

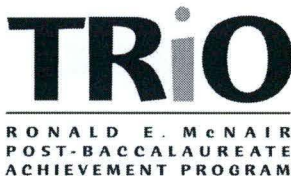


MCNAIR RESEARCH JOURNAL
UNIVERSITY OF OREGON
2013

University of Oregon McNair Scholars Program Research Journal

The Ronald E. McNair Post-Baccalaureate Achievement Program prepares low-income, first-generation college students and students from underrepresented groups to pursue graduate study that culminates in PhD degrees. At the encouragement of the McNair Foundation, Congress named the Program to honor the legacy of Ronald McNair, an African American NASA astronaut and physicist who died aboard the space shuttle Challenger in 1986. Each year the UO supports approximately twenty-eight qualifying undergraduate McNair Scholars who show potential and commitment to complete doctoral-level work.

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**University of Oregon
McNair Scholars Program
Research Journal**

2013

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**Abstracts by McNair Scholars
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Spindle Orientation in MDCK Cells

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Biology, Philosophy

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Graduate Student Mentor: Michelle Lu
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During development, cells organize into complicated structures such as organs and other tissues. Cellular organization requires precisely oriented divisions so that tissues grow into particular shapes. For example, Madin-Darby Canine Kidney (MDCK) cells are epithelial cells that use protein polarity coupled with mitotic spindle orientation to expand outward in a flat sheet. When grown on gel-like media, normal MDCK cells use the same process to form cysts with a single lumen at the center. If mitotic spindle positioning is disrupted, MDCK cells grow in random directions and form cysts with multiple lumens. My research characterizes one protein responsible for positioning the mitotic spindle and focuses on the mechanism during mitosis of 14-3-3 zeta, an adaptor protein that links together Dynein and KIF13B, two opposing motor proteins. Results show that 14-3-3 zeta aids in anchoring microtubules during cell division for the precise placement of daughter cells. These results were confirmed by analyzing cystogenesis in a MDCK 14-3-3 zeta RNAi system.

Parenting in Poverty: The Experiences of Fathers Who are Homeless

Brenda C. Barrett-Rivera

Family and Human Services

Faculty Mentor: Lauren Lindstrom

Counseling Psychology and Human Services

Fathers who are homeless face unique barriers in parenting. This qualitative study used semi-structured interviews to explore the experiences of fathers who are homeless in a Pacific Northwest city. Data were collected through in-depth interviews with four homeless fathers and staff members from a family shelter. Themes raised through the interviews included: (a) changes to the fathers' relationships with children and others; (b) stress related to a lack of resources available to homeless fathers; and (c) the impact on the experience of parenting while homeless arising from external perceptions of fathers as primary caregivers and providers. By giving voice to this underrepresented segment of the population, this study provides information that may improve the delivery of services to homeless families.

Leafcutter Ants Cut Six Times More Inside the Nest than Outside

Ryan Garrett

Biology

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Physics

Leafcutter ants collect leaf disks, carry them into underground chambers, then process and inoculate them with a fungus (Leucocoprineae) that serves as a key source of food for the colony. When processing leaf disks, ants use mandibular teeth to slice the disks into small fragments. The quantity of cutting that occurs during leaf processing has not been calculated or compared with cutting during foraging. This study estimates this ratio and provides video documentation of leaf disks being processed into fungus. Field samples of *Atta cephalotes* and *Atta colombica* were collected in Minca, Colombia, and Tiputini, Ecuador, respectively. Collections include whole leaf disks and leaf fragments that serve as the medium in fungal gardens. Measurements of leaf disk perimeters and surface areas were compared to corresponding leaf fragment dimensions. The resulting ratios indicate that roughly 6 times more cutting takes place during subterranean leaf processing than above ground foraging. This ratio may be used to calculate the net energy gained from a given mass of fresh leaves, and where the tipping point in profitability lies. The results of this study deepen our understanding of the leafcutters' behavioral ecology, as well as their limitations with regard to energy acquisition.

Mixed-Status Families: Legal Status and Access to Social Capital, Employment, Housing, and Education

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Planning, Public Policy and Management, Spanish

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Planning, Public Policy and Management

As of July 2011, fifty-two million people in the United States (or 16.7%) were Latino/a, making them the largest ethnic minority in the country. By 2050, the Latino/a population is expected to reach 30% of the total population. Also, the number of mixed-status Latino/a families has expanded rapidly in recent years. Latinos/as constitute about three-quarters of the nation's unauthorized immigrant population, but approximately three-quarters of the children in those families are U.S. citizens by birth. The shifting Latino/a demographic in the United States has major implications for a variety of areas, including politics, economics, and education. This study focuses on mixed-status families and compares the differences in access to social capital, employment, housing, and education because of legal status. By conducting informational interviews and analyzing quantitative data, this study: 1) expands the understanding of the complexities of the Latino/a community, specifically mixed citizenship families; 2) provides the costs and benefits of being authorized or unauthorized within a mixed status family; and 3) explores implications for mixed-status families within the United States.

Synthesis and Controlled Oxidation of Tungsten Oxide Nanostructures via Thermal Vapor Transport

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Chemistry, Materials Science Institute

Graduate Student Mentor: Jonathan Marshall

Chemistry

Ambipolar host materials have been shown to increase efficiency and stability in organic light emitting diodes (OLEDs) by balancing negative and positive (electron and hole) charge transport. These materials are key components in long-lived blue OLEDs, the development of which remains the key obstacle to creating organic solid-state white lighting. We present the synthesis and photophysical characterization of a series of 1,2-azaborine-containing potential ambipolar hosts. We also demonstrate how the inherent asymmetry of the 1,2-azaborine core can create chemical diversity within structurally identical molecules. Additionally, we discuss theoretical calculations demonstrating the electronic charge distribution and relative HOMO/LUMO energies of these molecules.

Gender Differences in Family Environment in the US, 1850-2010

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Economics

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Economics

Yamaguchi, in his paper, “A Formal Theory for Male-Preferring Stopping Rules of Childbearing: Sex Difference in Birth Order and in the Number of Siblings” (1989), shows that male-preferring stopping rules result in girls having more siblings. This paper examines whether certain characteristics other than size and the male-preferring stopping rule differ between families with girls and families with boys. Although scholars have not yet examined how these differences have changed over time, data from the US Census and American Community Surveys, collected from the Integrated Public Use Microdata Series (IPUMS) USA, allow an examination of changes over time and differences across family size, family income, and parental education levels. We expect to see that girls tend to live in households that have larger family sizes and smaller incomes, and that the sex of the children in the household does not affect the parents’ income. Parents’ preferences about gender may allow us to better understand how these preferences affect children and their outcomes in life.

Evaluating and Predicting Neural Recruitment in the Developing Social Brain

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Psychology

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Psychology

In a previous study, we investigated the developmental trajectory of neural correlates underlying trait evaluations of a close other (i.e., a same-gendered best friend). Twenty-four Chinese participants (twelve adults, twelve children) underwent functional magnetic resonance imaging (fMRI) while making trait evaluations in the social and academic domains. The present study investigates behavioral data, such as reaction time and self-evaluation agreement scores, to gain a better understanding of the brain imaging data and the extent to which individual behavior predicts neural activity. Additional analysis will reveal the relation between brain and behavior from a developmental approach. These findings will clarify how different patterns of behavior may be associated with different patterns of brain activity. Consequently, the findings from this study will expand the body of research on the developing social brain.

Bipyridine Receptors as Metal Ligands

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Copper is ubiquitous in the natural environment and performs vital functions in the body. The creation of a synthetic receptor capable of determining copper concentrations may have far-reaching biomedical applications, including testing for Wilson's disease and studying Alzheimer's. Previous studies have demonstrated the environmentally relevant aptitude of chemosensors built on a 2,6-bis(anilinoethynyl) pyridine core to sense anions such as chloride and cyanide. Although this class of anion sensors makes use of known metal coordinating moieties in their design, there has been little exploration into their ability to function as cation sensors. Preliminary studies on a bipyridyl adaptation of these molecules, bis(methoxy urea), have been successful at binding coppersalts over other biologically relevant materials such as iron and zinc.

Fathers: Social Stigma, Demographic Variables, and Childhood Development

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Many social changes, notably the significant increase of women in the workforce and the diversification of family structures, have modified the landscape of American families. Historically, fathers have been seen only as instrumental providers and protectors of children. With the ever-changing social landscape, perceptions of men as nurturers, however, have started to shift. A review of recent literature supports the need for further research into patterns of fatherhood and factors that support or prohibit fathers' active involvement with their children. Additional research would also enhance our general understanding of the impact of paternal involvement on children's development. This study specifically focuses on fathers who receive services at the Relief Nursery, a non-profit child abuse and neglect prevention agency in Eugene, Oregon. This exploratory study offers insight into the challenges and joys that fathers experience while raising their children, and may also serve as a base from which to implement services.

Diversity of Microbial Traits in the Zebrafish-Gut Microbiota

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Biology

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Microbial communities assemble in the gastrointestinal-tract of vertebrate organisms benefiting the host. However, the ecology, that is the processes that determine the spatial and temporal structures of these communities, is unclear. I use the model vertebrate, zebrafish (*Danio rerio*), to measure the diversity of various ecological traits in 19 unique bacterial strains derived from conventionally-raised zebrafish to reveal the diversity in these traits within the zebrafish-gut microbial community.

Ascetic Practices as Forms of Counter-Conduct: Michel Foucault and the Christian Pastorate

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Philosophy

Faculty Mentor: Colin Koopman
Philosophy

While much of the scholarship on Foucault's archeological and genealogical studies has focused on his analytics of power relations and disciplinary practices, the subject of resistance and counter-conduct in his research has received less attention. Following Foucault, I argue that the idea of a critical ontology of ourselves involves both a genealogical component, or a method for investigating the historically contingent conditions of our subjectivity, and an experimental component that allows us to transgress those conditions. The aim of my research is to situate the notion of a critical ontology of ourselves within the context of Foucault's studies on pastoral power and governmentality, especially those found in his 1977-78 course lectures *Security, Territory, Population*. I focus on certain techniques and practices of conduct exercised within the medieval Christian pastorate, namely the direction of one's conscience, confession as a mode of truth telling, and the pastoral teaching of truth. The implication of this analysis centers on the notion of ascetic and mystic practices as forms of counter-conduct and critique exercised within the Christian pastorate.

**Foods that Nourish Us:
Climate Change Impacts on Indigenous
Culture in the Pacific Northwest**

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Honors College

In the Pacific Northwest, the potential and ongoing impacts of climate change on tribes and First Nations are mounting. In response, tribal communities, academics and others are researching the effects of climate change. Much of existing climate change research focuses on analyzing impacts on natural resources, i.e. on quantifiable impacts. This paper argues that understanding the cultural impacts of climate change on indigenous people provides a more complete picture of what is at stake for native people today. Climate change has significant implications for traditional food use. This paper details impacts on culture, family, and sovereignty in order to show how climate change, by impacting traditional food use and species health, also impacts native culture and wellbeing in the Pacific Northwest. Furthermore, this paper demonstrates similarities between climate change and colonization and their effects on traditional food use as well as family and sovereignty in native communities.

A Synthesis of 1,2,3,5-tetrasubstituted-1,2-azaborines

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Biochemistry

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Chemistry

Tetrasubstituted arenes are important building blocks in many bioactive compounds. The development of 1,2-dihydro-1,2-azaborine, a surrogate of quintessential benzene that substitutes a C=C bond with an isoelectronic and isostructural B–N bond, extends the chemical space of the compounds relevant to biomedical research and materials science. To further investigate the potential applications of 1,2-dihydro-1,2-azaborines, we explore the synthesis of 1,2,3,5-tetrasubstituted-1,2-azaborines. The arene *N*-TBS-*B*-Cl-1,2-azaborine, which the Liu group developed in 2009, was halogenated at the C3 and C5 positions and underwent transitionmetal-catalyzed cross-coupling reactions to yield 1,2,3,5-tetrasubstituted-1,2-azaborines. The 1, 2, 3, and 5 positions of 1,2,3,5-tetrasubstituted-1,2-azaborines could be selectively functionalized by a variety of groups. The preparation of 1,2,3,5-tetrasubstituted-1,2-azaborines opens the possibility of incorporating 1,2-azaborines in biologically active molecules, a process that may provide new opportunities in drug design.

Selected Papers

Parenting in Poverty: The Experiences of Fathers Who are Homeless

Brenda C. Barrett-Rivera

Family and Human Services

Faculty Mentor: Lauren Lindstrom

Counseling Psychology and Human Services

Poverty rates in the United States have continued to climb in recent years as people struggle in the current economic downturn. According to the United States Census Bureau (2012), 46.2 million people lived in poverty in the United States during 2010, an increase from 43.6 million in 2009. Homelessness is one important issue faced by people in poverty. The US Department of Housing and Urban Development (2011) reported that nationwide the number of families who are homeless increased by 20% from 2007 to 2010, with families making up 23% of the homeless population.

