Medium to Low	$ 18.72	$ 36.56	$ 0.88
High to Low	$ 34.77	$ 73.23	$ (3.69)
		Model 3	
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**
Low to Medium	$ (25.88)	$ (0.22)	$ (51.53)
Medium to High	$ (39.60)	$ (16.63)	$ (62.57)
Low to High	$ (65.47)	$ (37.98)	$ (92.96)
Soldiers' Readiness			
High to Medium	$ 19.56	$ 56.28	$ (17.16)
Medium to Low	$ 18.82	$ 37.34	$ 0.30
High to Low	$ 38.38	$ 79.40	$ (2.65)

Table E1.4: Nested Logit WTP Values for Fort Irwin (Delta Method)

Critical Habitat	Mean WTP	95% Upper	95% Lower
		Model 1	
Low to Medium	$ (6.89)	$ (0.56)	$ (13.22)
Medium to High	$ (10.31)	$ (3.70)	$ (16.92)
Low to High	$ (17.20)	$ (9.25)	$ (25.15)
Facility's ability to train			
High to Medium	$ 8.64	$ 19.83	$ (2.55)
Medium to Low	$ 6.13	$ 11.29	$ 0.97
High to Low	$ 14.77	$ 27.81	$ 1.73
		Model 2	
Critical Habitat	**Mean WTP**	**95% Upper**	**95% Lower**
Low to Medium	$ (5.77)	$ 0.72	$ (12.26)
Medium to High	$ (10.98)	$ (3.88)	$ (18.08)
Low to High	$ (16.74)	$ (8.36)	$ (25.12)
Facility's ability to train			
High to Medium	$ 8.86	$ 20.17	$ (2.45)
Medium to Low	$ 5.49	$ 10.84	$ 0.14
High to Low	$ 14.35	$ 27.27	$ 1.43
		Model 3	
Critical Habitat	**Mean WTP**	**95% Upper**	**95% Lower**
Low to Medium	$ (5.09)	$ 1.16	$ (11.34)
Medium to High	$ (10.75)	$ (3.90)	$ (17.60)
Low to High	$ (15.84)	$ (7.90)	$ (23.78)
Facility's ability to train			
High to Medium	$ 8.73	$ 19.60	$ (2.14)
Medium to Low	$ 5.24	$ 10.44	$ 0.04
High to Low	$ 13.97	$ 26.27	$ 1.67

Table E1.5: Mixed Logit WTP Values for Camp Pendleton (Delta Method)

	Model 1		
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**
Low to Medium	$ (8.16)	$ 24.04	$ (40.36)
Medium to High	$ (44.33)	$ (23.29)	$ (65.37)
Low to High	$ (52.49)	$ (14.39)	$ (90.59)
Soldiers' Readiness			
High to Medium	$ 44.41	$ 90.21	$ (1.39)
Medium to Low	$ 6.90	$ 29.21	$ (15.41)
High to Low	$ 51.31	$ 105.22	$ (2.60)
	Model 2		
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**
Low to Medium	$ (17.05)	$ 20.35	$ (54.45)
Medium to High	$ (43.65)	$ (20.97)	$ (66.33)
Low to High	$ (60.70)	$ (18.48)	$ (102.92)
Soldiers' Readiness			
High to Medium	$ 45.62	$ 99.07	$ (7.83)
Medium to Low	$ 12.92	$ 37.93	$ (12.09)
High to Low	$ 58.54	$ 124.23	$ (7.15)

Table E1.6: Mixed Logit WTP Values for Fort Irwin (Delta Method)

	Model 1		
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**
Low to Medium	$ (5.09)	$ 2.60	$ (12.78)
Medium to High	$ (10.93)	$ (4.75)	$ (17.11)
Low to High	$ (16.02)	$ (6.78)	$ (25.26)
Soldiers' Readiness			
High to Medium	$ 19.98	$ 39.88	$ 0.08
Medium to Low	$ 3.59	$ 8.34	$ (1.16)
High to Low	$ 23.57	$ 44.16	$ 2.98
	Model 2		
Endangered Species Survival	**Mean WTP**	**95% Upper**	**95% Lower**
Low to Medium	$ (4.44)	$ 2.22	$ (13.76)
Medium to High	$ (12.21)	$ (3.58)	$ (18.38)
Low to High	$ (16.65)	$ (6.00)	$ (27.48)
Soldiers' Readiness			
High to Medium	$ 17.20	$ 33.36	$ 1.04
Medium to Low	$ 3.05	$ 8.73	$ (2.63)
High to Low	$ 20.25	$ 37.54	$ 2.96

