Leading Community Risk Reduction

Comparison of Urban Search and Rescue Resource Models to Determine Efficacy in Post-Hurricane Missions

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CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Signed: ___________________________
Abstract

This research project compared current Urban Search and Rescue (US&R) response models to determine efficacy in post-hurricane deployment missions. The problem is that South Carolina’s current plan for deploying US&R resources to a region utilizes models designed for search and rescue in collapsed structures. The purpose of this research was to identify if the current models were advantageous for use in search of urban areas where hurricane damage may have trapped victims. Descriptive research was used to answer the following questions:

1. What search and rescue models are currently being utilized?
2. What are the benefits of utilizing these models in post-hurricane search of urban areas?
3. What are the liabilities of these models?
4. Which models would be best utilized by the South Carolina Emergency Response Task Force to deliver the appropriate service?

The procedures consisted of a literature review, interviews, and an experiment involving search of areas of various densities.

The results established that the current urban search and rescue models appear suitable for searching the hurricane-stricken areas. The issue, however, is insuring the resources are appropriately matched to the type of hazards found. The results concluded that the South Carolina Emergency Response Task Force (SCERTF) should work with the State Emergency Management Division to recommend adoption of the National Incident Management System definitions, develop assets, determine the presence of existing assets, continue to be active in the standard development process, and insure measurement of capabilities for responding assets.
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Comparison of Urban Search and Rescue Resource Models to Determine Efficacy in Post-Hurricane Missions

Introduction

In September 2005, Hurricane Katrina struck the Gulf Coast, profoundly affecting the States of Alabama, Mississippi, and Louisiana. South Carolina’s state urban search and rescue (US&R) task force was among the assets requested to respond to this emergency. In command posts in St. Tammany Parish, Louisiana, then in St. Bernard Parish, the original plans for the search of surviving victims utilized a shotgun approach; the intent was to send as many available resources into an area as possible to see who could be found. The local incident managers were easily persuaded to institute systematic approaches to search that maximized the effectiveness of assets.

In each case, outside US&R teams were able to interact positively with the local emergency providers, flex with the problems presented, create systematic search parameters, and send units to areas where probabilities were high based upon pending 9-1-1 calls and initial reconnaissance efforts (South Carolina Emergency Response Task Force, 2005; California Urban Search and Rescue Task Force 3, 2005).

Due to the presence of federal and state US&R teams, there were several different configurations, all of which were summoned under the auspices of being a “Type 3 US&R team” (SCERTF, 2005; CA-TF3, 2005; see also Utah Urban Search and Rescue Task Force 1, 2005; Washington Urban Search and Rescue Task Force 1, 2005). Given anecdotal evidence gained from participation in the search and rescue operations of several national disasters, it appeared that the response models were modified each time in order to work on these incidents, rather than having a model that fit the needs of the incident.
The problem is that South Carolina’s current plan for deploying US&R resources to a search for victims after a hurricane strike utilizes models designed for search and rescue in collapsed structures. The purpose of this research was to identify if the current models were advantageous for use in wide-area search of urban areas where hurricane damage may have trapped victims. Descriptive research was used to answer the following questions:

1. What search and rescue models are currently being utilized?
2. What are the benefits of utilizing these models in wide-area search of hurricane-impacted urban areas?
3. What are the liabilities of these search and rescue models?
4. Which models would be best utilized by the South Carolina Emergency Response Task Force to deliver the appropriate service?
Background and Significance

South Carolina’s state urban search and rescue (US&R) program is tasked with ensuring the delivery of search and rescue service to the communities of the state under a number of different disaster scenarios. After a hurricane, certain factors can be planned for in advance of the event, especially as they relate to the numbers of resources that are allocated to the emergency. The problem, however, is that there are factors that cannot be known until after the event occurs, facts that often exacerbate the broad and diverse nature of the emergency. Furthermore, the response team models which are currently requested to respond to weather driven events like a hurricane commonly utilize models that were initially designed for mitigation of structural collapse, particularly in response to an earthquake. Given the anecdotal evidence presented from several incidents requiring the modifications of team structure (SCERTF, 2005; J. Walters, personal communication, September 10, 2005), it appears as if comparison is warranted to determine if these models are applicable for post-hurricane search and rescue operations.

This research project is significant to the South Carolina Emergency Response Task Force (SCERTF) and to the State of South Carolina in that it illuminates the current situation within the proposed National Incident Management System (NIMS) resource typing project and a possibility of misunderstanding by requesting authorities as to the resources necessary to mitigate situations evolving as a result of a hurricane. The project also intends to provide insight to the state’s US&R providers so that changes can be made to the existing plan and as a result, a higher level of service can be provided to their customers.

Study of the identified situation and providing solutions is related to the National Fire Academy’s (NFA) *Leading Community Risk Reduction* course goal in that it provides senior fire
executives with strategic perspectives on comprehensive risk management (National Fire

The research is also specifically applicable to the U.S. Fire Administration’s (USFA)
operational objective “to promote within the community a comprehensive multi-hazard risk
reduction plan led by the fire service organization” (NFA, 2005, p. SM 0-15) and the objective of
“responding appropriately in a timely manner to emerging issues”.

South Carolina is a relatively small state, measuring 32,020 square miles and aside from
agriculture and governmental support, a combination of manufacturing and tourism fuel the
state’s economy (“South Carolina”, 2006). Any detrimental change to the state’s economy could
be devastating, as South Carolina, with a median income placing it 45th in the United States, is
already one of the nation’s poorest states (South Carolina Almanac, 2005).

The State of South Carolina is vulnerable to hurricanes and tropical storms; of the most
devastating in recent history, Hurricane Hugo struck South Carolina in September 1989 and the
state found itself largely unprepared for the aftermath. Other hurricanes have also struck the
state with detrimental effect on both coastal and inland communities.

In the wake of Hugo, one of the pressing needs established by the state was the
implementation of a US&R plan (J. Bowie, personal communication, August 5, 2003). Other
than resources provided by local jurisdictions and various attempts to develop a state response
capability, programs at that time remained un-funded and unsupported.

In July 2000, Governor Jim Hodges signed South Carolina Public Law Title 23, Chapter
49 establishing the Firefighter Mobilization Oversight Committee. This committee’s charge was
to establish a coordinated fire service response to disaster requests both in and out-of-state. The
State Emergency Operations Plan was amended (South Carolina Emergency Management
Division, 2002), assigning responsibility for US&R to the South Carolina Department of Labor, Licensing, and Regulation, parent agency of the Division of Fire and Life Safety (DFLS).

Fourteen months later, with the September 11th disaster fresh in the minds of the nation, appointment of a state US&R Program Management Group became a high priority. The program management group recommended creation of the SCERTF as a coordinating entity for rescue under the Firefighter Mobilization Committee. The state US&R program identified one state-wide, state-managed task force modeled after the Federal Emergency Management Agency (FEMA) US&R task forces and supplemented by regional response teams (Mayers, 2004, p. 1) managed by local fire departments.

SCERTF was introduced to the state in July 2003 at the South Carolina Firefighters Association Annual Conference. In less than two years time, “South Carolina Task Force One” (SC-TF1) went fully operational with the first US&R cache in the nation to meet FEMA’s 2003-2004 recommendations (Federal Emergency Management Agency, 2003). In September 2005, South Carolina’s task force responded to the Hurricane Katrina disaster as the first state US&R team legally deployed to this incident through the Emergency Management Assistance Compact (EMAC) from outside of the FEMA US&R program. As such, SC-TF1 became the first American US&R task force to go into service in the heavily stricken St. Bernard Parish, Louisiana.

SCERTF is headquartered at the South Carolina Fire Academy in Columbia, the State Capital. Over 155 personnel represent 38 different South Carolina fire agencies, 10 emergency medical services, and five private businesses.

South Carolina’s Emergency Operations Plan identifies DFLS as responsible for the rescue of persons from urban disaster, and therefore, by designation, SCERTF has a lawful duty
to act. South Carolina Code of Laws Chapter 49, the “Firefighter Mobilization Act of 2000”, states:

The South Carolina Firefighter Mobilization Oversight Committee shall establish the South Carolina Firefighter Mobilization Plan. The purpose of the plan is to provide for responding firefighting and rescue resources from one part of the State to another part of the State or from one state to another state. The plan is operative (1) under emergencies declared by the Governor, or the President of the United States, (2) when a local fire chief needs additional assistance after mutual aid agreements have been utilized, or (3) when another state requests assistance in dealing with an emergency when a state mutual aid agreement exists between South Carolina and the other state. In addition, the plan operates and is a part of the State Emergency Response Plan (State Emergency Operations Plan, or SCEOP).