The literature suggests that there are issues unique to families who are homeless, but the majority of the literature on parenting and homelessness is focused on the needs and experiences of mothers (Seccombe, 2000; Toohey, Shinn, & Weitzman, 2004). While single mothers head the majority of homeless families, the Urban Institute (1999) reported that 16% of homeless families include a father.

The literature on homeless fathers is limited but suggests that the needs and experiences of fathers are not being met by the existing agencies that support homeless families, nor even fully explored by researchers and policy makers. A study by Buckelew, Pierrie, & Chabra (2006) concluded that involved fathers make a difference in the lives of children

and that, to best serve homeless families, the unique needs of fathers must be considered. The current qualitative study explores the experiences of fathers who are homeless through semi-structured interviews that sought to answer the following research questions:

1. What is the impact of homelessness on relationships between children and others?
2. What are the main stressors faced by fathers who are homeless?
3. How do perceptions of fathers as caregivers and providers impact the experience of parenting while homeless?

Impact of Poverty

Current literature and statistics reveal an increasing prevalence of poverty and homelessness in the United States. To understand the experiences of fathers who are homeless, it is important to look at what is known about poverty.

Prevalence. For a family of three, an annual income of \$19,090 or less is the threshold the US Census Bureau uses to determine poverty (US Department of Health and Human Services, 2012). In 2010, the poverty rates were 13.8% nationally, 14% in Oregon, and 16.7% in Lane County (US Census Bureau, 2012). These numbers show that Oregon, and Lane County in particular, have a high percentage of people in need. One issue resulting from poverty is homelessness. The One Night Homeless Count reported 2,140 people homeless in Lane County on a given night (Lane County, Oregon, 2011). This type of point-in-time count is required by the Department of Housing and Urban Development, which provides funds for housing and services that support the homeless in Lane County. However, the National Coalition for the Homeless reports that the number of people who are homeless is likely higher than reported because methods of counting people are often limited to counting those in shelters or on the

street. This does not account for people who are temporarily living with family or friends, nor does it accurately identify the number of people who are intermittently homeless (National Coalition for the Homeless, 2009).

Effects of Poverty. The effects of poverty are diverse, but some of the key areas of concern are chronic stress and poor mental and physical health (Seccombe, 2000; 2002; Wadsworth, 2012). People experience the effects of poverty in different ways; therefore, it is important to be aware of variation when exploring these issues. For example, depending on individual, family, and community factors, the chronic stress that debilitates one person may have almost no negative effect on the long-term success and health of another (Seccombe, 2002). Regardless of variation, the effects of poverty are widespread and create issues that negatively impact many families and children (Seccombe, 2000; Wadsworth, 2012).

Parenting and Homelessness

Parents who are homeless have unique experiences, but their identities as parents are still defined in relation to their ability to provide and care for their children. Parents who are homeless struggle everyday just to protect their children. This creates stress that often leads to depression, anxiety, guilt, and shame (Paquette & Bassuk, 2009). Some parents find it difficult to practice effective parenting within the structure and setup of shelter living. Privacy is non-existent, and parents feel pressure to adhere to the rules of the shelter or risk losing their housing (Friedman, 2000). Several factors impact the parent-child relationships of families experiencing homelessness. For example, the loss of a stable family home brings changes on many levels as families also lose their support network when they leave their homes. Shelters may serve as a social setting for families to begin rebuilding support, but the process takes time and needs a nurturing environment that is sometimes lacking in shelters (Toohey, Shinn, & Weitzman, 2004).

Homeless Fathers. Homeless fathers are the minority, as the majority of homeless families are headed by single women (Paquette & Bassuk, 2009). The statistics regarding homeless parents are often based on who seeks support from, and is eligible for, family shelters, an approach that may exclude anyone who does not fit the traditional single mother category (Paquette & Bassuk, 2009). Consequently, most of the research on parenting while homeless is focused on the experiences of mothers, and the literature on the experiences of fathers is limited. However, some of the literature includes brief sections on fathers (Paquette & Bassuk, 2009), and one qualitative study on homeless fathers provides a foundation for this study (Schindler & Coley, 2007).

Qualitative Study. Schindler and Coley's qualitative study explores the experiences of homeless fathers in the United States (2007). Researchers interviewed nine fathers who were staying in homeless shelters and three shelter directors. Participants in the study were single or married biological fathers residing with at least one child under the age of 18 at the time of the interview. Researchers used open-ended interview questions focused on pre-shelter and shelter life to gain insight into how men parent their children in challenging and constricting situations.

Differences in how mothers and fathers experience homelessness are often based on social constructs that define the roles of men and women. The adjustment to shelter life may also be different for men and women, as fathers who are newly homeless focused on the adjustment to their expected gender role and identity, whereas mothers focused on safety and ability to maintain their roles as parents (Schindler & Coley, 2007).

The support services in most shelter systems are geared toward women and fail to address the unique needs of fathers. Schindler and Coley (2007) found that fathers who were used to autonomous living found it difficult to adjust to the structured environment of shelter life. Another issue was

that many fathers struggled to become full-time parents in the extremely public setting of the shelter. It is difficult to strengthen the family unit without addressing and supporting the father's primary role as parent (Paquette & Bassuk, 2009).

Fathers also experienced many barriers as they navigated support services geared toward mothers. Shelter policies offered only limited accessibility to fathers. For example, the shelter system in the Schindler and Coley study allowed only biological fathers to stay in shelters with their families, although the shelter allowed stepmothers to stay with their families (2007). These types of policies make it necessary for families to separate in order to be sheltered (Paquette & Bassuk, 2009). Shelters may have valid reasons for the policies, but the message sent to fathers is that they do not belong. These types of policies make it even more difficult for homeless fathers to access critically needed support. To help fathers, it is necessary to understand how the experience of parenting while homeless is different for men (Schindler & Coley, 2007). With that understanding, considerations for the needs of homeless fathers may begin to be addressed.

Method

For the current study, qualitative semi-structured interviews were used to explore the experiences of fathers who have been homeless and received services at a homeless shelter for families. The study's format was based on Schindler and Coley's study of homeless fathers, but modified to focus on the experiences of single homeless fathers in a Pacific Northwest city. Qualitative interviews allowed for in-depth exploration of the experiences and views of a population (Schindler & Coley, 2007). Interviews with staff members of a homeless family shelter in the same Pacific Northwest city helped to triangulate data and obtain additional information about shelter rules, supports, and overall experiences with fathers who are homeless.

Additionally, shelter records provided information regarding services used by the fathers who participated in the study.

Establishing rapport is often an important part of a qualitative study (Schindler & Coley, 2007). As an intern and volunteer, the current researcher had an established and ongoing relationship with the families and staff of the shelter, a fact that served as an important connection for this study. The timeline included submission of a human subjects protocol in May, recruitment of participants in July, interviews with fathers and staff from July through November, and data analysis and writing in December and January.

Sample

The sample was purposefully chosen to provide information on the experiences of single fathers who were parenting while homeless. Participants included four fathers who resided with at least one child and had received services at the shelter. All four fathers were the biological parents of the children in their care, and each father had been homeless prior to his current shelter stay. Three of the four were assuming a primary parenting role for the first time. Table 1 provides demographic information about the fathers. The shelter staff members ($n = 4$), although not subjects of the study, provided additional information based on their professional roles.

Data Collection

The first step in the research after receiving a protocol number from the Institutional Review Board involved recruiting fathers at the shelter by using fliers and personal connections the researcher established while volunteering at the shelter. Each participant provided informed consent, and fathers received a \$25 gift card to a local department store for participation in the study. All of the interviews took place in a private

room at the shelter.

Data were collected through face-to-face interviews lasting from 43 to 58 minutes for fathers and 13 to 33 minutes for shelter staff. All interviews were recorded with a digital voice recorder and later transcribed. The interviews were semi-structured and followed an interview protocol that provided consistent coverage of topics with flexibility of order and tempo based on the participant's level of engagement. The interview protocols were derived from the themes in the literature review and focused on the areas of relationships, stressors, services and supports, and perceptions. Open-ended questions allowed participants to introduce new themes, and additional probes were used to clarify information and close gaps in the responses.

Data Analysis

Data were coded and analyzed following a series of steps recommended by Rubin and Rubin (1995). Following their model, analysis began as common themes emerged while transcribing the interviews. An initial set of codes were developed from the themes and applied to each transcribed interview. Coded data were separated into categories that allowed information to be compared across interviews. After thorough examination, descriptions were written to confirm the common experiences of fathers who were homeless.

Results

The interviews provided insight into the lives of four single fathers who were connected by the common experience of parenting while homeless. Common themes emerged over the course of the interviews regarding (1) the effects of homelessness on personal relationships, (2) the main stressors for fathers who are homeless, and finally (3) how external perceptions affect the experiences of fathers who are homeless.

Impact of Homelessness on Relationships with Children and Others

Being homeless, the fathers spent a great deal of time with their children, a fact that had positive and negative effects. For example, interactions with teenagers were more likely to be strained by the physical closeness and structure of communal living, while younger children seemed to respond well to the increased closeness.

Relationships with Young Children. Two of the fathers who were interviewed had children under the age of ten. Both of these fathers had been previously homeless, but they reported that this was the first time they had been primary caregivers. They talked about the amount of time that they spent with their children while living on the street or in shelters, and the impact this experience had on their relationships. This closeness provided safety for the children and aligned with the rules of the shelter, but it also served to strengthen the connection between father and child. One father described the effect on his relationship with his three-year-old daughter, “We have no choice but to grow closer together, our bond, in order to work together as a father/daughter, as a team in order to survive.” Fathers with young children embraced the role of primary caregiver and spoke about how the experience of parenting while homeless had changed them.

I just turned 50 in April, and, you know, having a seven-year-old at 50 is a trip, because everything he does ... The first 50 years I saw through my eyes, the second 50 I'm seeing through his eyes because what he does and everything. It blows me away, it's a trip. And every morning I wake up, and me and him are taking a trip, and it's like I try to do a lot of things with him. You know, I'm talking to a seven-year-old at 50, and me and him have conversations together because there's nobody else for me to talk to.

Relationships with Teenagers. Maintaining relationships with teenagers often can be challenging, and being homeless places an added

strain on relationships between fathers and teens. One father, who had previously parented while homeless, reported that now that his sons were older, they were more aware of the family's situation. Teens at the shelter are often coping with an adult level of stress while simultaneously losing the freedom to spend time with their peers outside of the shelter. The shelter rules allow teens to spend one night out per week, but otherwise they are required to be with their families. The teenage years are typically a time of growing independence and stretching of boundaries, but teens in the shelter have the added pressure of knowing that if they break shelter rules, they may jeopardize their family's ability to stay in the shelter. This consequence is steeper than what typical teens risk when they decide to rebel against a rule. One father reported that even though his sons were coping, the setup of communal living made it difficult to maintain the relationships that they had prior to becoming homeless.

Interviewer: So living together with potentially nine other families in one big room, do you feel like you were still able to hold on to what you had at home when you were in your own place?

Father: No, not when you're in Night Shelter you don't. It's, you try to push everybody else out, all the other families, but you can't keep, there is no sense of being your own little dwelling. It wasn't. All it was is a place to sleep. I mean that's what it was.

Another father described the difficulties of relating to his teenage daughter. He talked about the challenge of becoming the primary caregiver while his daughter was becoming a young woman. Sensitive topics like feminine hygiene became a challenge in the public setting of the shelter.

It's hard being a single dad to a teenage girl. That is even more difficult than a single dad with boys because I have to go, "hey, Jenna, did you take tampons with you? Or pads, do you have pads with you?" You know I have to be a parent since there isn't

a female with me. In shelter it's been nice because there's other moms around, and I can go, "hey can you talk to Jenna about this please? Why it isn't good to get underwear out of the free box."... The father daughter relationship has a total different dynamic than the mother daughter... She thinks that I'm just, like, alien to her so it's really difficult.

One father talked about the difficulty of maintaining relationships between siblings. The added stress of juggling school schedules, shelter time commitments, and work responsibilities made it difficult to maintain a peaceful relationship.

You know your kids can't bring a friend over, and you feel bad about them having to be, like, my kids. Their bedtime's not until 9:30, but they have to be in at 5:30. It's like four hours in a church ... You know, and they're siblings. They fight all the time, and I feel like I spend most of my time making sure it's ok for them to be wherever they're at—whether they be at work with me. Or Jenna's having some kind of issue, and it's causing a scene with me at work or with her brother, or they're fighting over something. Constantly I just feel like I'm making it ok to exist.

Relationships with Others. Fathers may experience changes in relationships or lose supportive relationships with friends and extended family when they become homeless. Changes in geographic location, differences in socioeconomic status, and the stigma about being homeless may make it difficult to maintain these connections. Some fathers developed relationships with other families in the shelter, but that was not always the case. When asked about support, two of the fathers expressed that they did not have any close friendships. One father said, "Yeah, I didn't befriend anybody in Night Shelter at all. I mean I talked to them. I was polite. I said, hi, you know, and that was about it. I didn't hang out with anybody." Another father explained that he did turn to people for

support, but that he did not consider them to be his friends.

Interviewer: When you need extra support or someone to talk to, who do you turn to in your life?