Appendix F

SAS Programming Code for Experimental Design

```
/*This follows Tech Note TS-677E, particularly the "Chair Example".*/
%mktex(4 3 3, n=3*3*4)
/*Create an efficient design from the full factorial.  This coding means that I have three attributes,
one with 4 levels, and two with 3 levels.  Here,n equals the full factorial.*/
data final(drop=i);
    set design end=eof;
            retain f1-f2 1 f3 0;
            output;
            if eof then do;
              array x[6] x1-x3 f1-f3;
                    do i = 1 to 6; x[i] = i le 3 or i eq 6; end;
                    output;
                    end;
            run;
/*This step creates the full factorial candidate set with variables x1
 through x3, because I only have three attributes, and assigns a 1
 in the flag column to levels of attributes that can be in any option
 (columns f1-f2).  The final observation is the status quo, or base option, and it is coded with a 1
in the f3 column.  The observations with flag codes f1 and f2 can be used for any alternative of
the first two alternatives, while the f3 observation may only be the third option (the status quo).*/
/*Options=noprint in choiceff and mktblk suppress the output.  The final mktlab will print the
output of interest.*/
%choiceff(data=final, model=class(x1-x3), nsets=18, maxiter=100, flags=f1-f3, beta=zero);
/*This set creates the most efficient design.  Nsets equals 18 choice sets with the options that vary
and it adds in the status quo option to each choice set.*/
%mktblock(data=best, nalts=3, nblocks=2, factors=x1-x3)
/*This option blocks the design into two blocks with 3 alternatives and 9 choice sets.*/
data key;
input payment endangered $ readiness $;
format payment dollar5.0;
datalines;
0   Low    High
10  Medium Medium
25  High   Low
50  .      .
;
%mktlab(data=blocked, key=key)
/*This option assigns labels to each of my alternatives.*/
proc print; by block set; run;
/*This prints the final 18 choice sets, by block, by set.*/
```