SCERTF is compelled in South Carolina to conduct search and rescue efforts for persons affected by natural disaster. The organization is obligated to handle them in the most efficient way possible, by providing resources to localities to search for victims of the disaster and rescue those victims from the hazards present.

Of factors influencing the deployment of resources, the type of resource configuration affects the capability of response because it dictates the equipment type and manpower allocation. In the event that the wrong type of resource is requested, that responding resource may or may not be adequately equipped or staffed to manage the needs of the affected jurisdiction.

Disasters will strike and these disasters will be unpredictable in time and enormity. SCERTF will respond to requests for disaster assistance as part of the South Carolina Emergency
Operations Plan. Rapid response of the appropriate resource for the emergency at hand is essential for success. Since people die quickly in major disasters, the faster the service is delivered, the more lives are saved, and thus the significance of this research.

Literature Review

A literature review was conducted to analyze the existing body of knowledge on US&R resource configurations and capabilities. Further review was conducted to understand the hazards and barriers present after hurricane impact on a community and how those factors affect the community and the rescuers. Finally, literature review was also conducted to discover how team operations have been affected in past adverse situations.

The literature review included an extensive search of private and public sector occupational publications, textbooks, and web-based information. Literature documenting issues in governmental and non-governmental organizations was reviewed in addition to fire service information. Articles written by experts in disaster research and organizational theory were also reviewed.

The extensive literature review lent support toward analysis of whether or not the current models were adequate for response to the events unfolding after a hurricane strike on the South Carolina coast.

This section will discuss critical findings in:

1. Current search and rescue resource models
2. Acute effects of hurricanes on the physical environment
3. Effects of post-hurricane environment on the community and rescuers
4. Past team operations within adverse settings
Current search and rescue resource models

The concept of search and rescue presents itself in many forms, from marine search and rescue (SAR) performed by the United States Coast Guard and many local and regional responders on the nation’s water bodies, to wilderness and mountain SAR, to the highly technical discipline of urban search and rescue generally associated with the collapse of structures.

While elements of marine and wilderness SAR exist in the search and rescue of victims after hurricane impact, in most cases victims trapped by either rubble or flooding in urban areas present the most significant challenges to emergency managers, if for any reason at all due to the numbers of victims involved and the wide range of locations in which the victims could be present. These numbers tend to complicate the existing situation and require a major coordination of resources and application of tactics and as a result, are the focus of this study. For the purpose of application to South Carolina’s situation, analysis concentrated on the resources applied to US&R task forces, collapse rescue teams, and swiftwater/flood rescue teams.

There are many providers of urban search and rescue in the nation, from local response teams to the twenty-eight federal US&R task forces, all of which define their resource according to particular needs. Discussion with other team administrators from around the nation revealed that the driving force for how many of the teams are organized appears to be the desire to comply with industry accepted standards or recommendations, of which the principal documents are the proposed NIMS search and rescue (NIMS SAR) resource typing document (FEMA, 2005a) and the Firefighting Resources of California Organized for Potential Emergencies (FIRESCOPE) recommendations (FIRESCOPE 2004; also 2001).
Two defining documents comprise search and rescue asset identification, FIRESCOPE and NIMS. The FIRESCOPE recommendations predate the proposed NIMS recommendations and were the basis for development of the FEMA US&R Response System (Rigg, 1998). The NIMS SAR typing definitions for US&R task forces are based on the FEMA US&R definitions and the collapse rescue and swiftwater/flood rescue teams have origins in FIRESCOPE’s definitions for those resources. Any other models fall into the category of “everything else” and obviously add much confusion. Unfortunately, there was a lack of documentation despite extensive literature searches.

FIRESCOPE search and rescue resource typing agreements are among the earliest in evidence. FIRESCOPE originated in Southern California and was established in 1972 to unify fire agencies involved with potential disasters (FIRESCOPE, 2004). In 1989, the California Office of Emergency Services proposed the concept of US&R task forces after the Loma Prieta earthquake. These initial task forces were designed to be self-sufficient for 72 hours and capable of sustaining a 10-day mission.

The FIRESCOPE US&R plan calls for resources of various levels to provide a tiered response to emergencies. The initial response to collapsed structures calls for intervention at the most basic level by local responders; if escalation is necessary due to the complexity or scope of the incident, resources are identified within the state which provide the next level of expertise as needed to handle the situation. The FIRESCOPE document goes so far as to identify the level of responder from a basic operational level to that of a heavy operational level. Since hurricanes are not a disaster inherent to the State of California, there is no discussion in FIRESCOPE as to what resources models would specifically be deployed to affected areas, although logic has it that given their ability to manage every other emergency they have experienced in a
revolutionary manner, they would logically deploy appropriate resources to match the search environment necessary. The swiftwater/flood rescue teams deployed by the State of California were designed for localized flooding response and subsequent rescue of victims in open flooding situations and because of their design, were small enough and mobile enough to perform many rescues and to be deployed effectively to areas where they were needed most. However, according to the cache lists, these teams do not carry equipment particular to search and rescue from partially collapsed structures or from debris (FIRESCOPE, 2001).

The proposed NIMS SAR resource typing models began as an initiative as a result of Homeland Security Presidential Directive 5 (HSPD-5) directing the Department of Homeland Security to, among other things, create NIMS to “provide a consistent nationwide framework for Federal, State, and local governments to work effectively and efficiently together to manage domestic incidents, regardless of their cause” (HSPD-5, 2003). The definitions used in NIMS SAR had their origin in FIRESCOPE, but have evolved over time based upon anecdotal evidence (N. Rooker, personal communication, June 2006, and M. Brown, personal communication, January 15, 2007). US&R task forces are described by the NIMS SAR document as being a “federal asset” (FEMA, 2005a, p. 38), despite the presence within the State Urban Search and Rescue Alliance (SUSAR) of at least four state assets that exceed these requirements (State Urban Search and Rescue Alliance, 2007).

According to the proposed NIMS SAR resource typing recommendations, US&R task forces can be deployed in one of two configurations: Type 1 assets involve a 70-person multi-disciplinary team capable of sustained 24-hour operations and self-sufficient for the first 72 hours; Type 3 assets are a 28-person response capable of 12-hour operations and targeting SAR activities involving light frame collapse and basic rope operations. The basic difference between
the two is that the Type 1 Task Force was originally designed to conduct operations at structural collapses in post-earthquake environments and evolved into much more. The Type 3 task forces rose from the need to have a resource able to work at weather-driven events. Both of these have been deployed to a number of varied incidents with successful adaptation to the operating environment to meet mission needs.

The proposed NIMS SAR document also classifies four types of collapse SAR teams ranging from the Type 1, with capabilities including rescue of persons from collapses involving heavy floor, pre-cast concrete, or steel constructed buildings, to that of the Type 4, which essentially mobilizes personnel trained for surface rescue and non-structural entrapment in non-collapsed structures (FEMA, 2005a). Evaluation for the purposes of this document went only so far as the Type 1 model; the other three resource types were essentially the definition of single units, which would automatically be unsuitable for deployment in this arena.

The final typing analyzed was that of the swiftwater/flood rescue teams, also categorized in a range beginning at Type 1, which involved the most difficult and technically challenging rescues, to the Type 4, capable of low-risk operations that are land-based and involving basic life support operations. Likewise, the only definition evaluated was the Type 1.

To determine the current search and rescue (SAR) models that would be called for in the event of post-hurricane response, several documents were reviewed, but most likely, the requests would be based on proposed recommendations of the FEMA US&R Operations Group as was discussed at the 2006 State Urban Search and Rescue Alliance meeting in Charlotte, NC (Endrikat & Gallagher, 2006). The models that would be called for would originate either from the federal US&R system or recognized state teams participating in EMAC and would eventually come from the proposed NIMS models. Prior to that time, the only recommendations were to
deploy FEMA Type 1 and Type 3 US&R task forces, sometimes in conjunction with one another.

Endrikat and Gallagher (2006) related in an overview of proposed changes included that there were four models of response assets in the proposed NIMS SAR document that would likely be deployed to hurricane-stricken areas upon request from a federal incident support team; the two types of US&R task forces and the Type 1 or Type 2 swiftwater/flood rescue teams, depending upon the nature of the search requirements.