Father: Um, acquaintances.

Interviewer: So not a close friend? Is that how you would describe acquaintances?

Father: Right, I don't keep many friends. They're acquaintances.

The communal setup of the family shelter provided fathers with the opportunity to connect with other homeless families. One father explained his connection with other single fathers:

Father: When I was in the shelter, I was totally blown away the first night I went in there, and all four of us. I even ended up rooming with one of the males and his kid at the first church we went to. We all four ended up sitting down, eating dinner together just sitting there talking to each other about how it's going.

Interviewer: What was that like to have other dads? Did you guys keep it on the surface or did you ask deeper?

Father: I would like tell them anything.

Fathers and other homeless parents in the shelter shared their first-hand knowledge regarding experiences accessing local services as well as parenting techniques. Another father explained why he turned to other families in the shelter for support.

Another single male with a kid saying this is what I'm going through or this is what I've been through, or you need to do this, because he's already been there and done that. I just try to do what I've gotta do, and it's good, though, to see that there's more of us getting our kids.

Fathers maintained relationships with extended family members but could not always rely on them for support. One father explained that other homeless families seemed to understand him and his situation:

I have friends that have really helped me out here locally. My family, my family is, like, "that's really, I'm sorry to hear that's what's going on." That's it. I find that the connections I have here with people in the shelter. I feel these are the only people that I can go, "this is what's going on with me," and they get it.

Main Stressors for Fathers Who are Homeless

The stress of parenting while homeless involves many of the same issues for both mothers and fathers. However, participants talked about stressors that may be different for fathers. They discussed the lack of services available for single fathers and the challenges of becoming the primary caregiver.

Lack of Resources. Many of the resources for families who are homeless are not available for single fathers. When fathers were asked about how they ended up in this particular shelter, they explained that there was no place else that could go and keep their children with them. One father talked about the search for a place to stay: "So, basically I was out. There was nothing available. I called shelters from [city name] to [city name], um just trying to find a place." Fathers explained that the other local shelters were not equipped to house fathers and children. "There is no other place. We were gonna have to be split up." A shelter staff member agreed that having no place else to go was a stressor for fathers. She said, "Well no place to go is the big one. We have four intakes this week with single dads who have no place to go with their kids. So that, I think, is a huge stressor." One father described the relief of hearing that he had a space at the shelter: "You know the day that (they) said, 'hey, look, we're

gonna let you into Night Shelter' was one of the greatest days I ever had with Chris because I seriously didn't know where I was going."

The lack of resources available created challenges for all of the fathers. Many of the services that are available to families are set up to serve mothers and are not able to provide for these single fathers. One father said that he wanted people to know how little was available.

The thing that I'd like people to know is that there really is not a lot out there. Agencies need to open up to what they're doin' for women with kids, single women with their kids. They need to do the same for single males with their kids. Have some kind of programs, you know, that are open to the males, too ... because there's not a lot out there. There ain't, and I just hope it changes, and I think it will with the more guys that are getting their kids.

Fathers talked about the lack of support they felt and how they would like to see more programs geared toward fathers.

Father: There's no support ... they have mother/daughter classes. They have no father/daughter classes. It doesn't even matter if they're a single parent. Fathers in general. They don't have a 'how to be an effective father' class."

Interviewer: If there was something, do you think you would go?

Father: If there was something right now that I could do that was a class or a group or even a support group that was other guys that I could talk to who are going through, again they don't even have to be single. Just guys who are willing to say, "hey, I did this and it didn't work," or "hey, my daughter's doing this and dressing like this." Having other dads say, "well, that ain't nothin'." Especially when you're a single parent. You don't have anybody to bounce things off of. You don't have any way to gauge where am I at on this issue, or where are they at.

The shelter staff agreed that the lack of resources was a stressor.

One staff member explained, “not getting any services, not being able to receive services, which is something that’s very real.”

Basic Needs. Providing for the basic needs of a family can be stressful for any parent, but parents who are homeless face unique challenges. Fathers talked about the issues that arose as they tried to protect, feed, and shelter their children. One father talked about the difficulties of his morning routine.

Mark has to be on a bus at 8 am. Jenna doesn’t have to be at school until 8:45, and she can walk from the center, and she’s a girl, and she likes to take showers in the morning. So I have to get him on a bus by 8 am and get her here to shower, but I can’t leave her here while I take him to go catch the bus. It’s just like, “oh my god, how do I do all this?” It took me, like, two to three weeks. I think Mark was on time everyday last week, and that’s the first time since we’ve been in shelter that he was on time to school every day that week. It’s just, like, every morning he’s late, every morning. ... It’s a logistics nightmare, every day, every morning, every week. I gotta get this kid here and this kid here by this time, and then there’s no consistency.

Mothers and fathers who are homeless have many of the same challenges, but most mothers have been the primary caregivers prior to becoming homeless. Many of the fathers became the primary parent under emergency situations that did not allow time for preparation. One father explained that he was so excited that the judge was awarding him custody, but that he really was not prepared to provide for his son.

It was, like, reality set in. I was, like, “oh my god, this kid. I’m responsible for this boy, and what am I going to do?” It all hit, and the joy and everything just went right out the door, and it was, like, reality set in and I was, like, “I don’t know how to cook, I don’t know what’s going on.” I mean I had no adult and family services. I had to go to Adult and Family Services. I wasn’t

receiving TANF, no food stamps. I was only getting food stamps for me.

One of the staff members explained that some of the fathers gain custody when the children are older and suddenly fathers have to parent a child whom they are still getting to know.

I mean, sometimes we have fathers who have gotten custody of their children when they were older, and they haven't been around them for a while. You know they have custody, or they've been a couple, and mom has taken care of all these things, and then mom leaves for some reason, and all the sudden leaves dad with the kids, and he has to figure out how to communicate, you know, personal information to a teenage child and really has no concept of how to do that.

Perceptions about Fathers

Fathers who were homeless were aware of expectations and external perceptions of them. They talked about the expectation that men should have jobs and be able to provide for the financial needs of their families. One father said, "Dads are expected to have a job no matter what so they have an income. They can pay the bills. I think that's the biggest thing, you know. Guys are expected to have a job." Another father felt that there was the lack of understanding for fathers who were unemployed.

People have been supportive, but at the same time they expect a lot of a single dad, and I don't think they really understand. A woman, it's okay. It's more accepted that a woman would be on TANF, but a single dad on TANF is a deadbeat. Why can't you go get a job? Because by time I get my kids off to school by 8:30 am, do the laundry, go grocery shopping, get my kid off the bus at 3 pm, I don't really have much of a work schedule to work with.

A father who is homeless may experience an increased sense of responsibility for their situation. As one shelter staff member commented:

By and large I'd say men are under the same stressors that women are plus the additional stressors on top. And that is the fact that you are not supposed to have this happen.... There's less belief that women should be able to bootstrap themselves up than there is for men. The male model is still John Wayne.

Some fathers said that people responded differently to them because they were single fathers. One father talked about applying for social services.

They don't want to deal with single fathers, dude, 'cause they think, or their big word "assume," that if it's a single dad, he's gonna screw up. If they provide the services he's gonna screw up. The child's gonna go back to the mother or go back to the state. Then they use services that they could have used somewhere else because they assume too much.

Fathers reported that initial impressions of their ability to provide adequate care were generally negative. One father gave an example of how this occurred at his son's school.

You know, there was a couple times where I had to call the school because there was a car wreck on the deal, and I called them up and, "hey, look I'm gonna be a little late. Is there a problem with you guys keeping him?" And they're, like, "no," and they'd have him in the office. And the lady was like, "You know what? I didn't think this was gonna, you know the way you look, I didn't think this was gonna go, but I've watched you, and you really have done a really good job with him. I notice that, you know, he looks around when he's leaving school to see if you're here." And the thing is, I don't do it for me, for people to be able to say something to me. I do it because that's my kid, and that's the way it should be.

These negative perceptions may mean that fathers have to prove that they are good parents even when they have done nothing wrong, a fact

that added stress for fathers. Mothers in the shelter commented that one father was constantly monitoring his son. When questioned about this heightened vigilance, he replied, “I’m gonna tell you something. Me being a single male with my son, I’m not gonna give anybody a chance to say I’m not watching my kid.”

The shelter staff commented on the discrepancy between the common perceptions about fathers who are homeless and the realities that they saw in the shelter.

By and large, the projections on them aren’t accurate. They’re not lazy, they care about their family, they want their children to have a good life. They may not have the tools or the skills that it takes to make that happen, but they want the same things that other people want. And that they’re carrying this extra burden that anyone who’s in poverty, especially long term, feels like there’s something wrong with them. It’s big time for the guys because the model is more rigid, and the expectations are higher.

The perception that fathers are less capable of being the primary caregiver is not accurate according to the shelter staff.

They are wonderful, courageous men. I mean, you hear all the time about deadbeat dads and men taking off and leaving their children and their wives or their girlfriends or whatever, not taking responsibility. And we see these men who are working hard to raise these children and do the very best that they can, and you know it’s tough for them because they don’t have the resources that women do, and they don’t have the places to stay with their kids. I mean, we have brought in single dads who have been living on the streets with their children ‘cause there was no place for them out there, and I just think they’re very courageous. I think they do an excellent job. Some of our single dads are some of the best parents I’ve seen in Night Shelter.

Discussion

The purpose of this study is to gain a better understanding of the experiences of fathers who are homeless. Given the lack of research on homeless fathers, this study was informed by a combination of literature regarding the effects of poverty, research about homeless mothers, and one prior study on homeless fathers (Schindler & Coley, 2007). The researcher also used personal knowledge based on direct experiences working with homeless fathers to create this exploratory study. Interviews with fathers and staff provided valuable insight into the experiences of fathers who are homeless. An in-depth analyses of the data and the words of the fathers themselves revealed that (a) relationships with children and others changed while fathers were homeless; (b) fathers faced a lack of access to resources for homeless families that made adjustments to primary parenting roles necessary but stressful; and (c) external perceptions of fathers as caregivers and providers had a negative impact on the fathers' experiences.

Limitations

Although this study contributes important findings regarding homeless fathers, several limitations should be considered when reviewing the findings. The study took place at a family shelter in a Pacific Northwest city, and the sample included only fathers who had accessed those services. The shelter's inclusive policies regarding access to fathers may have had an impact on the results. Also, the sample was fairly homogenous concerning age and race. Finally, as with all qualitative research, the results may have limited generalizability (Patton, 2002; Yin, 2009). Even with the limitations, three overarching themes were common across the experiences of the fathers.

Relationships

One overarching theme focused on the significant changes to fathers' relationships with children and important others. Reaction to the structure of the shelter, separation from existing social supports, and the developmental stages of children all seemed to play into these changes. These results are consistent with the literature regarding the impact of homelessness on the parent-child relationship and changes to the social networks of homeless families (Friedman, 2000; Toohey, Shinn, & Weitzman, 2004).

Fathers with younger children adapted well to the increased time spent together and reported that their relationships were stronger as a result of becoming homeless. This evidence is consistent with the findings from Schindler and Coley (2007) that fathers appreciate having this time with their children and may use it to redefine their fathering role. The young ages and maturity levels of children may have contributed to this positive outcome.

Fathers with teenagers reported that their relationships were difficult while homeless. Teenagers were more aware of the family's struggles and pushed back against the rules and constraints of shelter life. The response of teens to stress, as well as limited privacy, created tension between fathers and their teen-aged children.

This study showed mixed results regarding social support and homeless fathers. Two of the fathers quickly developed supportive relationships with other families in the shelter. This may be reflective of the supportive environment of that particular shelter or the social characteristics of these fathers. The other two fathers reported that they kept to themselves and did not rely on social supports while homeless. They reported having "acquaintances" but no close friends.

Stressors

Each of the fathers reported that the lack of access to resources and the adjustment to primary parenting were their main stressors. That finding illustrates the second overarching theme and is consistent with the other literature regarding stress and homeless fathers (Paquette & Bassuk, 2009; Schindler & Coley, 2007). The lack of resources available for homeless fathers severely limited the fathers' options for support. The shelter in this study is the only family shelter in the county that allowed fathers to stay with their families. The other main stressor that fathers identified was their abrupt transition into primary parenting. This finding supports the assertion that homeless fathers need services and support that consider their unique needs (Schindler & Cooley, 2007).

Paquette and Bassuk found that the stress felt by homeless parents as they struggle to protect their children may lead to anxiety, depression, guilt, and shame (2007). The fathers in this study spoke about the stress of trying to provide for their children within an inadequate and often inaccessible system of support and the anxiety and guilt that this stress caused. A lack of resources, combined with external perceptions about the role of men as providers, is an important issue for homeless fathers and is further explored in the next section.

Perceptions

Finally, each father faced the expectation that men should be employed and able to provide for the needs of their families. This expectation leads to negative perceptions of fathers who are homeless. The findings showed that fathers felt an increased sense of responsibility for being homeless and a lack of understanding from others. In addition, fathers in this study experienced negative reactions when people learned that they were the primary parent. This external reaction to fathers as primary parents

created added stress and undermined the fathers' confidence. This adds to Schindler and Coley's (2007) finding that ideas about gender roles can negatively impact homeless fathers. Interviews with shelter staff revealed that although these perceptions added to fathers' stress, single fathers are some of the best parents that the staff see in the shelter.

