

## CHAPTER IV

### DISCUSSION

As aforementioned, quantitative study results using bivariate correlations provided support for eight of the nine posited hypotheses. Comparison of these results with qualitative data provided additional insight regarding *why* these hypotheses were supported. Additional analysis using multiple regression provided a more complete test of the entire diffusion model.

#### Hypotheses One and Two

As scores within the HPWREN Relative Advantage Index (T1) and HPWREN Compatibility Index (T1) increase, positive diffusion communication channels (T2) increase. Specifically, the bivariate correlation coefficient between relative advantage and positive diffusion communication channels was  $+0.56$ , indicating a strong positive linear relationship in the sample of 37 respondents. Meanwhile, the bivariate correlation between compatibility and positive diffusion communication channels was  $+0.52$ , also indicating a strong positive linear relationship in the sample. The relationships are statistically significant according to the 99 percent decision rule.

Perhaps these relationships can best be explained by the following qualitative data collected during T1 interviews with respondents:

“Basically, we have a couple of people with dip nets that examine fish spawn. What we do is hike up the stream, take multiple samples, and count the number of fish - determining species and other things. We then type our field notes directly into a PDA and we actually hope to implement field records into an Internet database soon. Yes, real-time digital field notes would be terrific. I admire SDSU for pursuing this, as I find it entirely appropriate.”

-Fish ecologist

“Jumping spiders sit on patches of bare ground...I currently correlate what they are doing with abiotic measures such as cloud cover, temperature, and so on. My collection takes place a couple of times per week in the spring and I don't see why

I wouldn't use the network for my work. Measures such as solar radiance at micro-sites would be especially useful.”

-Evolutionary biologist

An additional response from a T2 interview specifically addresses positive diffusion communication channels and clearly illustrates support for H1 and H2.

“I've been talking with faculty around the country about using real-time data in their classrooms and feedback has been very positive.”

-Biology professor

### **Hypothesis Three**

As scores within the HPWREN Complexity Index (T1) increase, positive diffusion communication channels (T2) decrease. That is, the bivariate correlation coefficient between complexity and positive diffusion communication channels was -.44, indicating a moderately strong positive linear relationship in the sample of 37 respondents. Nearly one-fifth of diffusion communication is related to perceived complexity at T1 ( $r^2=.19$ ). The relationship is statistically significant according to the 99 percent decision rule.

Perhaps these relationships can best be explained by the following qualitative data collected during T1 interviews with respondents:

“Monitoring via sensors and equipment takes maintenance, which can be difficult to implement without causing disturbance...I did hear that this network was in the plan for the reserve, but don't know anything about it.”

-Golden eagle researcher

“The challenge that I see is the collection of metadata...it is important to have qualitative data along with quantitative measures. We really need metadata, an explanation of what the numbers mean - not just the numbers.”

-Botanist

“The automated collection of biological data is very hard...Broadband is wonderful to have there, but the biggest question is how do we automate biological sensing? Field biological collection tools are not yet to the point to fully utilize this type of technology. I just haven't really heard much about the technical aspects of this network, so I can't really say that much right now.”

-Mammologist

“The USGS has streamflow data available online and it is organized really well with a good interface. It is simple, easy to use...Organization of data can impact the usefulness of the data...Ease of access will control the usage of this data, too.”

-Watershed researcher

Additional qualitative information, such as the following comment, was divulged during T2 interviews with respondents:

“A presentation, even if it was just a group presentation, or some training on how we can use this network would be great. I just haven’t heard enough about it to really understand it.”

-Watershed researcher

#### **Hypothesis Four**

As positive diffusion communication channels (T2) decrease, the degree of perceived complexity (T2) decreases. Again, the bivariate correlation coefficient between positive diffusion communication channels and complexity indicated a negative relationship. The bivariate correlation coefficient was  $-.52$ , indicating a strong negative linear relationship in the sample of 37 respondents. More than one-fourth of continued perceived complexity at T2 ( $r^2=.27$ ) is related to diffusion communication. The relationship is statistically significant according to the 99 percent decision rule.

“It would be nice to keep everyone up to date about the network - to keep all in touch with available data...Keep in touch with the Supercomputer Center and see how we can best incorporate multiple databases, because that is what they do there and would help us know more about the network.”

-Biology professor

#### **Hypotheses Five and Six**

As positive diffusion communication channels (T2) increase, the degree of perceived relative advantage (T2) and compatibility (T2) increases. Specifically, the bivariate correlation coefficient between positive diffusion communication channels and continued relative advantage was  $+.57$ , indicating a strong positive linear relationship in the sample of 37 respondents. Meanwhile, the bivariate correlation between positive diffusion communication channels and continued compatibility was  $+.48$ , also indicating a strong positive linear relationship in the sample. Both relationships are statistically significant according to the 99 percent decision rule.