Historically, the determination as to what type of resource would be allocated to a stricken area has been left to the state coordinating officer, but in the aftermath of Hurricane Katrina and the total chaos involved in resource determination, both the United States Department of Homeland Security and FEMA have been directed to be more proactive, both in the way they have shifted from a “pull” philosophy to a “push” philosophy (The White House, 2006) and in the way that they have been integral in providing expert advice to the Gulf Coast to aid them in writing a viable US&R plan, much of which revolves around the pre-identification of resource needs (Endrikat & Gallagher, 2006; also C. Roberson, personal communication, August 17, 2006).

However, since prior to federalization of the event there are state and local authorities selecting resources to be deployed to affected areas, the likelihood is such that teams will be deployed through the Emergency Management Assistance Compact (EMAC). Since this will take place through existing local, regional, or state mutual aid agreements, or utilization of resources self-deployed to the event could occur, teams could be using any one of the four proposed NIMS Collapse SAR Team models, the four draft NIMS swiftwater/flood models, the FIRESCOPE models, or other configurations.
According to the South Carolina Emergency Operations Plan, Emergency Service
Function 9, US&R Standard Operating Procedure (South Carolina Emergency Management
Division, 2006), a call for in-state resources for hurricane response involves “drawing from the
fire service resources from around the state that are registered in the FFM (Firefighter
Mobilization) database”. However, the same document discusses the need to request specified
numbers of “FEMA US&R Type 1 Task Forces” for each category event as well as using the
“SC-TF1 Type 1 Task Force”, presumably using the proposed NIMS typing definitions.
Currently, there are in-state assets that could meet the proposed NIMS recommendations; SC-
TF1 has Type 1 and 3 US&R task force capabilities and the regional teams have NIMS Type 2
Collapse Rescue Team capabilities which could easily enough be reinforced to Type 1 levels.
Furthermore, there are various fire departments and rescue squads in the state that report they are
capable of operating swiftwater/flood rescue teams ranging from Type 1 to Type 3, but these
have not been verified at the date of this research.

Acute effects of hurricanes on the physical environment

The size and the multiple ways in which hurricanes affect communities cause them to be
among the most devastating of all natural events. Once hurricanes reach land, damage from high
winds, storm surge, heavy rain, and tornadoes can be anticipated. Power outages and
infrastructure damage are also common as high winds destroy power grids, storm surge lifts and
topples bridges, and water treatment plants are swamped. To best quantify the destructive
power of a hurricane, the Saffir-Simpson Hurricane Scale (2006) was developed to describe the
likely effects of a hurricane.

Where a Category 1 hurricane, with sustained winds of 74 to 95 miles per hour, does no
real damage to building structures and yet damages primarily unanchored mobile homes, a
comparatively larger Category 3 hurricane, with winds of 111 to 130 miles per hour, destroys mobile homes and causes some structural damage to small residences and utility buildings with a minor amount of curtain-wall failures. Obviously, a Category 4 or 5 hurricane is going to wreak havoc upon any communities in the path. With winds of more than 156 miles per hour, a Category 5 hurricane like Andrew will cause complete roof failure of many residences and industrial buildings, and result in some complete building failures. Flooding will cause major damage to lower floors of all structures near the shoreline.

The scale does not take into account rainfall or location, which means that a Category 2 hurricane that strikes a highly populated or vulnerable area will likely do far more damage than a Category 5 hurricane that hits a rural area.

The effect a hurricane has on the environment of a community is significant in that it increases the difficulty in finding victims. Umpierre stated in the report Hurricane Debris Modeling (2005, p.1) that “the faster cleanup occurs, the faster disaster-stricken communities can more on”. The millions of yards of debris, however, pose a daunting challenge in that before the cleanup can begin, searches must occur of the debris to identify the presence of victims. The three main types of debris defined by the report include vegetative debris, construction and demolition debris, and sediments. Vegetation includes downed trees and branches as well as marsh grass and within the category of construction and demolition debris, a sub-type was added to account for the presence of hazardous materials.

The utility of this report was that in addition to discussion about the debris classification, the report pointed out what should be a fairly obvious conclusion; that in more urban areas the construction and demolition debris would likely outweigh the presence of vegetative debris, and
likewise, in a more rural setting, vegetative debris values would likely outrank the construction and demolition debris values.

In an article in the Journal of Structural Engineering, Pinelli, Simiu, Gurley, et al (2004) discuss that debris will be different based on the strength of the storm, but the type of debris is also dependent upon construction type, as well as building codes and construction practices in the affected area. Similarly, the size of the debris is also affected by the storm strength and approach; a slow-moving rain event may cause significant flooding yet minimal vegetative debris because trees did not fall, whereas a wind-driven event may result in the presence of not only large trees, but racked and fallen structures with large structural component involvement.

A report prepared for FEMA in 1992 on Hurricane Hugo proved noteworthy in regard to structural performance. Non-engineered structures like frame dwellings received the most extensive damage from wind and water and in fully-engineered structures like high-rises and offices, “no damage was observed to main structural systems” (FEMA, 1992, p.18). Small commercial buildings, motels, and other buildings of unreinforced or lightly reinforced masonry construction suffered serious damage as well. Frame dwelling damage versus damage to engineered structures in other hurricanes and in simulation was confirmed in several other documents as well (Multidisciplinary Center for Earthquake Engineering Research, 2005; see also Levitan, Friedland & Stafford, 2006; Pinelli, et al, 2004).

The quantity and type of debris that is generated in a hurricane can be phenomenal. According to statistics compiled by the State of Louisiana after Hurricane Katrina (Louisiana Debris Statistics, 2006) there was an estimated 55 million cubic yards, or 22 million tons of debris generated by this storm. The content of this debris included nearly 60,000 damaged vessels, 1.5 million units of white goods, and more than 650,000 units of electronic goods.
Nearly 350,000 flooded and abandoned cars were part of the debris as well as more than 4 million orphan containers of unknown origin, like propane tanks, hazardous containers, and drums. Mix these items in with the structural, vegetative, and sedimentary debris and one can only imagine the effect on a community. Searching this kind of debris concentration is a nearly impossible task, but must be done.

*Effect of post-hurricane environment on community and rescuers*

Environmental impact is certainly not limited to physiological impact on the rescuers and their operations; the effect on victims and thus their own situation can influence whether or not they evacuate, or when hazards increase, whether they hide or place themselves into positions where more diligent search will be required.

Aguirre’s research (1993) on planning, warnings, evacuations, and the subsequent interrelation with search and rescue efforts argues that reactions to warnings are affected by how people define the situation in which they find themselves. The probability of evacuation appears to increase if the threat is seen as real and immediate, if the risk is personalized, and if the person has a way of responding to the threat. Where victims will be found will be related to the acute nature of the event, but also the likelihood of victims being present in a given search area is very much dependent upon a number of other factors as well. Among the factors which contribute to the possibility that victims may have remained in the area is whether or not adequate warning and sufficient lead time was given, the community’s previous experiences with disaster, the community’s perception of vulnerability, the transient nature of the neighborhood, and the average age of the population. Furthermore, Aguirre argues that the probability of evacuation increases if neighbors and significant others evacuate.
Glantz (2005) argues similarly that certain risks are apparent in communities with certain characteristics, although he presents these points as a discussion of the fallacies of natural disaster and relates them in this case to that of the Hurricane Katrina disaster. Glantz, in illustrating the problems associated with Katrina, confirms many of Aguirre’s theories, the most telling in that there was a less than realistic community perception of vulnerability; “there was uncertainty as to the exact location of landfall, and the impacts were not expected to be very threatening” (2005, p.1). Although it was not the only causative factor, that lack of fear most certainly was a cause for some of the fatalities experienced in the Gulf Coast.

The review of many of the US&R After Action Reports (SCERTF, 2005; see also CA-TF2, 2005; CA-TF3, 2005; CA-TF4, 2005) of teams operating at Katrina as well as discussion with some team leaders lent insight as to the variation in environment and also to the effects on individuals.

South Carolina was deployed to two distinctly different areas in five days over the course of their deployment. In the St. Tammany Parish, Louisiana neighborhoods located on the northern shore of Lake Ponchartrain, the debris was significantly choked with structural and vegetative matter, held together with sediment. Those neighborhoods were obviously hit with high winds, but although they were flooded as well, it appeared as if the water was fast moving and went back down in a reasonable time. The high and dense debris piles and standing water made searching a slow process.