Recommendations

The findings from this study suggest that services and supports for homeless families need to be inclusive of fathers and directed toward their needs. For example, fathers may benefit from support groups and parenting classes that consider their transition into primary parenting roles and recognize the impact of external perceptions regarding fathers.

Fathers also need service providers who understand and appreciate their unique needs. This understanding may lead to better relationships between agencies and homeless fathers and alleviate some of the stress that fathers reported feeling when accessing services. Further research is needed to better understand how homelessness affects fathers. Future studies could include follow-up interviews, samples that include additional people of color, and interviews with older children and other family members.

Homeless fathers represent a small but growing segment of the population. The four fathers in this study provided valuable insight into the experience of parenting while homeless. The issues discussed in this study provide a foundation for further research and immediate implications for practice. This study includes unique findings that extend our understanding of the experiences of fathers who are homeless. Participants shared their stories with the intention of helping other homeless families. With that intention in mind, it is my hope that this research not only adds to our understanding, but also may inform changes to services and support that improve the lives of homeless families.

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Table 1: Participant Demographics

Father	Age	Children	Employment Status
Jack	50	Son: Chris 7	unemployed
Bradley	42	Daughter: Anna 3	unemployed
Shawn	43	Sons: Eric 16 Jimmy 14	unemployed
Patrick	47	Daughter: Jenna 13 Son: Mark 10	employed part-time
<i>Note: All names are pseudonyms.</i>			

Leafcutter Ants Cut Six Times More Inside the Nest than Outside

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Introduction

Ants play a dominant ecological role in nearly every terrestrial environment on Earth. Owing to their social organization, ants have diversified and proliferated to over 10,000 species making up 15-33% of land animal biomass.¹ Throughout the neotropics, the Attini ants are top herbaceous consumers² and apply a unique means of food production. *Atta cephalotes* and *Atta colombica*, among the most derived and prolific species of the Attini,³ cut leaf disks from desirable plant species. Ants use mandibles to lift leaf disks overhead and carry them underground into small fungus (Leucocoprineae) filled caverns (Figure 1).⁴ Ants of all sizes mount and clean the leaf disks using glossae mouthparts and consume phloem sap from the edges.⁵ Once clean, disks are lifted and held stable by several ants, while one or more ants cut smaller fragments out of them. Ants transport fragments into various parts of the fungal comb where phloem sap is once again collected from fresh edges. Ants add fecal droplets, probably to aid in leaf breakdown,³ and roughen edges using their mandibles. Fragments may be reduced and roughened several more times before they are of adequate size (0.003cm^2 - 0.04cm^2) for comb-making. A nest generalist takes the fully prepared leaf fragment and pushes it into the existing fungal comb, rocking it back and forth with forelegs until it is firmly packed

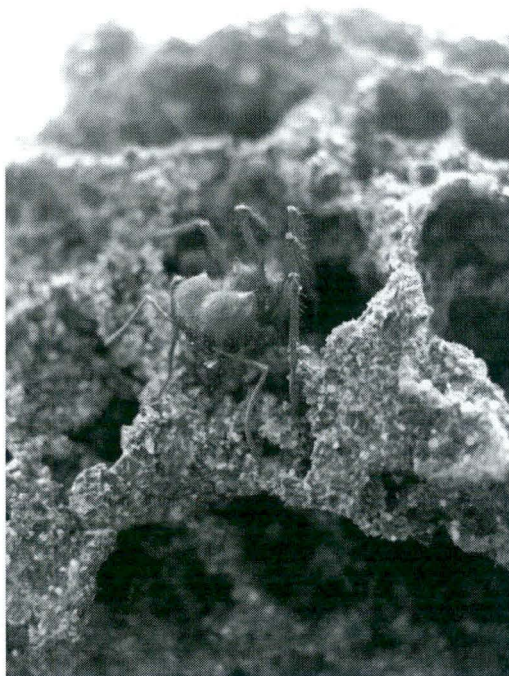


Figure 1: Young *Atta colombica* major on sample of fungal comb. Ants were removed and material placed into ethanol solution before spreading onto paper. Bilsa, Ecuador.

into the structure. The smallest ants of the colony pluck fresh hyphal tufts from the older substrate and plant them on the newly added leaf fragment. These same ants tend the fungus garden, ridding it of parasitic microbial species.⁶

Leaf cutting is likely the most energetically expensive task performed by *Atta* species.⁷ If most cutting takes place during leaf processing, then the quantity of underground cutting is an important factor in the calculation of the energy expenditure of an *Atta* colony. Using materials

collected in Minca, Colombia, and Tiputini, Ecuador, we have calculated a ratio that compares cutting outside of the colony to cutting inside of the colony. Though leaf processing has been described in detail, no study has quantified the amount of cutting that occurs during subterranean leaf processing.

Methods

Materials were collected from *Atta colombica* in the Tiputini reserve, Ecuador, and from *Atta cephalotes* in Minca, Colombia, in early June, 2012.



Figure 2: Author is shown after digging hole to large fungus chamber. Fungal comb was carefully collected and placed into bucket for sorting. Bilsa, Ecuador.

Leaf disks were collected after locating colonies and noting foraging trails. During 15 minute segments, every disk that passed a given line on the trail was collected. The colonies were then excavated for fungal substratum. Holes measuring up to 1 meter deep and 3 meters long were dug in order to locate fungus chambers (Figure 2). Duct tape around pant openings kept large ants outside of clothing.

Leaf disks and fragments were taped onto watercolor paper, labeled, and photographed with a ruler for scale (Figure 3a and 3b). Material from fungal combs was

placed into ethanol solution (1 part ethanol: 2 parts water) before being spread onto watercolor paper. To test the effect of ethanol solution on leaf fragment dimensions, nest material from a several-year-old lab colony of *Atta cephalotes* at the University of Oregon was placed into the same ethanol solution for one month. Leaf fragment measurements were taken before and after treatment, and no significant change was observed.

Leaf disk and fragment pictures were converted to black and white binary using imageJ software. The surface area and perimeter of every

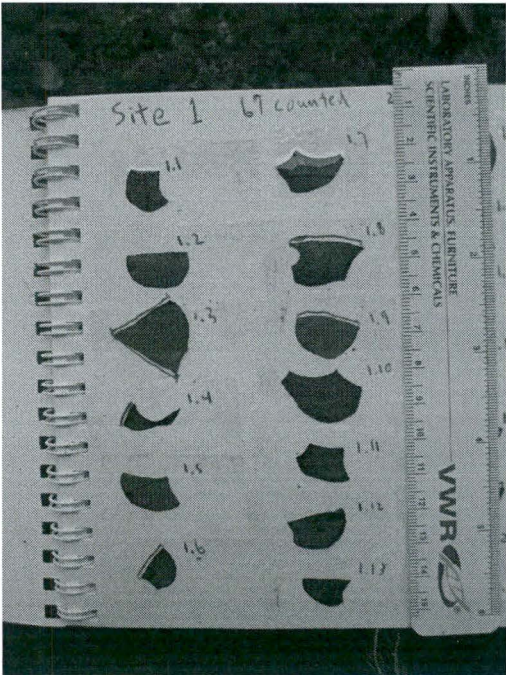


Figure 3a: Leaf disks collected on foraging trail. Minca, Colombia.

disk and fragment were measured, and averages were calculated for each parameter. Natural leaf disk edges were marked and subtracted from total leaf disk perimeters to avoid including natural edges into calculations of cutting quantity. By comparing surface areas, a ratio was created showing how many average fragments make up one leaf disk. This value was multiplied by the average leaf fragment perimeter, and the average total leaf disk perimeter was subtracted so it would not be counted in underground cutting. The value was divided in half because each cut during disk reduction leads to two new fragment edges. The average fragment cutting for one disk (cut inside nest) was divided by the average leaf disk perimeter minus natural edges (cut outside nest) giving us a ratio that quantifies the amount of cutting above ground versus underground. The result is the Cutting Ratio Equation shown below:

$$\frac{0.5\left[\left(\frac{\text{Disk SA}}{\text{Fragment SA}}\right)(\text{Fragment P}) - \text{Total Disk P}\right]}{\text{Cut Disk P}} = \frac{\text{Subterranean leaf cutting}}{\text{Above ground leaf cutting}}$$

Videos were taken with a Nikon Coolpix 4500 camera attached to a

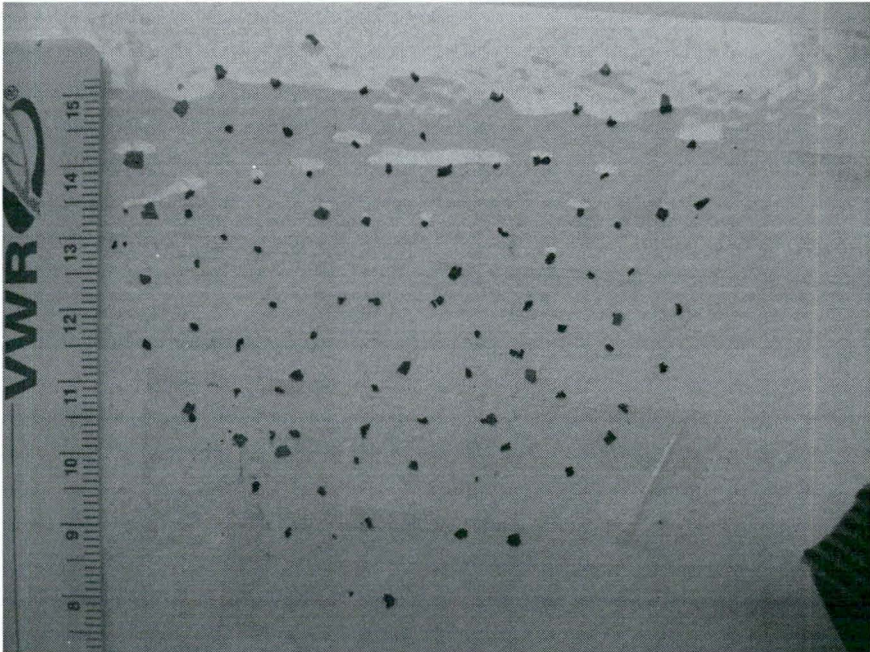


Figure 3b: Leaf fragments collected from fungal comb. Minca, Colombia.

dissecting microscope under various magnifications. Ants in the videos are from the University of Oregon lab colony. Fungal substrate and ants were collected from artificial chambers and placed into tupperware with a glass top. Ants were given one whole leaf (middle aged *Rubus armeniacus*) daily, and processing was recorded during subsequent hours.

Video data helped to determine the minimum size of fragments created using the mandibles and to avoid counting small fragments from decomposition as part of the cutting ratio. During the 40+ hours of processing observation, nine videos depicted final fragments incorporated into the fungal comb. The minimum threshold was based on the smallest fragment observed: 0.003 cm^2 . To determine how significant the bottom

threshold was on our final ratio, we subtracted the three smallest observed fragments and recalculated the final ratio with this new threshold (0.0098 cm²).

Results

Leaf disk data from Tiputini and Minca may be summarized as follows:

	Average Tiputini		Average Minca	
	Leaf Disk	Leaf Fragment	Leaf Disk	Leaf Fragment
Surface Area (cm ²)	0.939	0.00775	0.487	0.00568
Total Perimeter (cm)	3.73		2.93	
Natural Edges (cm)	0.596		1.18	
Perimeter (cm) (total – natural edges)	3.13	0.364	1.74	0.281

Cutting Ratio

With average surface area and perimeter determined, a ratio comparing cutting could be calculated. Using the Cutting Ratio Equation, we found the ratios of cutting inside the nest vs. outside the nest to be 6.52:1 (+0.20, -0.11) for the Tiputini data and 5.88:1 (+0.20, -0.08) for the Minca data. The average ratio for the two data sets is 6.2:1.

Error

Error was calculated for the measuring technique, minimum fragment threshold, leaf dimension analysis and effect of ethanol on leaf fragments. Pictures of leaf disks and fragments were taken several times from the same distance. For each set of leaves, three matching images were used for measurements, and the data were compared. The difference between the three data sets was 1.5%. When the minimum fragment threshold was adjusted to 0.0098 cm², the Tiputini and Minca cutting ratios were

decreased by 27% and 34% respectively. Increasing the minimum fragment threshold by a factor of three decreased the cutting ratio for both data sets by about one third. The effect of ethanol on leaf fragments proved negligible. After one month of soaking in ethanol solution, the surface area changed by 0.007%, and the perimeter changed by 0.09%.