These relationships can best be explained by the following qualitative data collected during T2 interviews with respondents:

“I just received your packet of information about the network and am now taking a class out to SMER...I hope to show them some of this technology out in the field.”

-Biology professor

“The network has just been explained to me by SMER staff and I would love to use this sometime in the future. Before when you talked to me, I just didn’t know enough about it, but now I may try to work out some research project around the technology in the future.”

-Mammologist

These hypotheses also indicate that respondents who have negative, or simply a lack of, diffusion communication channels will not have a positive perception regarding relative advantage and compatibility. Instead, these respondents are likely to have a negative or no opinion about the network’s relative advantage and compatibility with their work. Qualitative examples that illustrate this concept include the following data collected during T2 interviews:

“I am still not sure about HPWREN, but that is probably because I have not heard about it as I am somewhat disjunct from the school as an adjunct faculty member.”

-Adjunct biology professor

### **Hypotheses Seven and Eight**

Subjects who score high within the HPWREN Relative Advantage Index (T2) and HPWREN Compatibility Index (T2) are more likely to use the network connectivity (T3) than those who score low. That is, the bivariate correlation coefficient between positive diffusion communication channels and continued complexity was  $-.52$ , indicating a moderately strong positive linear relationship in the sample of 37 respondents. The relationship is statistically significant according to the 99 percent decision rule.

The following qualitative data collected during T2 interviews best explain these relationships.

“I will soon be recording sounds from owls, as there may be a correlation between moon phase and weather. Real-time weather data streamed via this network and correlated with owl data and moon phase data will allow me to measure the spacing between calls and see if there are relationships between the sounds, weather, and moon phases... Yes, I will use this network.”

-Biologist

“We now have our moss research at the James Reserve online and it’s great... We want to set up more of these real-time stations... We need more experiments to gauge results... Yes, we will use HPWREN at SMER.”

-Fungus and moss researcher

“This is a fantastic program and I’m anxious to see how this changes both research and teaching in profound ways. I’d also be interested in seeing the use of SGI Visual Area Networks with HPWREN, as I am already using both networks.”

-Geology professor

Likewise, respondents who score lower within the relative advantage and compatibility indices are less likely to adopt the technological innovation. Further qualitative results, such as the following comments from respondents during T2 interviews, support this hypothesis.

“The data related to my research hasn’t yet been collected and put onto the network... Until this monitoring is set up, I can’t really use the network.”

-Hydrology researcher

“My biggest concern is not the technology, but HPWREN is just not going to really aid me with my data collection. This would require radio collars on the animals, which to my knowledge is not easily available at this time. Although there are passive integrative transponders that allow for the animal to be injected with a tag under the skin and then records their actions as they move through underground hoop antennas, this technique requires hoop antennas everywhere - which causes a trampling issue. There are also radio transmitters that you can put in an animal... this is used largely in quail research... the animal transmits a signal to a nearby radio tower. However, this technique is rarely used due to challenges like automatic triangulation. If auto-triangulation was in place at SMER, we could use this, but until then, it is just not feasible for my particular research agenda.”

-Mammologist

### **Hypothesis Nine**

Subjects who score high within the HPWREN Complexity Index (T2) are less likely to use the network connectivity (T3) than those who score low. The bivariate correlation coefficient was  $-.31$ , indicating a moderate negative linear relationship in the sample of 37 respondents. However, the relationship is not statistically significant according to the 95 percent decision rule. The findings indicate that even when a potential adopter does not fully understand the innovation at hand, he or she may still consider adoption. Further, qualitative remarks by participants during T2 further explained the lack of support for the hypothesis.

“It is assumed that most have a background knowledge that they usually don’t really have. My current research probably won’t use the network, but it may be useful for future research. To take advantage, we will have to modify our research techniques - but, maybe it will allow us to find answers to questions that we currently cannot answer.”

-Biologist that examines Eucalyptus tree pests

“I wouldn’t even know how to turn on a computer...I would have to be spoonfed...But, I wouldn’t know of any disadvantages...Any information you can get like this is valuable for the classroom...I don’t know the costs, but it seems worthwhile.”

-Retired biologist that surveys golden eagles at SMER

Because simplicity typically attracts more users to a technological innovation than complexity (Rogers, 1995), this finding was somewhat surprising. However, it should be noted that the current sample consists of highly educated field scientists who are possibly less intimidated by “high-tech” innovations than less educated adopters. Further, multiple regression results contradicted the bivariate correlations and showed that perceived complexity (T1) has an impact upon both diffusion communication (T2) and adoption (T3); see Figure 11 for details.

### Summary

Simultaneous regression analysis of diffusion communication with relative advantage, compatibility, and complexity as predictors resulted in significance for both relative advantage ( $r=.55$ ,  $p=.02$ ,  $r^2=.30$ ) and complexity ( $r=.36$ ,  $p=.029$ ,  $r^2=.13$ ). That is, diffusion communication (T2) is significantly effected by perceived relative advantage (T1) and perceived complexity (T1); however, multiple regression results indicated that perceived compatibility is not a significant predictor of diffusion communication.