St. Bernard Parish, however, was different in many ways. The first impressions of Chalmette as the advance team rolled into town was that of arriving in a war zone, with the occasionally homeless dog wandering the streets but otherwise void of life; hazardous materials tankers sitting at unusual angles to the roadways; oil, mud and other unimaginable chemicals
commingled to form a toxic and tenacious slop. Buildings remained upright, but were two feet deep with sediment, or in several cases, the buildings were blocks away from their foundations, obstructing the highway. In very home entered, rescuers could see the high water marks on the remaining walls, for sheet-rock had begun falling off of the studs, exposing wet insulation which sagged to the ground without support. The deceased were found in this community in attics or obviously having fallen out of the attic, but on occasion, live victims were found; one remarkable rescue performed by SC-TF1 involved a woman who had been left by her family because she could not fit through the hole chopped by rescuers in the roof. She was found dehydrated and malnourished, but alive. Teams reported that each entry after that gave them hope, but before long, it was apparent that most of the viable victims had made their escape and all that remained were the unlucky. Attitudes began to change precipitously after hours of searching, only to find more unfortunate stories.

*Past team operations within adverse settings*

In an article on FEMA US&R task forces, Rigg (1998) indicated that the models for the FEMA US&R task force drew on the California models. Subsequently, California was also the pioneer of the swiftwater/flood rescue teams, along with their associated typing; both of these models and the collapse rescue teams are all being proposed by the NIMS project as the standard. However, according to personal communications with several key US&R leaders from around the nation (J. Segerstrom, personal communication, September 2006; also N. Rooker, September 2006; M. Brown, January 15, 2007) as to origin of the California team models, it appears that the decisions were based upon anecdotal evidence. Given the success of the overall concept, using experience was a good decision, but when pressed for how each asset deployed into affected areas of Katrina met their operational needs, the overwhelming answer
was that just like every other disaster, “we flexed and made it work” (M. Brown, personal communication, 2007).

Wachtendorf and Kendra’s study Improvising Disaster Response (2006) points toward a lack of flexibility as being problematic. Just as when the water and airborne search operation was undertaken by the United States Coast Guard outside of its normal scope of work, simply staying put in the configuration the team was deployed in because that’s the way it is done certainly doesn’t serve the mission needs and doesn’t save lives.

Effective planning and improvisation can indeed work in concert with each other. Wachtendorf and Kendra continue to argue that planning is critical and cannot be put aside. Their point though is that when organizations take the time to plan, the development of the plan educates the participants in the identification of assets and vulnerabilities, as well as to encourage flexibility. What makes a guitar player a guitar virtuoso is that when a virtuoso is playing and makes a mistake, he weaves it into his performance instead of throwing up his arms and walking away. As Wachtendorf and Kendra state: “Spontaneous composition of music and performance depends upon the ability to draw upon a repertoire of training, experience, and a shared vision with fellow performers” (2006, p.3).

With that in mind, Donahue and Tuohy (2006) assert that despite our training and repeated experiences, the same problems continue to occur. This situation isn’t from one or two disasters previous, but time and time again. With the plethora of lessons learned in disaster management, the question is why are the nation’s elected and appointed officials and emergency leaders repeatedly confronting the same command and control issues?

Given eight prominent incidents occurring since 1995, in each case, the authors stated that there was a “striking consistency” (Donahue & Tuohy, 2006, p.5) in the lessons that were
identified. In an effort to gain further insight, Donahue and Tuohy convened a panel of 10 veteran emergency managers who corroborated that observation. In regard to US&R missions, it appeared that several factors influencing operations at the team level: uncoordinated leadership, communications failures, and resource constraints were those that became obvious. If the lessons learned don’t result in improved capability, then why should anecdotal evidence be relied upon to make decisions on how to organize and deploy needed resources?

Auf der Heide in The Importance of Evidence-Based Disaster Planning (2006) argues that there are issues involved in data collection and bias that cause assumptive planning when in fact, documented evidence points elsewhere. His insight as a prolific author of disaster research lends to credible defense of Donahue and Tuohy when he states that much of the nation’s disaster response problems “seem to be ‘learned’ over and over again in disaster after disaster” (Auf der Heide, 2006, p.1) and more valuable lessons can be learned from formal disaster studies. This seems to suggest that better data gathering is necessary, but furthermore, in the preparation of organization and support for US&R missions, more effort should be placed on gaining objective information based on scientific method.

Given this situation several items cause questions to be raised about the way search and rescue after disasters occurs and in the actual mission objectives for trained professional rescuers. Aguirre (1993) poses the question of what gauges the relative success of search and rescue activities in disasters, and whether we are limited to the use of trained providers for conducting searches. He contends that “volunteer and emergent group response is often massive and that the initial activity is accomplished by volunteers and emergent groups” (1993, p.16). Aside from entombed or entrapped victims, what types of rescues are actually being performed
by the emergency responders? Given the sheer numbers of searches that must be done, should we be encouraging volunteer response instead of turning it away?

Aguirre seems to suggest a little of both would be beneficial, although serious limitations to using non-credentialed, self-deployed civilians as have also been documented. Fernandez, Barbera, and van Dorp (2006) also agree, but suggest caution in the use of volunteer methods as well. Their research, defining volunteer as individuals and groups that were spontaneous or recruited, indicates that since personnel are at a premium anyway and rogue volunteers will do nothing but add to an already chaotic situation, why not channel them, give them some very rudimentary training, then utilize them in teams.

Finally, Schapelhouman’s 2006 article on tactical water-rescue teams deployed in New Orleans revealed observations on standardization of resources; his points clearly were useful in the context of defending rigid minimum organization and support, yet remaining flexible, fast and mobile. The need for resource typing is apparent; local or state emergency managers requesting resources require the ability to call for a resource and expect that the resource is exactly as advertised. Flexibility, however, is necessary to adapt to an emerging situation and to solve the associated problems.

Interview results

In an effort to learn more about particular subject matter, two interviews were conducted. Realizing that a hasty search could be compared to the door-to-door walking responsibilities of a postal carrier, a brief interview was conducted with Therese Willis, Customer Service Supervisor for the United States Postal Service (USPS) Savannah Region. Willis and City Carrier Academy Instructor Robert Covino, of the USPS South Georgia District explained that desired city postal carrier performance was not measured in deliveries per hour, which I had hoped to translate into
units searched per hour, but in the number of paces per minute, measured by a pedometer with recommended output of 120 paces per minute. One pace is the measurement of two steps and the geometric pace measures about five feet (“Geometric pace”, 2007). At that rate, 120 paces roughly translates into 600 feet per minute or 6.82 miles per hour. A quick and relatively unscientific experiment at my home revealed that utilizing that pace, an individual conducting a hasty search could easily approach a residence, knock and call out at the front door, circle the house, looking in windows as they went and calling out the entire time, stop and bang loudly on the back door, then move on to the next house, all in under one and a half minutes, and my house is in a neighborhood with a housing density of 3.14 homes per acre, my home is over 4000 square feet and has a 100 foot setback from street to front door.

The second interview was with Donna Horseman, a Planning Officer for the Town of Hilton Head Island, South Carolina. Since there was quite a difference between average housing density and applied density levels, she was able to provide an education on the approved housing density standards for the local area, not only for the purpose of finding representative survey areas, but also in regard to the coastal regions of South Carolina. Given that information, local research locations which provided decent representation were obtained.

Literature review summary

Disasters are inevitable as every community has been, or will be, affected by disaster at some point. When disaster occurs, as has been documented in the wake of Hurricane Katrina and virtually every other major emergency in the history of our nation and others, the community will naturally participate in the detection and rescue of easily found survivors of the event.

In order for disaster planning to be truly effective, the effects on the community as a whole and the communities inability to manage these events with organic assets have to be
considered and the types of resources that are brought in need to be appropriate for the mission. Failure to meet that need will result in the mismanagement of the overall emergency in that search and rescue will not be efficiently performed and resources will not be utilized where they are best needed. Identification of the correct assets is crucial for the state and federal responders to deploy the appropriate type of response asset so that people will be saved sooner rather than later.

What the fire service does to convince community leaders to be visionary; to be proactive and innovative requires emergency managers to look beyond their current body of knowledge and delve into the make-up of special teams that will be able to function in extremely austere environments. The personnel used to function at a high level of commitment and quality while faced with morbid and distressing emergencies need to be capable of working outside of their silos and fit in each part of the system but must have special gifts to bring to the table that break them out from the norm. One of the apparent solutions is to give the leaders the tools necessary to solve the problem.