Differences in the shape of leaf disks and leaf fragments were analyzed to determine if the range in shapes had a large effect on the final ratio. For each leaf disk, the measured perimeter was squared (to eliminate disk size as a factor) and divided by the area. We determined the average value of P^2/SA for all disks and the standard deviation between them. We added and subtracted one standard deviation from the average value and recalculated the perimeters. This gave us a larger perimeter to area ratio (oval shaped disk) and a smaller perimeter to area ratio (circular disk). These steps were repeated for all of the leaf fragments as well. The resulting four figures were plugged into the Cutting Ratio Equation in every combination (e.g. oval leaf disk with circular leaf fragment) to calculate how the shapes affected the cutting ratio. This gave us error values of +0.20, -0.11 for the Tiputini cutting ratio and +0.20, -0.08 for the Minca cutting ratio.

Discussion

The results support our hypothesis that more cutting takes place in fungus chambers than during foraging. This novel information can be applied to the average cost of cutting, allowing us to estimate the overall energy gained from leaves.⁸ Given our understanding of the quantity of work needed to process leaves, the amount of energy gained from each leaf disk is likely lower than previously believed. A low energy profit from leaves may be part of the reason *Atta* colonies are not able to expand and defoliate very large areas. If foraging sights are too far away from the nest, there may be a net loss in energy resulting from the cost of transporting leaves.

For this study, the shape and size of leaf fragments were of interest. The ants cut roughly circular fragments, recreating the shape of the disk from which they are made. During comb building, the ants spend considerable time wedging fragments into the wall. The circular shape may be easier to cut for ants, but it could also be easier to build structures of that shape. Ants also put energy into roughing the edges of the fragment before inserting it into the comb. The fragment size may be determined by length of the mandible, where the center of a fragment is never more than a mandible length from the edge, and the fragment can be roughened on all surfaces.

This research could lead to further investigation of age polyethism (change in work throughout workers lifetime). In a recent study, Schofield et al. found that the mandibles of *Atta cephalotes* wear out significantly with age.⁸ Ants in the later stages of mandible wear take twice as much time and energy to cut leaves as their younger counterparts. Older ants are therefore more likely to carry leaves, an action that does not diminish in proportion to mandibular wear. If the majority of cutting takes place underground, perhaps this represents another phase in the ants' life-cycle. Leafcutter ants may spend the beginning portion of their lives underground, while mandibles are sharpest, because they are the most fit to process the endless stream of leaf disks.

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Bipyridine Receptors as Metal Ligands

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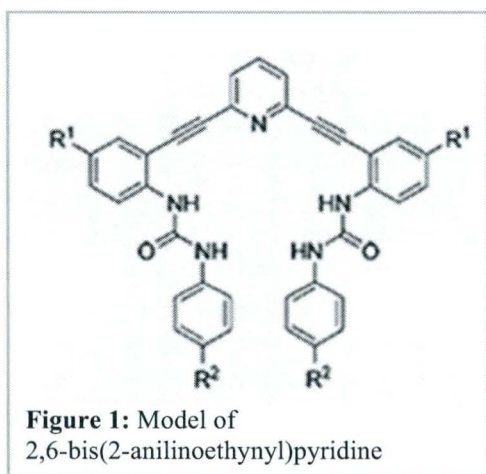
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Archeological evidence shows our industrial dependence on copper may date as far back as 8700 BCE when the metal began to be used for jewelry and, in combination with tin, early tools. In our homes, copper is integral to wiring, plumbing, heating, cooling, appliances, and telecommunications because of its high thermal and electrical conductivity and corrosion resistive properties. Our dependence on copper, however, does not always have benign consequences. The widespread use of cupric sulfate in pesticides¹ and waste from the electronics industry² are shifting natural copper levels. This imbalance is causing massive damage to ecosystems and generating growing environmental concern.³ Humans need synthetic receptors designed to remove copper contamination safely and efficiently from our soil and water systems.

In addition to its uses in tools, copper is an essential bio-element,⁴ vital to processes in all systems of the body. Health is dependent on delicate balances of ionic concentrations of copper, making the ability to test for molarity physiologically relevant. Recently, for example, medical researchers have been studying links between copper deficiencies and Alzheimer's disease.⁵ Testing for the raised copper levels associated with Wilson's disease⁶ may replace the current need to rely on a biopsy of the

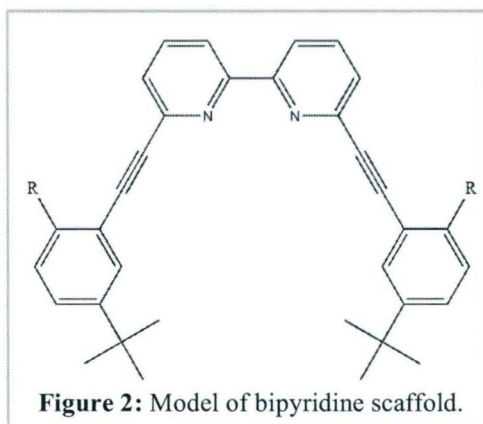
liver for an accurate diagnosis. It may be possible to design the same chemosensors used for waste remediation to be adaptable as biomedical probes, capable of noninvasively determining copper molarity in organs and systems.

A supramolecular approach inspired by naturally occurring enzymes that selectively bind substrates⁷ may provide a solution to the problems imposed by copper. It is possible to synthesize host molecules that utilize



non-covalent interactions to aid in the complexation of specific guests. Just as a lock requires a distinctly shaped key, these systems target a precisely shaped ion. Recently, supramolecular receptors⁸ have gained much attention because of their broad-range of usefulness in biomedical, chemical, environmental, and industrial fields.

Previous studies have demonstrated the biologically relevant aptitude of chemosensors built on a 2,6-bis(2-anilinoethynyl)pyridine core (Fig. 1) to sense anions such as chloride.⁹ Although this class of anion sensors makes use of known metal coordinating moieties in their design, little

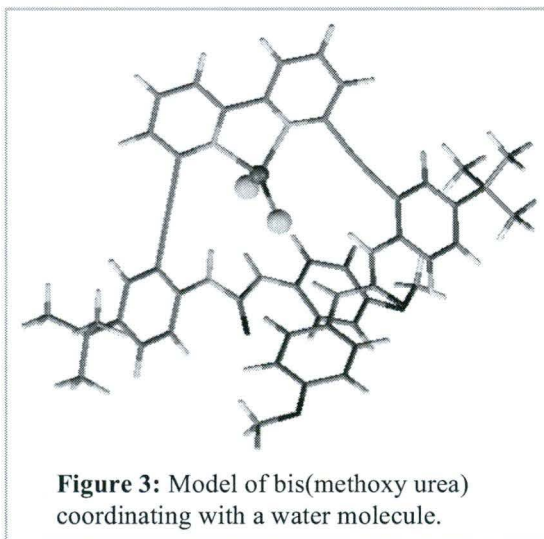


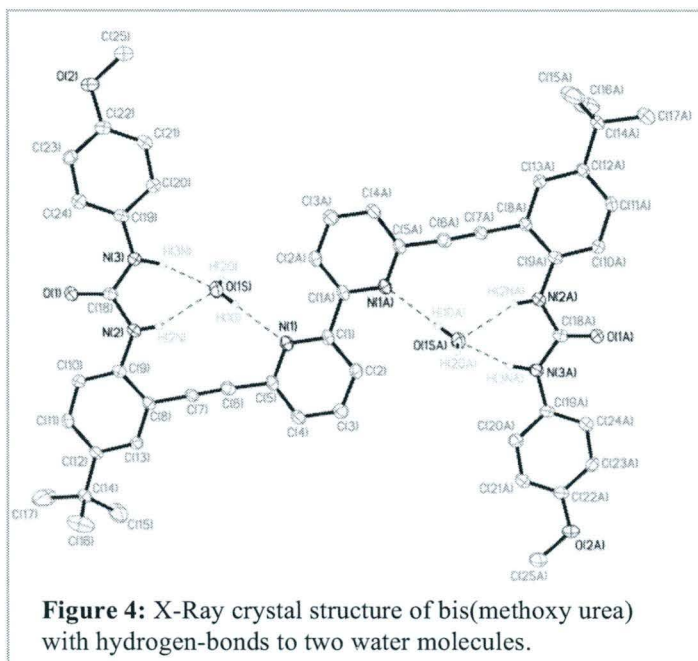
research has explored their ability to function as cation sensors.

This research explores a new receptor class built on a bipyridyl adaptation of 2,6-bis(2-anilinoethynyl)pyridine. This scaffold (Fig. 2) contains two articulate urea arms amenable to the addition of tailored functional groups for preferential binding based on the size and polarity of the targeted guests. Targeting ion-partners capable of cooperation, instead of cations or anions alone, increases selectivity and binding strength.¹⁰ Receptors built on this bipyridyl core are ditopic with two lone pairs of electrons on the bipyridine nitrogen atoms capable of coordinating Lewis acidic guests and two urea groups able to form up four hydrogen bonds with anionic guests. For this study, our research focuses on bis(methoxy urea), which is a member of this bipyridine-based receptor class bearing 4-methoxyphenyl ureas, and its ability to function as a ligand for relevant metal salts (Fig. 3).

One method to create molecular models is x-ray diffraction crystallography. By firing x-rays at organized crystals and studying the resulting diffraction pattern, we are able to generate a computational representation of the crystal's molecular structure. After slowly evaporating the chloroform-based solution, we

obtained crystals suitable for analysis. Figure 4 shows that, in its solid state, the receptor forms an S-shaped conformation with two water mol-

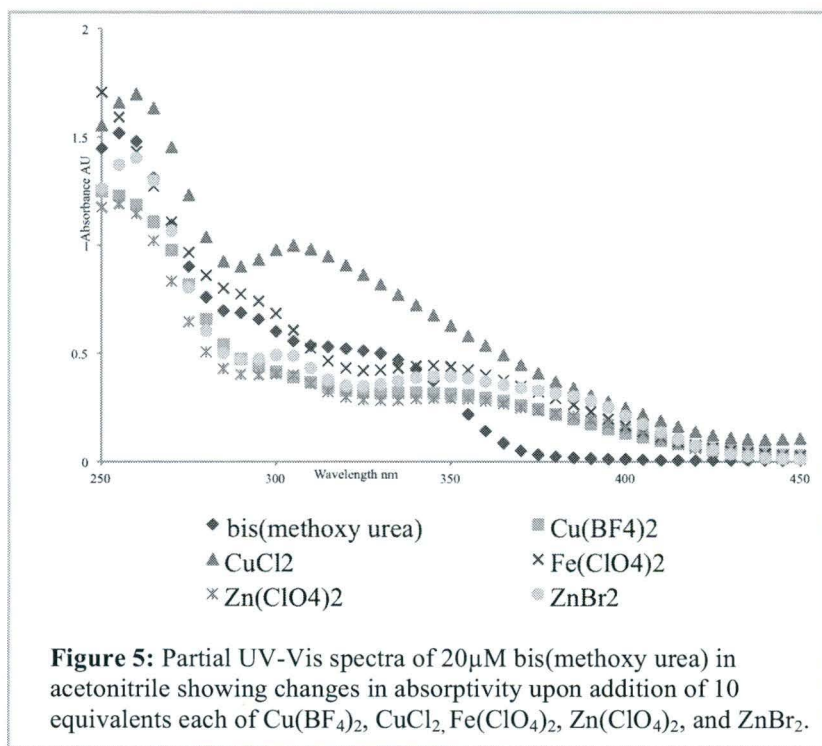




ecules coordinated. This structure provided further confirmation that we successfully synthesized our desired molecule. The coordination of polar water molecules demonstrates the ability of this receptor to bind guests simultaneously via the bipyridyl and urea moieties.

We were interested in determining the ability of this receptor to function as a fluorescent sensor for metal salts. Initially, we screened a number of metal salts—copper chloride, CuCl_2 ; copper tetrafluoroborate, $\text{Cu}(\text{BF}_4)_2$; zinc bromide, ZnBr_2 ; zinc perchlorate, $\text{Zn}(\text{ClO}_4)_2$; and iron perchlorate, $\text{Fe}(\text{ClO}_4)_2$ —in acetonitrile (MeCN) and measured the fluorescence of the free receptor and the receptor in the presence of metal salt. Unfortunately, we observed no visible fluorescence. Modifying the solvent system resulted in similar outcomes. These results indicate that this receptor is not well suited as a fluorescent sensor for the salts under study.