On the other hand, simultaneous regression analysis of all variables, with adoption acting as the dependent variable, showed that perceived compatibility ( $r=.45$ ,  $p=.04$ ,  $r^2=.20$ ), perceived complexity ( $r=.37$ ,  $p=.04$ ,  $r^2=.14$ ), and diffusion communication ( $r=.33$ ,  $p=.04$ ,  $r^2=.11$ ) all have a significant impact upon HPWREN adoption.

Perhaps the most important lesson learned during this study was the vital role played by communication during the innovation development, implementation, and use stages. The

interview process alone allowed many SMER field researchers to consider an innovation (HPWREN) that they might have otherwise never heard about. Further, the thesis showed that even though some respondents are not technologically savvy, they are willing to adopt technological innovations - provided perceived attributes are favorable.

Although a few respondents already use PDAs, the majority of respondents use a manual field notebook for recording data collection findings. They then transfer the information to their office or laboratory computer. However, qualitative data, such as the following, indicates consideration of new electronic field devices:

“It depends on where I am going, as most of the time it is easier to carry a notebook than a computer in remote areas. I am thinking about getting a PDA though.”

-Hydrologist

Again, this type of insight shows that if the innovation proves to be compatible with their current data collection procedures, the field researcher is likely to utilize it - as long as they receive information about it via their communication channels.

### **Limitations of the Study**

Even though this thesis project proved to be quite successful, limitations were trifold: (a) only one reserve was examined, (b) only one innovation was studied, and (c) the sample was relatively small.

In order to compare the results of the Santa Margarita Ecological Reserve study participants with another sample, broadband connectivity must first be established at an additional reserve. This would allow for further analysis of the hypotheses. Consequently, HPWREN researchers are currently planning to connect the SDSU Sky Oaks Field Station to the network; this will provide an optimal comparative sample set.

The current study's limitation of only one innovation was also somewhat problematic. When only generalizing to the adoption of HPWREN, the diffusion of innovations theoretical framework works perfectly and results are impressive; however, if generalizing to overall innovation diffusion, this study is somewhat problematic as only one innovation was

examined—rather than multiple innovations. Therefore, because the research examines only one innovation, HPWREN, the results cannot be generalized to all technological innovations (e.g., dataloggers and PDAs) related to field science. Perhaps another study that examines the attitudes, communication, and adoptions of dataloggers and PDAs among field scientists would also prove useful for the NSF and additional entities.

Finally, the sample size was also somewhat limiting for the study. Although the sample consisted of nearly all (37 of 40) field scientists affiliated with the Santa Margarita Ecological Reserve, this small number of participants is somewhat problematic. Again, an additional study that examines Sky Oaks scientists would help address the issue.

### **Further Research**

This thesis not only quantitatively describes the attitudes of the field researchers toward broadband connectivity, but also outlines a model for a longitudinal future study. From the analytical research standpoint, the described objectives are important, as additional ecological reserves may be added to the NSF-funded HPWREN and diffusion of this technology is better understood by determining the perceived attributes and utility of broadband connectivity among ecological field researchers—as oftentimes these perceptions are discussed in qualitative manners, but never truly quantified. Additionally, this study provides a propositional model that may be used for future longitudinal studies involving the diffusion of technological innovations among particular social systems.

Perhaps even more important, the study has the potential for providing quantitative information to an array of publics regarding the impact of broadband connectivity on ecological research. These findings further allow policymakers, such as those charged with NSF proposals like NEON, to better understand how such environmental monitoring projects might positively impact the future of ecological monitoring and the overall environmental research agenda in the United States.

Because our society often relates environmental protection with technological innovations (Miller & Garnsey, 2000), it is important that scholars continue to research the

diffusion process and publish their findings in applicable journals so that the information is widely disseminated. Further, diffusion studies that better explain the benefits to the environment via particular technological innovations should be a focus of mass media channels so that the general public is also aware of important environmental issues and how their attitudes and behaviors impact the environment.

Additionally, NEON researchers may be able to learn from the Dutch science shops, which have existed for more than 30 years, and better match the agenda of environmental research with that of the greater community by providing not only information about the issues and concerns at hand, but immediate ways that individuals can participate in science and environmental protection initiatives.

Further, initiatives like LTER and NEON also allow societal members other than those with the most education and financial resources to access information that is typically reserved for citizens that are the best-educated and most wealthy (Miller & Garnsey, 2000). That is, once NEON sites are in place, common citizens can virtually tour ecological observatories around the country, ranging from the mountaintops of Colorado's front range to the swamplands of the Mississippi delta. NEON will not only be a resource that allows scientists to better communicate with one another and thereby promote interdisciplinary collaborations, but the network has the potential of serving as a national treasure to be shared by every citizen.