The currently proposed NIMS models appear to be made on sound decisions, since the configurations have been barely changed since inception yet have been successfully used in repeated emergencies. As part of more personal communication with members of the State Urban Search and Rescue Alliance, it appears as if organizations that originally appeared to resist modifications to their own model are beginning to reevaluate the need to use an accepted definition of their resource for a number of reasons, but instead of the reason being the need to fit into a label, the decisions should be based on evidence that is objective and measurable. Since the US&R typing concept is only a little over a decade old, there are very few studies on the effect of these specific resources in publication. The good news is that organizations like the
State Urban Search and Rescue Alliance, in concert with organizations like FEMA, the National Institute of Urban Search and Rescue, and the National Association of Search and Rescue are providing at the least a network of knowledge so that collaboration can occur more readily.

The current models employed were designed for the effects of single-occupancy or close in support in a structural collapse situation, whereas the Type 3 weather driven configuration as utilized in Louisiana did not seem to be appropriate for the type of searches being utilized, nor were they adequately equipped. In report after report, there were variations on the theme of self-sufficiency which led to the belief that robust logistical support is imperative regardless of the configuration of the team. This need, however, must be weighed against the need for these teams to be “light, fast, and mobile”, as Schapelhouman (2006) reflected on in his article as a success of their effort.

The evidence simply does not bear out the efficacy of exclusively assigning Type 1 US&R task force deployments in these scenarios except as a support to lesser-equipped teams. With that being said, however, the type of equipment that they bring to bear on an emergency of this scale is essential because if it actually is needed, getting that equipment to the scene in a hurry will be problematic due to infrastructure damage and lack of personnel. Given the sheer numbers of searches that must be done, the need for speed outweighs firepower but efforts must be made to insure that a contingency force is in place. The proposed FEMA US&R standard operations procedure that evolved after Hurricane Katrina (Endrikat & Gallagher, 2006) appears to consider this very need by assigning three Type 3 US&R task forces to every one Type 1 deployed in the event of a hurricane.

US&R has to have capability for land and water transportation ability. Task forces can be large in overall numbers, but the subdivisions must be task oriented and able to move quickly.
These teams need a robust planning, communications, and logistics ability that can plug into an overall incident management system. There are certain advantages to each of the models that are compared in Table 2 and require consideration. A problem that is germane to South Carolina, however, is that any hurricane strike on a coastal location is sure to involve a heavily developed barrier island like Hilton Head Island, James Island, or Pawley’s Island. Each of these areas, especially in southern South Carolina, need to be considered as their own micropolitan area due to population size and density and infrastructure impact. The advantage, however, lies in the recency of construction and current building codes, and the proactive outlook of most of the coastal counties’ leadership in both educating and alerting residents and visitors, among other factors.

The effects of hurricanes on the community impact the US&R models, but the force of a hurricane as described by Saffir and Simpson (2006) and then quantified means nothing outside of the context of the strike location. The literature upheld the concept that the actual effects of the hurricane, as horrendous as they can be, can be at least somewhat resisted by new construction techniques and codes, resulting in a definable or predictable behavior. The structural collapses occurring after a hurricane are largely in frame and unreinforced masonry or concrete construction, not in engineered concrete or steel buildings. Due to the debris modeling, we know that the debris is likely going to be as a result of the frame buildings and modular homes breaking up. Compounded with vegetative and sedimentary debris, the rescue efforts will be influenced in that they will not need the tools necessary for operating in the traditional collapse environment, but lighter hand tools and the ability to move quickly and efficiently.
Procedures

Research methodology

The desired outcome of this research project was to evaluate existing response models and determine if they are suited for response to a hurricane-driven emergency. The research methodology used to answer the research questions was descriptive.

The research was descriptive in that comparison was performed to determine the current situation by way of assessing current models and in communication with key US&R leaders within the nation, and by observing the actions of US&R teams in real and contrived situations to determine how long it took trained rescuers to search areas of different density and occupancy type.

Process

Three steps were employed to conduct this descriptive research project. The first step was to conduct a thorough search of existing literature in regard to urban search and rescue resource typing and descriptions. Further review was also conducted of literature referencing the effect of hurricanes on communities and conditions experienced by rescuers performing their duties after these storms.

Two searches were conducted at the Learning Resource Center (LRC) of the National Fire Academy at Emmitsburg, Maryland. Other searches for data and reference material were conducted at the Fire and Rescue Department Library, Hilton Head Island South Carolina; at the Beaufort County (South Carolina) Library; the Medical University of South Carolina Learning Resource Center; and the Savannah (Georgia) Technical Institute Library. Studies and reports were obtained through the Internet, and in particular, the archives of the University of Delaware Disaster Research Center and the University of Colorado at Boulder Natural Hazards Center.
The literature, especially that of the proposed NIMS Search and Rescue Resource Typing document, was instrumental as it provided a basic descriptions of resource capabilities. Comparison was conducted of the proposed NIMS search and rescue resource models which would likely be requested in the event of hurricane impact. The types selected were based upon past experiences as an emergency manager and upon the information provided by Endrikat and Gallagher (2006) in a presentation advising on proposed changes to hurricane response and resource allocation. The types evaluated were also the ones that have been requested by agencies since Hurricane Katrina. The models not evaluated were the Type 2, 3 or 4 swiftwater/flood or collapse rescue teams, as well as the myriad others for which no documentation is available.

The comparisons include criteria which define each resource model, then listed advantages and disadvantages as a result of observation of the models being applied, as well as personal communications with key US&R leaders, and ultimately, using data gathered in the next step, that of observation of simulated missions.

The second step was to gather data by observing trained rescuers searching areas representative of different density and occupancy types as well as to compare those efforts to searches conducted at Hurricanes Katrina and Hugo, given in Table 3. The purpose of the observation was to measure the amount of time necessary for trained rescuers to cover defined areas to determine what manpower needs would be best under certain occupancy densities. The results would be utilized to determine if the staffing numbers associated with defined teams were sufficient. Given the information found in the literature review and personal observations from 25 years in disaster response, it seemed as if teams are not encountering the collapses of large engineered concrete or steel structures requiring the use of Type 1 US&R task force capabilities,
yet South Carolina’s current disaster plans continue to include the request of those assets instead of perhaps a more suitable model.

Furthermore, it appeared as if most deployed US&R teams were adapting their model to the situation, which should always be the case, but that these adaptations were happening more instead of less frequently. The parameters were developed by first researching the occupancy densities of specific areas where anecdotal evidence gave an idea of the time necessary for trained rescuers to perform a “hasty search” of a particular area, framed in the context of a hurricane impact. Similar occupancy and density areas were then identified in our jurisdiction using planning zone maps and pre-incident plans.

For each representative area, personnel were told to conduct a hasty search as defined, insuring that all sides of structures were viewed. Personnel were given letters stating the reason for their presence in the neighborhood, shown as Appendix A, but interaction with civilians was encouraged as this would be similar to that of a disaster setting, with residents asking questions about the disaster, looking for advice on available services, and other interactions. When encountering single family dwellings or outbuildings, personnel were to go to the front door area first, simulate knocking three times and announcing, “fire department”, then pausing briefly to listen for any answer. The participants were to then simulate again knocking three times and calling out and listening briefly again, before physically observing all four sides of the structure if possible, and then to move as quickly as possible to the next unit.

In the multi-family dwellings where there was a choice between elevators and stairs, the stairs were used instead of elevators and each building was physically observed by walking around the outside, then personnel went door to door and simulated knocking three times and
announcing “Fire Department”, pausing to listen, then repeat the knocking and calling out again before moving to the next unit.

The participants were members of trained US&R companies assigned to Hilton Head Island Fire and Rescue Department Special Operations and were also either members of South Carolina’s state US&R task force or the regional response team assigned to Hilton Head Island. In each case, the search team was supervised by the same person, a 24-year veteran Fire Captain with extensive US&R credentials, including multiple deployments on post-hurricane search and rescue missions.

A four-man company was selected because the collected data could also be utilized for future research in the remaining models if desired, and also because it reflects a basic truck company assignment making the research more applicable for others.

Finally, interviews were conducted of two subject matter experts, one on the United State Postal Service standards for mail carriers and the other on urban planning as it relates to housing density data interpretation.

Limitations and assumptions

The results of this research project were limited by several factors and should be noted. The literature review was limited by the existing research on the subject, much of which is actively in the development stage and in draft form, or literature that is incomplete or based on the opinions of authors rather than based on scientific findings. Evaluation of non-NIMS models were unable to be performed because their design parameters were unable to be located in any literature searches.