Another method to determine the ability of molecules to sense guests involved ultraviolet-visible (UV-Vis) spectrophotometry titrations.¹¹ Many molecules absorb ultraviolet or visible-spectrum light of various wavelengths. Generally, the host will absorb an amount of characteristic wavelengths that differs from the amount absorbed by the host-guest complex. Knowing the absorbance allows the use of Beer's Law to monitor the concentration of host present as we introduce a guest into solution. We obtained spectra by plotting absorbance measured in absorbance units (AU) against wavelength in nanometers (nm). By obtaining UV-Vis spectra after the repeated addition of small amounts of the guest molecule, we are able to follow the transition of free host to bound host in solution with increasing amounts of the guest. Aided by computer software we are



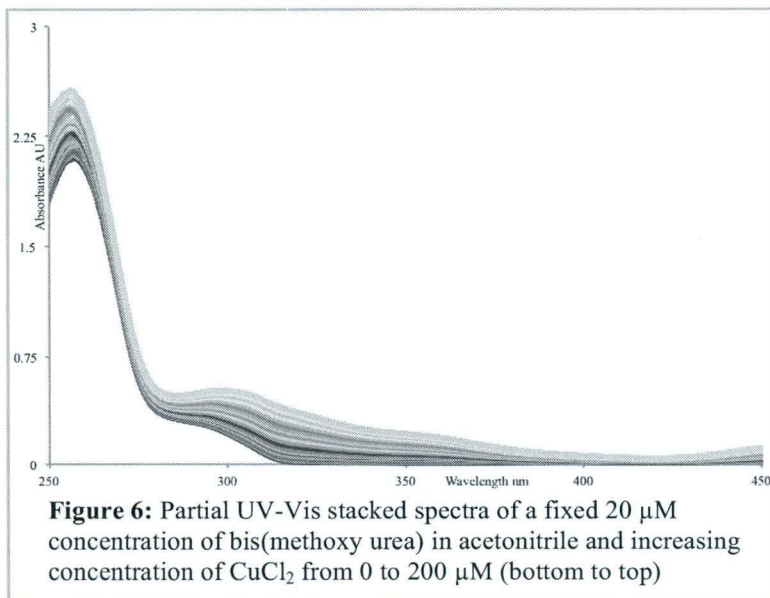


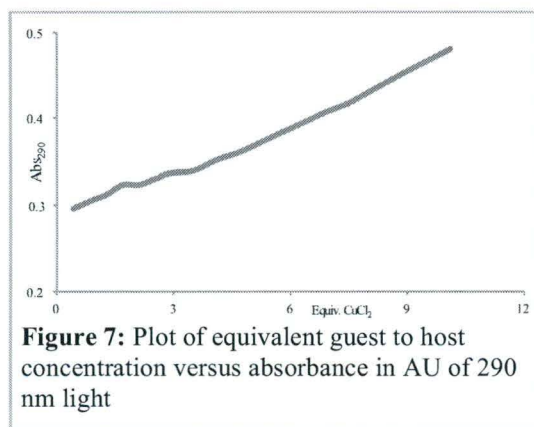
Figure 6: Partial UV-Vis stacked spectra of a fixed 20 μM concentration of bis(methoxy urea) in acetonitrile and increasing concentration of CuCl_2 from 0 to 200 μM (bottom to top)

able to extract from the data an association constant for the guest.

Initially, we screened several biologically relevant metal salts to determine which guests produced a meaningful response using UV-Vis. A 5 mM stock-solution of bis(methoxy urea) was prepared using MeCN in a volumetric flask. Aliquots of stock solutions of bis(methoxy urea) were diluted with the same solvent in a separate volumetric flask to yield a solution of approximately 500 μM concentration. In each case, we transferred 2 ml of this solution to a cuvette and used the remainder to generate the guest stock solution to maintain a constant host concentration throughout the titration. We used Hamilton gas tight syringes to add aliquots of the guest solution to the host solution in the cuvette and obtained spectra using UV-Vis. We acquired and removed a baseline sample of MeCN from each spectrum. In Figure 5, the diamonds represent the signal from bis(methoxy urea). Overlaid with the plot of bis(methoxy urea) are signals from five solutions containing 20 μM receptor-MeCN solution and 200 μM of either

CuCl_2 , $\text{Zn}(\text{ClO}_4)_2$, $\text{Cu}(\text{BF}_4)_2$, $\text{Fe}(\text{ClO}_4)_2$, or ZnBr_2 . All of the plots from the metal salts are relatively close together with similar slopes except for CuCl_2 , represented with triangles, that shows a substantially higher absorption. Changes in the levels of absorbance can indicate shifts from host to host-guest complexes, although inconclusive, merit further research.

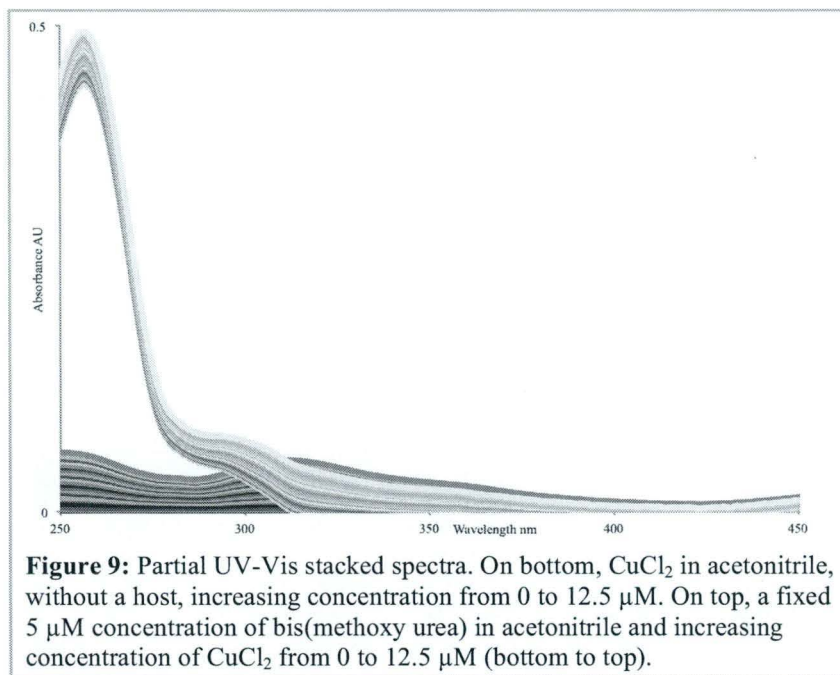
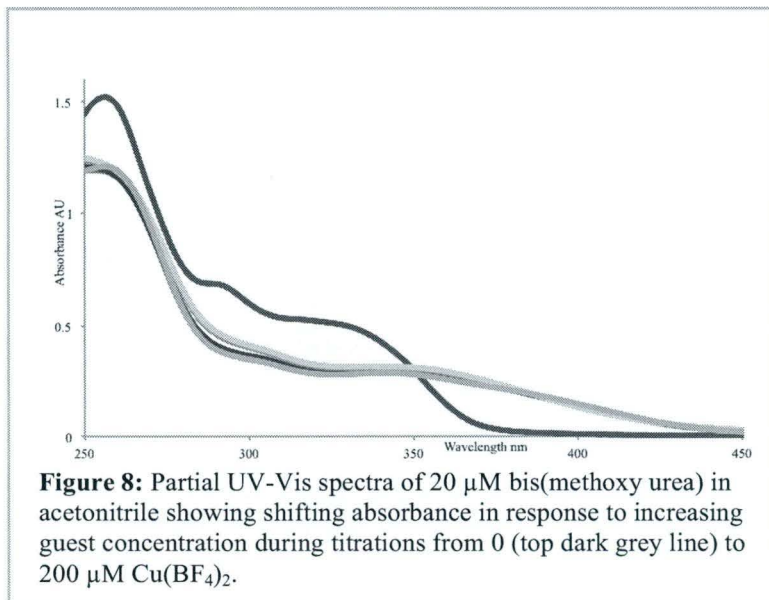
We conducted several titration experiments at various concentrations by incrementally adding CuCl_2 into solutions of the bipyridyl receptor in MeCN. Each time there was a substantial linear increase in absorbance (Fig. 6) but no isosbestic point indicating a clean transition from the host to host-guest complex.



In order to monitor titrations we plotted equivalence of guest to host versus absorption of a single wavelength. To confirm coordination, the graph should increase as guest is introduced into solution and then level off as the host becomes saturated,

creating a curved line. Figure 7 is a plot of 290 nm measured in the titration from Figure 6. Although the shifts in data were interesting, there was no saturation point indicating an alternative host-guest interaction.

We repeated the previous studies, replacing CuCl_2 with $\text{Cu}(\text{BF}_4)_2$. As tetrafluoroborate is a non-coordinating counter anion, we were able to study the effect of copper cation alone. The results were markedly different for this system (Fig. 8), in that there was a red-shift upon the addition of a minimal amount of salt, but no substantial additional shift with increasing concentrations of the cation.



We studied CuCl_2 by slowly increasing the ratio of guest to host and then repeated the trial with the same increments of guest but no host present (Fig. 9). This showed that CuCl_2 guest was absorbing in the range of the host molecule and interfering with the titration experiments. We remedied this problem by calculating what the absorbance of copper chloride should be at each titration point based on the molar absorptivity at a single wavelength (290 nm) and subtracting that value from the observed absorbance at the specified wavelength. The resulting graph revealed a decreasing curved line indicating coordination (Fig. 10). Future work will involve further calculations to account for how metal salt absorption may affect quantitative results.

This study has provided direction for future experimentation with this receptor class. Future studies will include bis(nitro urea) bearing 4-nitrophenyl urea groups and other adaptations to target other metal salts with this bipyridine core. These preliminary qualitative results have suggested bis(methoxy urea) may have copper specificity, but it is necessary to further explore these interactions.

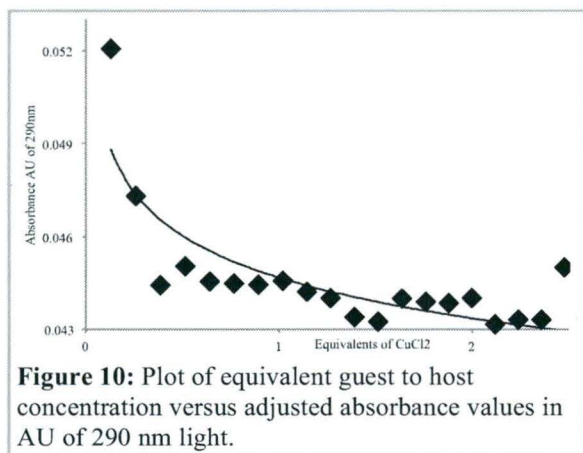


Figure 10: Plot of equivalent guest to host concentration versus adjusted absorbance values in AU of 290 nm light.

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Diversity of Microbial Traits in the Zebrafish-Gut Microbiota

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An estimated 10^{14} microbial cells are associated with the human body. Those microbial cells represent approximately 90% of the cells present¹ and most densely occupy the distal gut. In both presence and composition, the structure of the complex communities of microorganisms associated with the gut aid the development and health of the host.² In the model vertebrate zebrafish (*Danio rerio*), the gut microbiota regulates aspects of gut-epithelium development,³ primes the host immune system against the invasion of pathogens,^{4,5} and regulates intestinal homeostasis.⁶ Further, changes in the relative abundance of Bacteroidetes and Firmicutes, the two dominant bacterial divisions found in the distal gut,⁷ occur in lean versus obese phenotypes in both humans and mice.^{7,8} Moreover; several disease phenotypes (including inflammatory bowel disease) are associated with altered gut microbial compositions.⁹ Despite the need to understand the ecological processes determining the structure of the vertebrate gut microbiota, elucidation of the processes structuring the gut microbiota is incomplete.

The vertebrate gut is a unique environment with a unique microbiota. Several interconnecting factors determine the gut microbiota; those

factors include diet,⁸ environmental drivers,¹⁰ host filtering,^{10,11} and microbial community interactions.^{2,12} Studies of co-occurring microbes and their interactions (e.g., niche competition, cooperation, facilitation, and inhibition) have focused on microbial communities associated with the human mouth. However, more recently, research has been gravitating towards studying the whole human microbiome as we realize its important role in human health (e.g., The Human Microbiome Project). I investigated the diversity of individual traits of the microbes in the gut microbiota because they may predict how well microbes establish and proliferate in the gut. To do this I used the *Danio rerio* model, which is ideal for this study because it can be reared germ-free and inoculated with known microbes.

We derived 66 individual taxa of microbes from conventionally-raised zebrafish and then isolated, identified, and characterized 19 taxa, representing 17 unique genera and 6 phyla of the known gut community. The primary methodology depended on measuring several common traits using well-established and efficient bacterial culture assays.¹³ The measurements focused on motility (possession of a mechanism by which to move), speed, doubling time, hemolysis (production of a protein that opens blood cells), biofilm production (the ability of cells to attach to a surface and encase themselves within a protective structure made of polysaccharides and proteins), mono-associated colonization (assembly and growth of a population in the germ-free gut), and co-associated colonization (assembly and growth of a population in the germ-free gut along with another known microbe). The choice of these traits rested on the assumption that, if possessed by some organisms but not others of the community, there may be a possible advantage in assembly and persistence in the gut.

Materials and Methods

Bacterial strains and culture conditions. The bacterial strains in this study are listed in Table 1. All strains used in this experiment were maintained in glycerol stocks stored at -80°C . Each time an assay was conducted, these bacterial strains were grown in overnight cultures for the following day (except where indicated).