LIMDEP Code for Conditional Logit (including Krinsky and Robb Confidence Intervals and Delta Method Confidence Intervals)

```
Title         ; Irwin Conditional Logit Output$
NLOGIT   ; LHS =choice    ?Conditional Logit specification, no sociodemographic
             ; Choices =A,B,C
             ; RHS =Payment, ASC, SPEC_MEC, SPEC_HEC,SOLD_LEC,SOLD_MEC$
Matrix       ;Bu=B;Vu=VARB$

NLOGIT   ; LHS =choice    ?IIA test on previous specification
             ; Choices =A,B,C
             ;Ias=B      ?If IIA doesn't hold, B is the most likely reason
             ; RHS =PAYMENT, ASC, SPEC_MEC, SPEC_HEC, SOLD_LEC, SOLD_MEC$

NLOGIT    ; LHS =choice    ?Conditional Logit specification, ASC, no sociodemographic
             ; Choices =A,B,C
             ; RHS =PAYMENT, ASC, SPEC_MEC, SPEC_HEC, SOLD_LEC, SOLD_MEC$

Matrix     ;Bu=B;Vu=VARB$

NLOGIT    ; LHS =choice    ?IIA test on previous specification
             ; Choices =A,B,C
             ;Ias=A           ?test IIA on both options A and B
             ; RHS =PAYMENT, ASC, SPEC_MEC, SPEC_HEC, SOLD_LEC, SOLD_MEC$

?----------Compute Willingness to Pay for Species Low to High and Soldiers High to Low using
Delta Method
NLOGIT    ; LHS =choice    ?Conditional Logit specification, no sociodemographic
        ; Choices =A,B,C
        ; RHS =Payment, ASC, SPEC_MEC, SPEC_HEC,SOLD_LEC,SOLD_MEC$
Matrix     ;bb=b;varbb=varb$
Wald; Start   = bb ;
     Var     = varbb ;
     Fn1     = (b3)/-b1 ;        ?Part-worth Species Low to Medium
     Fn2     = (b4-b3)/-b1 ;     ?Part-worth Species Medium to High
     Fn3     = (b4)/-b1;         ?Part-worth Species Low to High
     Fn4     = (b6)/-b1 ;        ?Part-worth Soldiers High to Medium
     Fn5     = (b5-b6)/-b1 ;     ?Part-worth Soldiers Medium to Low
     Fn6     = (b5)/-b1;  $      ?Part-worth Soldiers High to Low

?Calculate table value for confidence interval calculations
calc; list; tablevlu = Ntb(.95,1) $

?------------------------Krinsky and Robb Procedure ------------------------------
MATRIX; Bu=B;Vu=VARB$
MATRIX; cu = Chol(vu)$ Computes the Cholesky Decomposition of the Covariance Matrix
MATRIX; cu1=cu'$    Takes the inverse of cu (as per Haab and McConnell)
MATRIX; sn1=rndm(1001,6)$ Computes 1,001 random standard normal variables
```

```
MATRIX; sncu1=sn1*cu1$    multiples the inverse of the chol. decomp. by the standard normal
variables
MATRIX; aaa=[1001|1]$     Creates a matrix of 1s (1001 x 1)
MATRIX; aaa1=aaa'$        creates the inverse of aaa (1 X 1001)
MATRIX; mbetas=bu*aaa1$   multiplies (6x1)x(1x1001) - 6 rows of estimates of beta
MATRIX; mbeta1=mbetas'$   computes the inverse of mbeta, 1001 rows of beta
MATRIX; y=sncu1+mbeta1$   create new parameter vector  from the multivariate distribution
(Step 5 from H&M)
MATRIX ; YCol1 = Part(Y,1,1001,1,1) $  Column vector, col 1 (Payment coefficient)
MATRIX ; YCol1neg = -1 * YCOL1 $       Negative of the payment coefficient
MATRIX ; YCol1Inv = DIRI(YCol1NEG) $      Element by element reciprocal of payment
variable
MATRIX ; YCOL3 = Part(Y,1,1001,16,16) $ Column vector, col 3 (species low to medium)
MATRIX ; YCOL4 = Part(Y,1,1001,17,17) $ Column vector, col 4 (species low to high)
MATRIX ; YDIFF1 = YCOL4 - YCOL3$ Difference between two matrices  (species high to
medium)
MATRIX ; YCOL6 = Part(Y,1,1001,19,19) $ Column vector, col 6  (soldiers high to medium)
MATRIX ; YCol5 = Part(Y,1,1001,18,18) $  Column vector, col 5 (Soldiers high to low)
MATRIX ; YDIFF2 = YCol5 - YCOL6 $ Difference between two column vectors  (soldiers low
to medium)
MATRIX ; WTP1 = DIRP(YCol1Inv, YCOL3) $ Hadamard product
MATRIX ; WTP2 = DIRP(YCol1Inv, YDIFF1) $ Hadamard product
MATRIX ; WTP3 = DIRP(YCol1Inv, YCol4) $ Hadamard product.  DONE!
MATRIX ; WTP4 = DIRP(YCol1Inv, YCOL6) $ H. product.
MATRIX ; WTP5 = DIRP(YCol1Inv, YDIFF2) $ H. product
MATRIX ; WTP6 = DIRP(YCol1Inv, YCOL5) $ H. Product.
?--------------------C.I. and median WTP for WTP1-----------
Create; u1=0$
namelist; nu1=u1$
create; nu1=WTP1$
SORT; lhs=nu1  $  Sort WTP1 in ascending order
MATRIX; WTP11=nu1 $ Create matrix WTP11 equal to the sorted WTP1
MATRIX ; list; WTP1LCI = PART(WTP11,25,25,1,1)$ Extract the lower CI
MATRIX ; list; WTP1UCI = PART(WTP11, 976,976,1,1)$ Extract the upper CI
MATRIX ; list; WTP1MN = PART(WTP11, 501,501,1,1) $ Extract the median WTP
?-------------------------------------------------------------
?--------------------C.I. and median WTP for WTP2-----------
CREATE; u2=0$
namelist; nu2=u2$
create; nu2=WTP2$
SORT   ; lhs = nu2$  Sort WTP2 in ascending order.
MATRIX ; WTP22 = nu2$ Create matrix WTP22 equal to the sorted WTP2
MATRIX ; list; WTP2LCI = PART(WTP22,25,25,1,1)$ Extract the lower CI
MATRIX ; list; WTP2UCI = PART(WTP22, 976,976,1,1)$ Extract the upper CI
MATRIX ; list; WTP2MN = PART(WTP22, 501,501,1,1) $ Extract the median WTP
?-------------------------------------------------------------
?--------------------C.I. and median WTP for WTP3-----------
CREATE; u3=0$
namelist; nu3=u3$
```

```
create; nu3=WTP3$
SORT   ; lhs = nu3$  Sort WTP3 in ascending order.
MATRIX ; WTP33 = nu3$ Create matrix WTP33 equal to the sorted WTP3
MATRIX ; list; WTP3LCI = PART(WTP33,25,25,1,1)$ Extract the lower CI
MATRIX ; list; WTP3UCI = PART(WTP33, 976,976,1,1)$ Extract the upper CI
MATRIX ; list; WTP3MN = PART(WTP33, 501,501,1,1) $ Extract the median WTP
?-------------------------------------------------------------
?--------------------C.I. and median WTP for WTP4-----------
CREATE; u4=0$
namelist; nu4=u4$
create; nu4=WTP4$
SORT   ; lhs = nu4$  Sort WTP4 in ascending order.
MATRIX ; WTP44 = nu4$ Create matrix WTP44 equal to the sorted WTP4
MATRIX ; list; WTP4LCI = PART(WTP44,25,25,1,1)$ Extract the lower CI
MATRIX ; list; WTP44UCI = PART(WTP44, 976,976,1,1)$ Extract the upper CI
MATRIX ; list; WTP44MN = PART(WTP44, 501,501,1,1) $ Extract the median WTP
?-------------------------------------------------------------
?--------------------C.I. and median WTP for WTP5-----------
CREATE; u5=0$
namelist; nu5=u5$
create; nu5=WTP5$
SORT   ; lhs = nu5$  Sort WTP5 in ascending order.
MATRIX ; WTP55 = nu5$ Create matrix WTP55 equal to the sorted WTP5
MATRIX ; list; WTP5LCI = PART(WTP55,25,25,1,1)$ Extract the lower CI
MATRIX ; list; WTP5UCI = PART(WTP55, 976,976,1,1)$ Extract the upper CI
MATRIX ; list; WTP5MN = PART(WTP55, 501,501,1,1) $ Extract the median WTP
?-------------------------------------------------------------
?--------------------C.I. and median WTP for WTP6-----------
CREATE; u6=0$
namelist; nu6=u6$
create; nu6=WTP6$
SORT   ; lhs = nu6$  Sort WTP6 in ascending order.
MATRIX ; WTP66 = nu6$ Create matrix WTP11 equal to the sorted WTP6
MATRIX ; list; WTP6LCI = PART(WTP66,25,25,1,1)$ Extract the lower CI
MATRIX ; list; WTP6UCI = PART(WTP66, 976,976,1,1)$ Extract the upper CI
MATRIX ; list; WTP6MN = PART(WTP66, 501,501,1,1) $ Extract the median WTP
```