Further limitations of the literature review in regard to disaster community data include the lack of researchers on site in the initial stages of disasters to gain objective overview of the
situation rather than obtaining retrospective and possibly subjective information from responders, victims and bystanders after the event.

Although the observations were more to get an idea as to the adequacy of staffing of the existing models, they still endured their share of limitations. The most apparent limitation on the observation section was that the physical environment was not destroyed, as it would have been after a hurricane. Therefore, there was no flooding, no debris, no hazardous materials, the access was clear. Debris fields, as noted in the literature review, will vary in consistency and type according to the storm category, direction of impact, and the proximity to water bodies, among other characteristics. Terrain, however, was considered in the comparisons.

In addition to the experience and training of participants, the fact that the participants knew that the event was an exercise lent to certain limitations. Having been involved in the search process of actual disasters, the first-hand experience of the stressors involved that cannot be duplicated during an evaluation lend one to believe that this may have positively skewed the results. Rescuers in a real disaster would be winded and tired; often there are no facilities for breaks and the rescuers are not well-fed during those first hours of rapid searching. This all coupled with the knowledge that the job must be done correctly or people will die lends to potentially affect results. The chaos and frustration involved in communication with other teams during a disaster and the lack of relative distractions only add to the physical stressors. One example of a compounded distraction would be that as personal equipment gets waterlogged or dirty while searching, as is often the case while searching after a hurricane, while the condition physically slows team progress, it also affects team morale and concentration, causing distraction.
There was no intent to measure the ability of rescuers to perform entry searches, since the many variables in construction type, construction practices, pre-existing building conditions, hurricane force and strike location, as well as many other factors would affect the reliability of the survey regardless of the magnitude of the event. Comparison data from South Carolina’s response to Louisiana (SCERTF, 2005), however, reflects area searches where the mission actually resulted in entry searches being performed or rescues executed, thus some of the elapsed times may be slightly skewed. For the purpose of illustration and discussion, this data was left in the study.

Certain assumptions were present due to previous experience in post-hurricane search and rescue operations from the standpoint of a search team leader. The nature of the debris fields would obviously impact the amount of time involved in searching, as well as the local construction type and practices, as to the condition of the structures to be searched. Likewise, unit density, expressed in terms of units per acre, would have an impact not only on the numbers of units searched and the time involved, but would also factor the amount and type of debris expected to be present.

As an example, from personal experience while searching for victims of Hurricane Hugo in Pawley’s Island, SC in 1989, search teams were able to clear areas at a relatively rapid rate as storm surge had almost totally removed all vegetative and structural debris. Much of what remained was sediment in the form of new dunes, sometimes to the ceiling height in beachfront homes, and in the absence of cladding, where we could look directly into many of the homes with almost no effort. However, while searching in Slidell, LA after Hurricane Katrina, teams encountered almost totally obstructed conditions with profound vegetative and structural debris, standing water conditions, and total destruction of homes. Teams searching in this example area
were literally bogged down by the remaining mud and search was at some points, excruciatingly slow. For the purposes of scientific comparison, the experiments were still conducted to establish some quantitative value as to what resources would be necessary.

Terms defined

**Search**: Act of locating victims or eliminating the presence of victims using defined parameters and a systematic approach; phases of search for the purpose of technical rescue include “smart”, “hasty”, “primary”, and “secondary”, in that order.

**Search, “Smart”**: Search of a specified area where rescuers are directed to occupancies or spaces with highest index of suspicion of victims being present based on occupancy type and/or known information. Examples: hospitals, nursing homes, schools in session, addresses with pending 9-1-1 calls.

**Search, “Hasty”**: Search of a specified area given rules of engagement limiting rescuer entry into occupancies or spaces to those only having a high index of suspicion. In the case of a post-hurricane event, clues to possible occupants could be cars left in the driveway, reports from neighbors, open doors, or pending 9-1-1 calls.

**Search, “Primary”**: Search of the occupancies of a specified area permitting rescuer entry into all occupancies or spaces to either confirm the presence of victims or to cause reasonable belief that eliminates those occupancies or spaces from the possibility of victim presence. Primary searches are quick, and intended to find all possible victims of a disaster, involving all accessible parts of occupancies and requires doors and other openings to be forced if necessary to investigate that area.

**Search, “Secondary”**: Search of occupancies permitting rescuer entry and are very thorough in nature, positively confirming the absence of victims.
Results

**Comparison 1:** Folly Field Subdivision, Hilton Head Island, South Carolina

Utilizing a residential community, one four-man team searched a three-block area measuring approximately 12.33 acres. Conditions were good, as the exercise took place on a clear July afternoon with relatively low humidity, 90-degree temperature, and a 5-10 mile an hour breeze from the southeast. Personnel were having a routine day with normal station duties and physical training in the morning, a break, and afterward conducting this exercise.

Within this area were 32 occupancies resulting in a density of 2.6 units per acre. The company took 72 minutes to search this area, physically walking around most of the structures, and interacting with two civilians throughout the search. Both conversations lasted less than two minutes, during which it was determined that many residents were either at work or away, and some rental units were occupied. The result was that the team performed a hasty search of the defined area at 10.27 acres per hour at rate of 26.6 units per hour.

**Comparison 2:** Holiday Homes Subdivision, Hilton Head Island, South Carolina

Utilizing a residential community, one four-man team searched a four-block area measuring approximately 15.5 acres. The exercise took place three days later on a partly cloudy July afternoon, 92-degree temperature, and a 5 mile an hour variable breeze. Personnel again were having a routine day with normal station duties and physical training in the morning, a break, and afterward conducting this exercise.

Within this area were 56 occupancies resulting in a density of 3.6 units per acre. The company took 123 minutes to search this area, physically walking around most of the structures, and interacting with eight civilians throughout the search. The result was that the team performed a hasty search of the defined area at 7.56 acres per hour at rate of 27.3 units per hour.
Comparison 3: Inverness Neighborhood, Palmetto Dunes Resort, Hilton Head Island, South Carolina

Utilizing a residential community, one four-man team searched a two-block area measuring approximately 14 acres. This exercise was conducted on a partly cloudy September afternoon, 88-degree temperature, and a 5-10 mile an hour wind from the south. Personnel were interrupted by two routine alarms that morning, then performed their daily routine and physical training in the morning, and then their lunch break.

Within this area were 44 occupancies resulting in a density of 3.14 units per acre. The company took 132 minutes to search this area, physically walking around most of the structures, and interacting with no civilians throughout the search. The result was that the team performed a hasty search of the defined area at 6.36 acres per hour at rate of 20 units per hour.

Comparison 4: Ocean Lane Neighborhood, Palmetto Dunes Resort, Hilton Head Island, South Carolina

Utilizing three buildings of a five-story condominium, one four-man team searched approximately six acres, which was the size of the complex. This exercise was conducted on a mostly sunny September afternoon, 90-degree temperature, and a 10 mile an hour wind from the southeast. Personnel were not interrupted by alarms; they performed their daily routine and physical training in the morning, and then took their lunch break.

Within this area were 84 occupancies resulting in a density of 14 units per acre. The company took 73 minutes to search this area and interacted with four civilians throughout the search. The result was that the team performed a hasty search of the defined area at 4.95 acres per hour, but at a rate of 69.4 units per hour.
Comparison 5: Hilton Head Island Beach and Tennis Resort, Hilton Head Island, South Carolina

Utilizing one three-story condominium building, one four-man team searched approximately three acres, which was the approximate size of the area as estimated using aerial photographs. This exercise was conducted three days after the same mostly sunny September afternoon as Comparison 4, with a 90-degree temperature, and a 5-10 mile an hour wind from the southeast.

Within this area were 174 occupancies resulting in a density of 58 units per acre. The company took 176 minutes to search this area and interacted with two civilians throughout the search. The result was that the team performed a hasty search of the defined area at 1.02 acres per hour and at a rate of 59.3 units per hour.

Discussion

The purpose of the research was to compare existing US&R models that would be deployed to South Carolina in the event of a hurricane. The intent was to determine which models would be most appropriate for use in the post-hurricane environment. An experiment was conducted in which observation of personnel was conducted to measure the amount of time necessary for trained rescuers to cover defined areas. The question was whether or not current staffing recommendations for each model would be best for the post-hurricane environment under certain occupancy densities.