Isolation of bacterial strains. The bacterial strains listed in Table 1 that originated at the University of Oregon were derived by sampling dissected guts from zebrafish conventionally reared in the UO zebrafish facility. All bacterial strains (conditions in Table 1) were derived from fish

Strain ID	Phylum	Host Facility Origin	Culture Condition
ZOR0001	Gamma Proteobacteria	This study UO	Aerobic; 30°C ; LB / TSA
ZOR0002	Gamma Proteobacteria	This study UO	Aerobic; 30°C ; LB / TSA
ZOR0008	Gamma Proteobacteria	This study UO	Aerobic; 30°C ; TSA
ZOR0011	Gamma Proteobacteria	This study UO	Aerobic; 30°C ; BHI / TSA
ZOR0012	Gamma Proteobacteria	This study UO	Aerobic; 30°C ; BHI / TSA
ZOR0014	Gamma Proteobacteria	This study UO	Aerobic; 30°C ; NA / M17
ZOR0017	Beta Proteobacteria	This study UO	Anaerobic; 30°C ; BHI; *
ZOR0019	Actinobacteria	This study UO	Aerobic; 30°C ; BHI; *
ZOR0020	Actinobacteria	This study UO	Aerobic; 30°C ; BHI; *
ZNC0006	Beta Proteobacteria Beta	U. North Carolina	Aerobic; 30°C ; BHI
ZNC0007	Proteobacteria Beta	U. North Carolina	Aerobic; 30°C ; BHI
ZNC0008	Proteobacteria Alpha	U. North Carolina	Aerobic; 30°C ; BHI
ZNC0028	Proteobacteria Alpha	U. North Carolina	Aerobic; 30°C ; BHI
ZNC0032	Proteobacteria Alpha	U. North Carolina	Aerobic; 37°C ; stationary BHI broth
ZNC0037	Proteobacteria Gamma	U. North Carolina	Aerobic; 30°C ; Columbia
ZWU0006	Proteobacteria	U. Washington	Aerobic; 30°C ; BHI / LB / TSA
ZWU0009	Firmicutes	U. Washington	Aerobic; 30°C ; BHI / LB
ZWU0011	Firmicutes	U. Washington	Aerobic; 30°C ; BHI
ZWU0020	Gamma Proteobacteria	U. Washington	Aerobic; 30°C ; BHI / TSA

LB = lysogeny broth TSA = tryptic soy agar BHI = brain heart infusion NA = nutrient agar

* sonicated gut for 4 minutes

Table 1: Strain ID, origin, and characteristics.

at various ages and by altering the growth conditions (aerobic, anaerobic, sonication, boiling) and the media (nutrient contents) in which they were incubated. Several of the strains listed in Table 1 originated from University of Washington and University of North Carolina.

Motility assays. Motility assays were performed on 2.5-2.7 mg ml⁻¹ Bacto Agar plates consisting of 10 mg ml⁻¹ tryptone and 5 mg ml⁻¹ sodium chloride. Plates were stabbed with one fresh colony grown on Tryptic Soy Agar (Difco), incubated at 30°C for 16 hours, then placed stationary at 30°C for 4-6 hours. Controls for this assay consisted of a motile wild-type *E. coli* strain (positive control) and a non-motile mutant-type *E. coli* (Δ fliM) (negative control). (For more information on these strains, see Eberl & Boneca.)⁵ The area of outward migration from the site of inoculation was recorded with an Apple digital camera. The standard size of *E. coli* growth area was compared to growth areas of the zebrafish isolate strains in Table 1 to determine binary results. Strains with growth areas most similar to wild-type *E. coli* were considered motile, and those with growth areas most similar to Δ fliM were considered non-motile.

Video speed assay. Brain Heart Infusion (BHI) broth was inoculated with one fresh colony plated on BHI agar and then grown at 30°C until the liquid culture reached an optical density at 600 nm (OD₆₀₀) of 0.05 $\pm$ 0.025, corresponding to mid-exponential phase. I used a protocol devised previously to record speed.¹⁴ Samples of 2 μ l for each culture were transferred into a 10-well microscope slide (MP Biomedicals), ten strains at a time. With a cover slip placed on top of the slide, videos were taken through a 203 objective lens at 15 frames per second using a Cohu CCD camera (model 4912) and USBVision Capture software. Videos were analyzed using custom particle-tracking programs written in MATLAB. Analysis was performed on inverted image frames (white bacterial particles on black background) of 352 x 240 pixels where 1 pixel

equaled 1.73 μm . Background and nonmotile particles for each frame were digitally removed by subtracting the average image intensity, integrated over the entire movie. Tracked particles were identified as local intensity maxima in high-pass filtered and thresholded images, with a filter size of 4 pixels and an intensity threshold of 99%. Each particle's position was assigned to be the centroid of the thresholded object. The bacterial length (approximately 3 μm) spans several pixels, and so centroid finding provides a measure of localization that is sufficiently precise relative to bacterial size. Particles were constructed into tracks by searching for the nearest particles in adjacent frames. Particles needed to be within 7 pixels of each other to be considered part of the same track. When edited, tracks longer than 1 sec or a frame-to-frame variance greater than 1 pixel were retained. Any segment of a bacterial track was included in the analysis if it lasted for at least 1 second (15 frames) without containing any of the following: a NaN (not a number; particle not tracked for that particular frame), a turn greater than 90 degrees, or movement less than 0.5 pixel for one frame. The average distance traveled per frame for all the included data is the mean speed (in pixels/frame).

Bacterial growth curve and doubling time calculations. Bacterial cultures were inoculated with BHI broth from a single colony that had grown overnight on BHI agar plate stationary at 30°C, then shaken at 200 RPM and 30°C. Culture samples of 1 ml were removed every 30 minutes for an average of 200 minutes and recorded. The natural log of the OD₆₀₀ measurements for each time point were plotted versus time using R statistical software. A regression analysis of the data was used to calculate the doubling times at exponential growth.

Hemolysis assay. Hemolysis assays were performed using blood agar plates consisting of Fastidious Anaerobe Agar with 10% defibrillated sheep blood (Hemostat). Bacterial strains were inoculated on agar plates

from colonies grown overnight on BHI agar plates at 30°C. Bacterial cells were streaked on agar surface and stabbed into the agar to create oxygen labile pockets, incubated at 30°C, and observed frequently for three days for any clearing or discoloration of blood agar surrounding colonies. No control was used. Results were recorded with an Apple digital camera, and clearing and discoloration were compared across all plates.

Biofilm assay. Biofilm assays were performed using 18x150 mm Borosilicate glass culture tubes (VWR). Tubes containing 100 ml of BHI broth were inoculated with single colonies that were grown overnight at 30°C on BHI agar plates. The bacterial tube cultures were stationary and incubated at 30°C for 4 days and closely observed for visible biofilm formation at the air-fluid surface and glass-liquid interfaces. Observations were recorded with an Apple digital camera. After 4 days the cultures were diluted with 1 ml of sterile 1% potassium bisphosphate (PBS) solution. Next, 1 ml of 1% crystal violet was added to the cultures before they were set stationary for 15 minutes at room temperature. The culture was gently removed and the tubes gently rinsed with sterile PBS. Bacterial cultures that produced violet bands on the glass of tubes were considered to have formed a biofilm. The biofilms were then classified as biofilm, weak biofilm, and no biofilm, depending on the thickness and intensity of the violet bands.

Colonization assays. Zebrafish for this assay were derived by using a standard protocol for generating zebrafish embryos, deriving and rearing germ-free zebrafish, and colonizing zebrafish with microorganisms.¹⁵ The sterilized eggs were transferred into flasks with 50 ml of growth medium (BHI or TSA broth depending on the medium of origin) and incubated until they reached 4 days post fertilization (dpf). Mono-associated colonization assays were performed by inoculating BHI and TSA broth (depending on which was broth of origin) from glycerol stocks of bacterial strains.

When the fish reached 6 dpf, their guts were dissected and manually homogenized before 10 µl samples were spot-inoculated onto BHI and TSA agar plates (depending on medium of origin). The plates were air dried, and then placed at 30°C overnight. Colony forming units (CFUs) were counted, and an industry-standard calculation was used to estimate the cellular concentration within the gut samples at the time of dissection. Co-association assays were conducted in the same way except that two strains at a time were introduced into the flasks instead of one. Seven strains that successfully colonized in mono-associations were co-inoculated with ZOR0012, which also successfully colonized in mono-associations.

DNA collection and extraction. DNA was extracted from isolated cultures using the Ultraclean microbial DNA extraction kit from MoBio. Extracted 16S rDNA sequences from isolates were amplified by polymerase chain reaction (PCR) using 27F and 1492R primers. Sequences were purified using GeneJET PCR purification kit from ThermoScientific and sent to Sequetech (<http://sequetech.com/>) for sequencing. Strains were then assigned a taxonomic identification by matching sequences to a 16S sequence database (Green Database).

Results

Motility and speed traits across 19 taxa in zebrafish-gut microbial community. Motility and video speed assays revealed (Fig. 1) that 14 of the 19 strains measured exhibited motility. Among the motile strains, the motility speed ranged from 1.9 to 3.1 µm/second. I was unable to obtain speed data for one of the strains.

Hemolysis across 19 taxa in zebrafish-gut microbial community (Fig. 1). Oxygenic Beta hemolytic activity was observed in 9 of the 19 measured taxa. Aerobic Alpha hemolysis was observed in 1 of the strains, and 1 of the Beta hemolytic strains also exhibited anoxygenic (in oxygen labile pockets) Beta hemolytic activity.

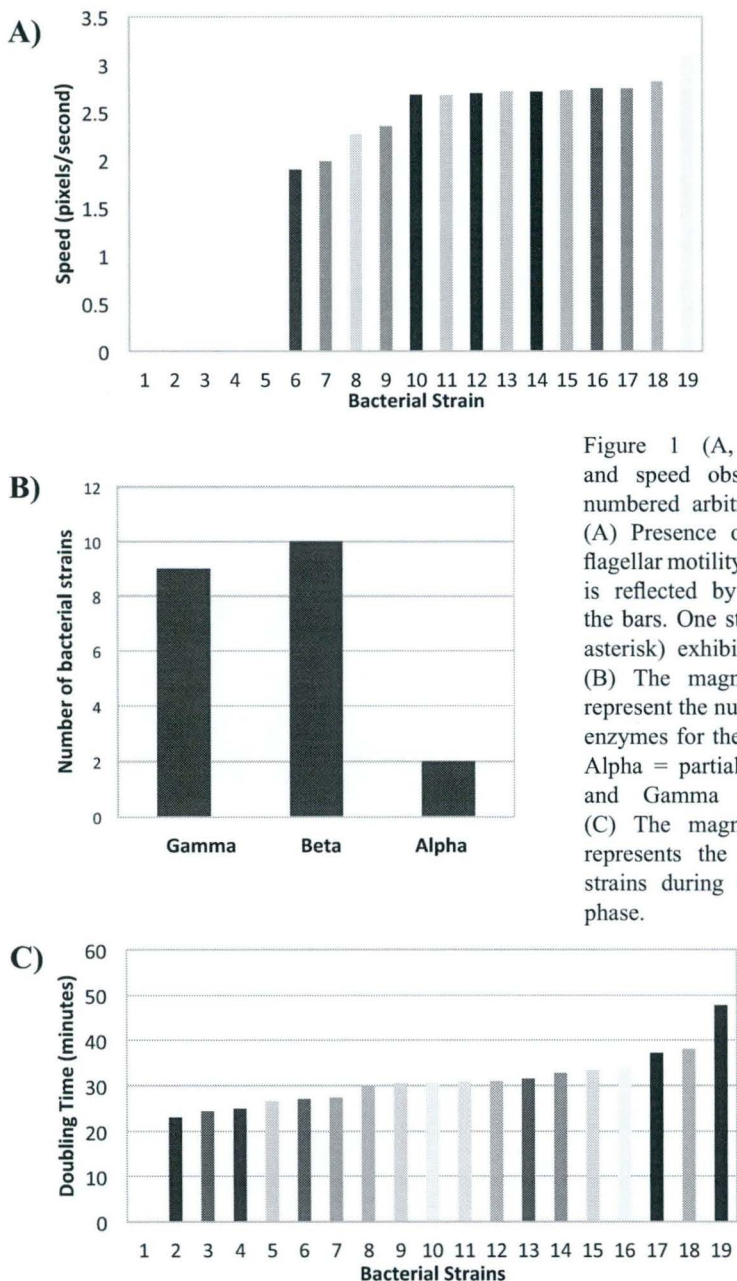
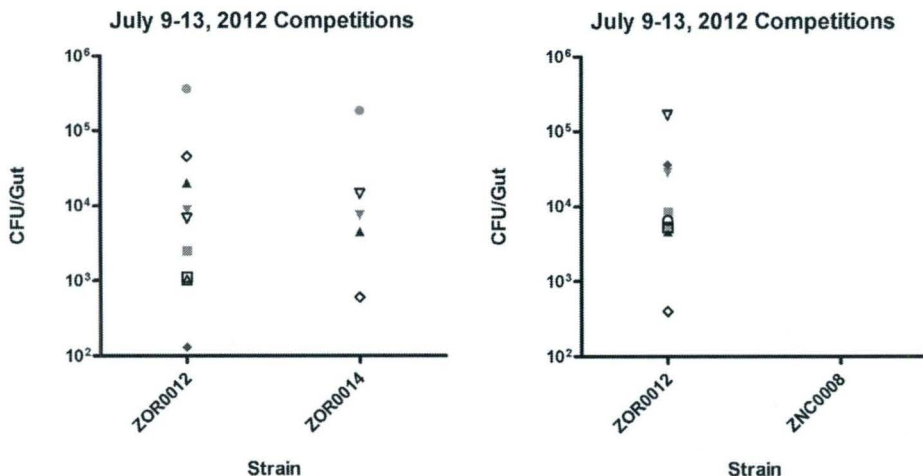
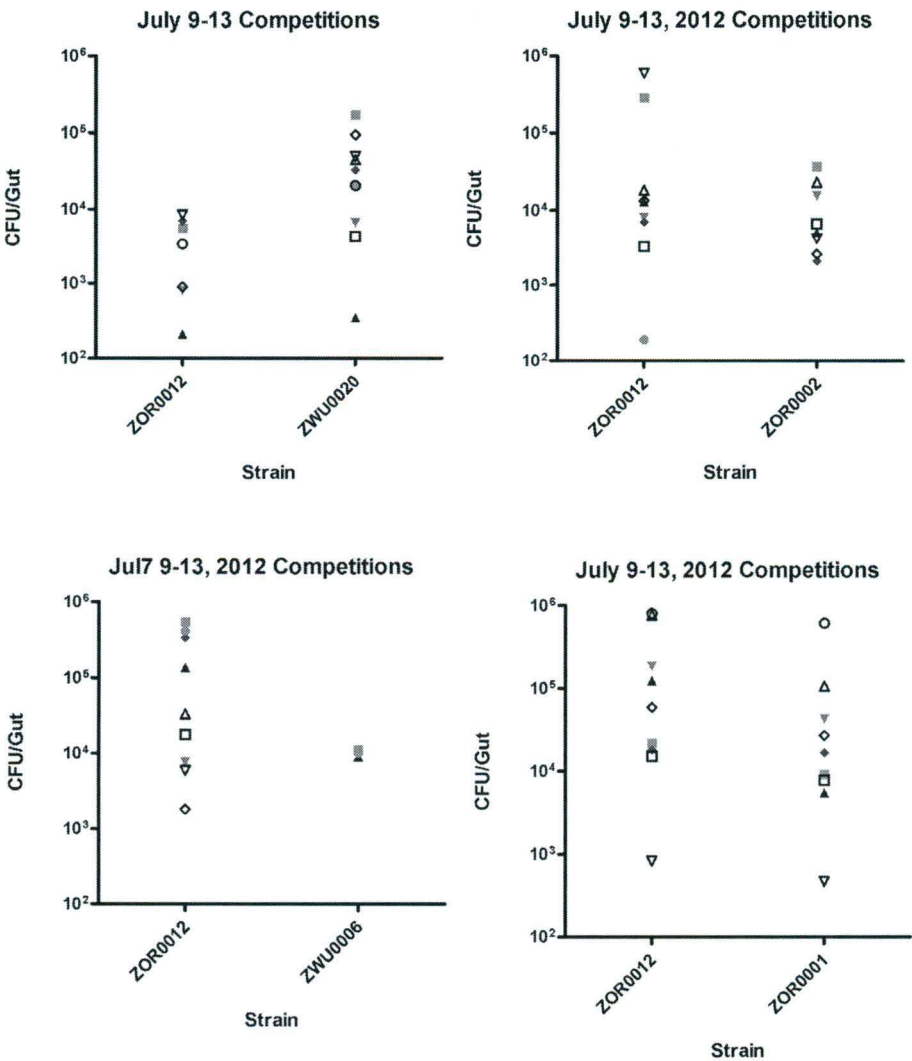