LIMDEP Code for Nested Logit (including Delta Method Confidence Intervals)

```
Title     ; Irwin Nested Logit Sociodemographic Output$
NLOGIT    ; LHS =choice    ?Nested Logit specification, ASC, some sociodemographic
          ; Start = logit
          ; Choices =A,B,C
          ; RHS =PAYMENT, ASC, ASC_AGE, ASC_INCO, ASC_Sex, C_LBACH, C_POSTGR,
            C_DEM, C_INDEPE, C_GREEN, SPEC_MEC, SPEC_HEC, SOLD_LEC, SOLD_MEC
            ;Tree=Choose(A,B), SQ(C);RU2$              ?Normalize using Random Utility 2 Preferred
             by Greene
Matrix     ;bb=b;varbb=varb$
?Willingness to pay for nested logit, sociodemographic, using delta method
```

```
Wald; Start   = bb ;
     Var     = varbb ;
     Fn1     = (b11)/-b1 ;        ?Part-worth Species Low to Medium
     Fn2     = (b12-b11)/-b1 ;     ?Part-worth Species Medium to High
     Fn3     = (b12)/-b1;         ?Part-worth Species Low to High
     Fn4     = (b14)/-b1 ;        ?Part-worth Soldiers High to Medium
     Fn5     = (b13-b14)/-b1 ;     ?Part-worth Soldiers Medium to Low
     Fn6     = (b13)/-b1;  $      ?Part-worth Soldiers High to Low

?Calculate table value for confidence interval calculations
calc; list; tablevlu = Ntb(.95,1) $
```