Given the information found in the literature review and personal observations from 25 years in disaster response, it seemed as if teams were not encountering the collapses of large engineered concrete or steel structures requiring the use of Type 1 US&R task force capabilities, which have traditionally been deployed to communities affected by hurricanes.
Furthermore, the literature review lent credence to the idea that most deployed US&R teams were adapting their model to the situation anyway, which should always be the case, but that these adaptations were happening more instead of less frequently, which led to the question as to whether or not a different model might be more advantageous.

Three basic models were considered; US&R task forces, subdivided into two types; and the Type 1 swiftwater/flood rescue teams and collapse rescue teams. The remaining subdivisions were not evaluated.

Depending upon the context of the incident and the status of the community, there are benefits and drawbacks to each model. The characteristics of each model are listed as Table 1 and the benefits and drawbacks as Table 2.

The Type 1 US&R task force is the most widely recognized US&R application due to highly-visible deployments to many disasters in the past decade. With 70 personnel covering various aspects of the search and rescue effort, responsibilities are divided into command staff, search, rescue, planning, HAZMAT, medical, and logistics teams. These teams are designed for 72 hours of self-sufficiency and 24-hour sustained operations. The advantages are that these teams are the battleships of the fleet; they bring a lot of highly trained personnel with a lot of equipment. These teams are very effective for what they were originally designed for: operating at large collapses of heavy construction, after man-made or natural events. Just like battleships, however, they are difficult to maneuver, with at least ten vehicles in their convoys, three or four of them tractor-trailers, and the transports for personnel, they take up a lot of room.

The Type 3 US&R task force was designed to address weather-driven events. Staffing approximately 28 personnel, they draw on cross-functional personnel, and bring two large squads to search missions. This model also carries divisions of labor for command staff and logistics,
but the search, rescue, HAZMAT, planning and medical responsibilities are mostly handled at
the squad level. These teams are also designed for 72 hours of self-sufficiency and sustained
operations, but don’t carry the equipment of the Type 1 task force, opting to use equipment more
suited for working in frame collapses, of which the hurricane does a good job of delivering. The
advantages are that these teams have proven very effective in operating in these types of
environments; their personnel packages are made up of the same personnel from the Type 1
assets and thus normally enjoy a high level of expertise. There were some remarkable
disadvantages, however, associated with the ability to sustain operations. In most cases of Type
3 assets working in Hurricane Katrina, because these models are designed for fast movement into
affected areas, issues were found with the equipment packages, supply and support, and
transportation issues. One frustrated comment expressed from a SC-TF1 manager was, “I don’t
care what anyone says, the next time we go somewhere as a Type 3 team, we need to bring the
Type 1 cache” (J. Walters, personal communication, September 10, 2005).

The other glaring disadvantage of the Type 3 assets is the lack of water capabilities.
They weren’t designed for water rescue so that shouldn’t come as a surprise. The arena in which
they are likely to operate in, however, dictates that at least some water transportation needs to be
attached to the cache. The model primarily employed in New Orleans, the Type 1
swiftwater/flood rescue (SWR) team, on the other hand, was very much suited for that
environment.

The Type 1 SWR model utilizes 14 personnel, two managers and two squad leaders
supervising a five-rescuer squad each. These teams are designed as fast movers; a minimum
amount of personnel, equipped for the intended mission, with a small convoy to transport them.
Ideal for search of totally flooded areas, SWR teams were used also for reconnaissance, and
being at platoon size, supporting these teams required a minimum of space and materials. One of the biggest complaints heard about these teams were simply that there weren’t enough of them to go around. There are drawbacks though keeping this model from being declared the most effective for the post-hurricane environment; because of their size and their ability to move, they have to travel light. Type 1 SWR teams require logistical support so deploying one exclusive of any is asking for failure and in the event that sustained flooding is only sporadic, as is the case in most coastal hurricane areas because there just isn’t any way for the water to remain built up, the teams are tied to their boats.

A drawback associated with the swiftwater/flood models is that these teams carry only minimal hazardous materials decontamination abilities and the water they will be operating in is most assuredly contaminated. Since a Type 2 SWR model is essentially no more than one Type 1 squad minus some other equipment, drawbacks abound to utilizing these assets outside of a larger command and support group, thus the reason for not evaluating them further in this study.

The Type 1 collapse rescue team (CRT) model is a lot like the Type 1 SWR model, and equipped for much of what will be seen after a hurricane in regard to rescue in associated debris, but not with all of the overhead support of a task force. In fact, these teams seem more like the squads of a Type I task force but more mobile, like the SWR is. This model has similar drawbacks to the SWR with the need for logistical support, but married to a larger asset, or paired with several other different models to create a reinforced response asset, the Type 1 CRT appears to have many of the redeeming qualities necessary for response into a disaster community. Likewise, the other three models in this category were not pursued further.

As discussed by Endrikat and Gallagher (2006), FEMA’s US&R working groups realize that improvement can be made, but it sounds like they are locked into the current models. The
whole idea of marrying several Type 3 US&R task forces to a Type 1 US&R task force is an idea that has a great deal of merit. Taking that idea one step farther, however, would be to utilize the Type 1 SWR models in conjunction with Type 1 CRT models to create reinforced assets that could be sent into a community and insure proper coverage of all rescue needs. Regardless of what assets are actually used, most rescue personnel realize that flexibility is of the essence in the rescue industry and so it also goes in the management of rescue teams.

As discussed, other subsets of each of the SAR resource types, the Type 2, 3 and 4 assets of CRTs and SWRs exist, but these are basically local response assets that should be employed to perform light duty rescue and hasty searches. These models were not evaluated as they would not likely be utilized in the post-hurricane environment as an independent resource, but be grouped with other resources as parts of strike teams or task forces. However, if utilized in strike teams along with appropriate support, these could be valuable to the search mission and a plan for utilizing these assets in that method would be strongly recommended.

The measurements conducted in the observation confirmed what should be obvious, but was not measured previously; that teams operating in an environment with hazards take longer to cover area and occupancies. However, the data for conducting these hasty searches indicated that one four-man company could be expected to search an average of 5.5 acres per hour regardless of the amount of destruction and the density of occupancies. This could be translated into 18 units of single-family dwellings searched per company per hour, after taking the multi-family searches out of the equation.

One company can do a significant amount of hasty searches, but since the initial hours after the impact are crucial, and since there just aren’t the numbers of teams available to cover all the areas, use of volunteers may be indicated. Some of the indications, given the literature,
would recommend the development of supervisors who could interact with unsolicited and uncredentialed volunteers to manage them and utilize that response.

The data indicates, however, that the personnel numbers assigned to these four assets appear sufficient for each of their mission types, except that significant flexibility must be considered to utilize them in the most advantageous manner.

If people would evacuate when instructed, searching their neighborhoods after a disaster wouldn’t be necessary. We all know that so long as residents cannot be dragged kicking and screaming from their homes, we will need to search those homes after a hurricane strike to determine victim presence or confirm absence. Pressure must be tactfully maintained on elected and appointed community leaders to insure that in addition to preparation, vulnerable communities should support a response asset as well. When making presentations in that regard, I say to people that we aren’t necessarily building a US&R team to respond to a South Carolina disaster so much as we are building a resource to help our neighbors in the hope that they are willing to do the same for us. The concept of educating and lobbying for financial and moral support from the community and representative government is repulsive to some. With many, it seems, the disaster has to be fresh in their minds before they are willing to consider any proposals for increasing capability or improving response. As emergency service leaders, we need to make sure plans are in place in advance so that when an event occurs, we can educate the unenlightened and strike while the iron is hot. An informed and visionary government wouldn’t have to do that, but unfortunately, not everyone can enjoy that kind of leadership in their community.

Of 450 fire departments in South Carolina, 26 are fully-paid and 148 are combination organizations (South Carolina State Firefighters Association, 2005). Personnel numbers range
from 10 to 453 for volunteer organizations, 11 to 500 for combination departments, and 11 to 247 for career departments. If half of the fully-paid departments and one-quarter of the combination organizations agreed to field one Type 4 asset, the State of South Carolina could provide 50 companies that could be easily utilized in a massive search and rescue effort. Of course, an effort like this would require some basic training, an agreement to provide certain equipment, and the equivalent of one four-man company using hand tools, knowing that if their own communities were in similar situations, help would be on the way.