LIMDEP Code for Mixed Logit (including Delta Method Confidence Intervals)

```
?----FULL RANDOM PARAMETERS LOGIT SPECIFICATION----------------------------------
------------

Reject; ASC=-999 | ASC_AGE=-999 | ASC_SEX=-999 | ASC_INCO=-999 | C_DEM=-
999|C_LBACH=-999| C_POSTGR=-999 | C_GREEN=-999 | C_INDEPE=-999 $

CALC  ;Ran(12345) $ Establishes a seed value
NLOGIT          ; Lhs= CHOICE
          ; Rhs= Payment, ASC, ASC_SEX, ASC_AGE, ASC_INCO, C_LBACH,
            C_POSTGR, C_DEM, C_INDEPE, C_GREEN,
            SPEc_MEC, SPEC_HEC, SOLD_LEC, SOLD_MEC
          ; Choices= A, B, C
           ; Tlg = 1.d-10
          ; RPL
           ; Fcn =  payment(C), ASC(N), ASC_SEX(N), ASC_AGE(N), ASC_INCO(N),
            C_LBACH(N), C_POSTGR(N), C_DEM(N), C_INDEPE(N), C_GREEN,
            SPEC_MEC(N), SPEC_HEC(N), SOLD_LEC(N), SOLD_MEC(N)
          ; Cor ?Allows correlation among individual responses
           ; Pds = 9  ?Identifies how many choice sets per individual
           ; Pts = 1000 ? # of replications to use
           ; Halton$ Type of random number sequence to use
Matrix; bb = b; varbb = varb $
Matrix; bb1 = Part(bb,1,11);       ?takes rows 1 thru 12 from coeff matrix
      varbb1 = Part(varb,1,11,1,11) $   ?takes diag elements for coeffs 1-12
Wald; Start   = bb ;
     Var     = varbb ;
     Fn1     = (b8)/-b1 ;        ?Part-worth Species Low to Medium
     Fn2     = (b9-b8)/-b1 ;     ?Part-worth Species Medium to High
     Fn3     = (b9)/-b1;         ?Part-worth Species Low to High
     Fn4     = (b11)/-b1 ;       ?Part-worth Soldiers High to Medium
     Fn5     = (b10-b11)/-b1 ;     ?Part-worth Soldiers Medium to Low
     Fn6     = (b10)/-b1;  $      ?Part-worth Soldiers High to Low
?Calculate table value for confidence interval calculations
calc; list; tablevlu = Ntb(.95,1) $
```

VITA

Jeffrey Stewart Smith was born on Friday the Thirteenth, in the Year of the Monkey. In 1990, he was awarded a Bachelor of Arts degree in Economics from The University of South Carolina while being commissioned as a 2nd Lieutenant in the United States Air Force. Jeff has completed Squadron Officers School in 1994, earned a Master of Science degree in Economics from Wright State University in 1995, completed Professional Military Comptroller School in 1997 and completed Air Command and Staff College in 2002. He enrolled in the University of Tennessee in August, 2001. In August 2004, he received a Ph.D. in Economics from The University of Tennessee, Knoxville, and began teaching at the Air Force Institute of Technology in Dayton, OH.