Since these departments are mostly small, have limited manpower, and even more limited budgets there seems to be a rational expectation that cooperation on a broader scale would supersede any existing political conflicts. Further inability to obtain cooperation from local and regional emergency managers complicates the ability to plan and hampers the effective delivery of the right assets to the right crisis.

Recommendations

Success in disaster management is directly related to risk identification, which leads to analysis and preparation. Based upon the research, the following recommendations are made:

1. The SCERTF should work with the State Emergency Management Division to recommend adoption of the National Incident Management System definitions for resource typing and include that terminology in the State Emergency Operations Plan.

2. The SCERTF should identify personnel available to meet with communities interested in developing company sized assets and forming response capability that could be used in the scope of a larger disaster.
3. The SCERTF should work with other state disaster agencies to determine the presence of existing assets and educate the state’s fire service leaders in how to access those assets through the State Emergency Operations Plan.

4. The SCERTF should continue to be active in the standard development process through participation in industry working groups and committees, working to use objective evidence to develop these standards.

5. The SCERTF should begin to insure measurement of capabilities to ultimately insist on credentialing for responding assets and to make plans for using non-requested assets that can maximize that eventuality.

6. The SCERTF should encourage fire chiefs to interact with the State Emergency Management Division to understand the State’s needs, so that the State may understand theirs.

The Department of Homeland Security and FEMA have already laid much of the groundwork through the development and proposal of the National Incident Management System Search and Rescue Resource Typing to push responders and managers toward speaking a common language. When you are hungry for an apple and ask for an apple, you want an apple, not a watermelon. When emergency managers request a “Type 3 urban search and rescue task force”, they want a 28-person team with special capabilities, not ten firefighters and a stake-bed truck. The definitions are essential to the proper requesting of resources and obviously, in the proper application of those resources as they are made available.

The State of South Carolina and the South Carolina Emergency Response Task Force encourage all fire departments to take advantage of opportunities for educating personnel as to what the capabilities are for these resources. Knowing what to ask for, and when to ask for it, is
as much of a part of incident management as dealing with the emergency itself. Insuring that the resource definitions we use are based upon meaningful and objective evidence is also much of the solution because if our decisions are based upon supposition, there is no telling what surprise could await us at the next turn in the road.
References


_Urban search and rescue operational system description._ Riverside, CA: Author.


_Swiftwater/flood search and rescue: recommended training, skills, and equipment list._ Riverside, CA: Author.


National Fire Academy. (2004). *Executive fire officer program applied research self-study course* [student study guide]. Emmitsburg, MD: Author

National Fire Academy. (2003). *Executive fire officer program operational policies and procedures, applied research guidelines, 2nd edition* [student manual]. Emmitsburg, MD: Author


Your Fire Department is conducting important research on the ability to search neighborhoods for victims in the event of a disaster. This research will be used to improve service and aid in delivering more effective response to emergencies.

If you have any questions regarding this project, please contact Hilton Head Island Fire and Rescue Headquarters at 843-682-5100 for more information.
Appendix B

Table 1

*Comparison between NIMS SAR resource types as related to post-hurricane response*

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>NIMS SAR resource types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type 1 US&amp;R Task Force</td>
</tr>
<tr>
<td>Basic mission</td>
<td>Large structural collapse</td>
</tr>
<tr>
<td>Number of personnel</td>
<td>70</td>
</tr>
<tr>
<td>Sustained operations</td>
<td>24 hour operations, self-sufficient for 72 hours</td>
</tr>
<tr>
<td>Organization</td>
<td>Multi-disciplinary; Command, Search, Rescue, Medical, HAZMAT, Logistics, Planning</td>
</tr>
<tr>
<td>Search company size and configuration</td>
<td>(4) 6-man squads of rescue discipline, (2) 3-man squads of search discipline</td>
</tr>
<tr>
<td>Logistical support</td>
<td>Robust support, extended operations</td>
</tr>
</tbody>
</table>
Table 2

Advantages/disadvantages of NIMS SAR resource types as related to post-hurricane response

<table>
<thead>
<tr>
<th>Comparison item</th>
<th>NIMS SAR resource types</th>
<th>Type 1 US&amp;R Task Force</th>
<th>Type 3 US&amp;R Task Force</th>
<th>Type 1 Collapse Rescue Team*</th>
<th>Type 1 Swiftwater Flood Rescue Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic mission capability</td>
<td></td>
<td>Advantage; also able to manage additional units assigned because of robust staffing</td>
<td>Advantage; designed for this type of operation, carries multi-discipline staff</td>
<td>Designed as initial intervention to localized event; not supported by communications, medical, HAZMAT, logistics; would require support</td>
<td>Water or flood rescue advantage; however, not supported and would require logistical support</td>
</tr>
<tr>
<td>Number of personnel</td>
<td></td>
<td>70; needs lots of space for base, large convoy, large logistical requirements</td>
<td>28; can fit into many areas, convoy smaller, logistical requirements limited</td>
<td>13-14; very mobile, easy to insert into existing teams or groups to support operations</td>
<td>14; very mobile, easy to insert into existing teams or groups to support operations</td>
</tr>
<tr>
<td>Sustained operations</td>
<td></td>
<td>24 hour operations, self-sufficient for 72 hours; designed for extended unsupported mission</td>
<td>12 hour operations, self-sufficient for 72 hours; limited unsupported mission capability</td>
<td>18-24 hour operations; must have support for extended operations</td>
<td>24-hour operations; must have support for extended operations</td>
</tr>
<tr>
<td>Land coverage</td>
<td></td>
<td>Advantage; could cover large areas with mass of personnel in blitz mode</td>
<td>Advantage; designed for moving in weather driven emergencies</td>
<td>Could cover areas as part of a strike team or task force</td>
<td>Not designed for this; could be detached from boats and assigned as part of strike team or task force</td>
</tr>
<tr>
<td>Water coverage</td>
<td></td>
<td>Would require additional equipment not part of standard cache</td>
<td>Would require additional equipment not part of standard cache</td>
<td>Would require additional equipment not part of standard cache</td>
<td>Advantage; designed for this type of operation</td>
</tr>
</tbody>
</table>
Table 3

*Results of simulated and actual area searches*

<table>
<thead>
<tr>
<th>Location</th>
<th>Condition &amp; description</th>
<th>Density units/acre</th>
<th>Acres per company per hour</th>
<th>Efficiency Mins/unit</th>
<th>Area Total acres</th>
<th>Units per company per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Folly Field (simulated)</td>
<td>No hazards Single family</td>
<td>2.60</td>
<td>10.27</td>
<td>2.25</td>
<td>12.33</td>
<td>32.00</td>
</tr>
<tr>
<td>Holiday Homes (simulated)</td>
<td>No hazards Single family</td>
<td>3.60</td>
<td>7.56</td>
<td>2.20</td>
<td>15.50</td>
<td>27.30</td>
</tr>
<tr>
<td>Inverness (simulated)</td>
<td>No hazards Single family</td>
<td>3.14</td>
<td>6.36</td>
<td>3.00</td>
<td>14.00</td>
<td>20.00</td>
</tr>
<tr>
<td>Ocean Lane (simulated)</td>
<td>No hazards Multi-family</td>
<td>14.00</td>
<td>4.95</td>
<td>0.87</td>
<td>6.00</td>
<td>69.42</td>
</tr>
<tr>
<td>Beach and Tennis (simulated)</td>
<td>No hazards Multi-family</td>
<td>58.00</td>
<td>1.02</td>
<td>1.01</td>
<td>3.00</td>
<td>59.30</td>
</tr>
<tr>
<td>Avery Acres (actual; Katrina)</td>
<td>Destroyed Semi-rural mix</td>
<td>0.77</td>
<td>4.25</td>
<td>9.10</td>
<td>34.25</td>
<td>3.30</td>
</tr>
<tr>
<td>Lakeview Drive (actual; Katrina)</td>
<td>Destroyed Single family</td>
<td>1.57</td>
<td>6.68</td>
<td>5.71</td>
<td>26.72</td>
<td>10.50</td>
</tr>
<tr>
<td>Chalmette Vista (actual; Katrina)</td>
<td>Destroyed Urban mix</td>
<td>4.95</td>
<td>3.00</td>
<td>3.63</td>
<td>50.00</td>
<td>16.50</td>
</tr>
<tr>
<td>Debordieu (actual; Hugo)</td>
<td>Destroyed Single family</td>
<td>3.10</td>
<td>21.9</td>
<td>1.13</td>
<td>13.30</td>
<td>32.89</td>
</tr>
</tbody>
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