Figure 1 (A, B, C): Motility and speed observed. Strains are numbered arbitrarily in all charts. (A) Presence of a bar represents flagellar motility on the graph; speed is reflected by the magnitude of the bars. One strain (noted with an asterisk) exhibited twitch motility. (B) The magnitude of the bars represent the number of strains with enzymes for the type of hemolysis; Alpha = partial, Beta = complete, and Gamma = no hemolysis. (C) The magnitude of the bars represents the doubling time for strains during exponential growth phase.

variability across gut samples, a result also demonstrated in previous work. The source of the variability across gut samples within strains is unknown. Possibly, the variability occurs because of the inconsistent size of gut dissections. Strain ZOR0012, which successfully colonized in mono-associations, was co-inoculated with 6 other strains that also successfully colonized in mono-associations. Co-inoculations demonstrated variability as well. In the co-inoculation of ZOR0012 and ZNC0008 (Fig. 3), ZOR0012 colonized and ZNC0008 never colonized successfully. In the co-inoculation of ZOR0012 and ZWU0006, again ZOR0012 colonized, yet ZWU0006 colonized in only 3 of the 12 fish sampled. In all other co-inoculations both strains were able to colonize. These results suggest the possibility that competition is occurring between some strains during colonization, and that the degree of competitive success may be affected by other variables (including host factors).

Figure 3: Co-association of isolates in the zebrafish gut. Each point on the charts represents one CFU enumeration and each set of points represents all the gut samples inoculated and enumerated from one group of fish inoculated with the same strain.





Discussion

This study reveals that the 19 taxa of the zebrafish microbiota do not all share the same traits. Diversity of traits in a microbial community may mean that the gut habitat is not homogeneous (has a variety of niche, pH, and salinity levels) or that the gut does not strongly filter for specific types of microbes. Therefore, a more thorough examination of the whole gut community should be measured with more representatives of the gut community included. Future investigations should involve a power analysis to determine the number of representatives that would be most informative for a better understanding of the vertebrate-gut ecosystem.

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Foods that Nourish Us: Climate Change Impacts on Indigenous Culture in the Pacific Northwest

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Introduction to Climate Change and Indigenous People

Climate change is a major issue facing indigenous people today partly because of their strong cultural relationship to their homelands.¹ In addition, the place-specific status of treaties means that tribal people cannot simply move when climate change negatively impacts their homes.² Together, these effects lead to disproportionate climate change impacts for indigenous people.³ In the Pacific Northwest, climate change and its effects on indigenous people are raising concerns in native communities. The changing relationship to their traditional foods has emerged as a particularly strong concern for many native people in the Northwest.⁴ An increasingly severe set of impacts associated with climate change such as loss of traditional gathering sites due to sea level rise, changing distributions of first-food species, and the decline in health of riparian species, such as salmon, make up these challenges.⁵ Historically and today, colonization and industrialization negatively impact traditional, first-food use in the Pacific Northwest compounding the effects of climate change.⁶

An emerging body of literature focuses on the effects of climate change on first foods in the Northwest. This research details how the impacts of shifts in climate as well as climate change policy are affecting

native peoples. Much of the existing research acknowledges the cultural and religious importance of these foods and the potential impact that climate change could cause to native cultures. However, the research does not explore the depth of cultural importance that first foods have to indigenous society, and especially to native family and sovereignty. Little of the existing research makes meaningful links between nuanced understandings of the multifaceted cultural importance of first foods with the ongoing and projected effects of climate change on the cultural aspects of traditional food use. Instead, much of the research focuses on quantifying or cataloguing how climate change affects first-foods species and how change affects the ability of indigenous people to continue to use these foods. Existing literature often treats first foods as a resource, as something to be counted and monitored. Scientific studies tend to quantify and track first-foods species and document the nutritional importance of first foods, while social research tends to explore access to first foods as an issue of resource management.⁷ Little has been written, however, on climate change in the Northwest as an issue primarily about culture. Existing research does not lend itself to link the cultural elements of first-food use with the impacts of climate change. Instead, current research tends to focus on how, when, and where first foods are accessed, and how access will be impacted by climate change. Having developed for thousands of years alongside first foods, native cultures are deeply intertwined with those foods and the traditions surrounding their use.⁸ The continued use of these foods, then, is profoundly important as an expression of native culture.⁹ Therefore, understanding how native culture becomes impacted by climate change and first-food loss provides a critical avenue for allowing native people to protect their culture.

Viewing native peoples' relationship to first foods through the lens of resource management and quantification may actually be counter-productive for indigenous efforts to maintain the security of first foods

in the face of climate change. Overlooking the cultural importance of first foods leaves an incomplete understanding of how they are integral to indigenous cultural functioning in the Northwest. Instead, it places first foods within a broader climate change narrative that reduces the environment to natural resources that are becoming increasingly scarce. I suggest that overlooking the cultural importance of first foods construes the devastating cultural impacts of climate change on different peoples as simply quantifiable while ignoring the complex relationship between native people in the Northwest and traditional foods. For example, the loss of foods, such as salmon who have immense religious importance, would rob the ability of many coastal peoples to practice their religions.¹⁰ Additionally, viewing first foods as a resource ignores the historical context of first-food use and colonization in the Pacific Northwest. This historical relationship between first foods and culture that developed among native people offers a more complete understanding of how first foods impact and shape native culture, and how native culture will therefore be affected by climate change with the loss of first foods.

Without exploring what first foods have meant in the past, and how that meaning has translated into today's native communities, it is difficult to assess the cultural importance of these foods. As the destruction of fisheries and the decreased gathering of roots, berries and other foods across the Northwest during the late 19th and early 20th centuries have demonstrated, immense cultural loss accompanies the diminished access of native people to first foods. First-food loss becomes cultural loss, because of the vital role that these foods play to indigenous culture. Drawing from the history of colonization in the Northwest helps to establish the important cultural role that first foods have played and continue to play in native culture. This historical perspective facilitates moving beyond viewing first foods only as a resource and lends credibility to the argument that first foods and climate change are issues of culture. Furthermore,

the efforts of native people to maintain a relationship to first foods in the face of both colonization and climate change paints a vivid picture of the importance that these foods have had for native cultures through time and the impacts that first-food loss can have for native people now and in the future. Finally, discussing climate change alongside colonization provides a more concrete understanding of issues facing native people today. Cultural and natural resources are affected by colonial and climatic issues simultaneously and in interrelated ways.¹¹

My research has two principal goals. First, the research ties together tribal and First Nations accounts and writings about the importance of first foods in their communities in order to draw out the vital roles that these foods play throughout the Pacific Northwest. Second, my research explores how the impacts of climate change may affect the important and unique roles that first foods play in many cultures in the Pacific Northwest. The impacts of climate change, however, should not be viewed in a vacuum. Culture is something that changes and evolves over time, and therefore the past relationship between native people and first foods needs to be considered alongside the current place of first foods in native culture. I compare oppression of first-food use during historical colonization to the potential and ongoing impacts of climate change on first foods today. In doing so, this research ties together native and scholarly voices on the cultural importance of first foods with emerging research on the potential impacts of climate change on these foods, while drawing lessons from the history of threats to first-food use in native North America.

First foods are deeply embedded within many aspects of indigenous cultures in the Pacific Northwest. Family, kinship, and sovereignty are aspects of indigenous cultures in which first foods play integral roles. The gathering of first foods is structured around family relationships, and likewise first foods shape native definitions of family.¹² Historically,

sovereignty was denied to native people in part by denying access to first foods, and the sovereignty of modern native people still depends on the continued ability to access first-food species.¹³ These particularly important aspects of first-food use help to establish a stronger understanding of what is at stake as first foods are threatened by climate change. Breaking first foods into the aspects of family and sovereignty helps to illuminate the complex cultural importance that first foods have in native communities of the Northwest. Yet family and sovereignty are not all encompassing. Some important aspects of first foods may not fit within family or sovereignty. Moreover, there are many cultures and by extension ideas, philosophies, and relationships to first foods in the Pacific Northwest. This research does not claim that these diverse worldviews are somehow identical. Instead, while recognizing that the aspects of family and sovereignty are far from comprehensive, this research seeks to synthesize existing voices concerning the importance of first foods and to provide an understanding of how first foods and climate change are important issues in today's native Northwest. By giving greater voice to indigenous people on issues of climate change, this research helps to explain to the community-at-large the traditional importance of first foods, the struggles native people have faced in the past to continue first-food use, and the impacts that climate change can have on these foods. Climate change, with its impact on first foods, poses a threat to the indigenous family and indigenous sovereignty by denying native people in the Northwest access to those foods. Furthermore, comparing the effects of colonialism and the potential of climate change reveals that colonialism contextualizes the impacts of climate change. Viewing these effects as common and part of a continuum of negative impacts to first-food use gives a more complete understanding of cultural importance of first foods and demonstrates how the health of first foods is central to indigenous wellbeing.

First Foods and their Role in Family and Kinship

First foods have a long and multifaceted role in family life in native communities, a role first challenged by colonization and again by climate change. Since time immemorial, native families have come together spatially and interpersonally by gathering traditional foods. Therefore, gathering first foods provides culturally meaningful places and activities that bind families to ancestral and traditional practices. Moreover, the manner in which families gather food, not simply the accumulation and consumption of those foods, brings them together. The relationship between first foods and native people in the Northwest has shaped how native families function and defines the roles that kinship play and have played in native communities. Traditional foods have provided a space for creating and maintaining family networks and have shaped native conceptions of family. Denying access to first foods was a main colonial tool used to weaken native families; similarly, climate change represents an attack on the ability of indigenous families to maintain themselves.

For the Witsuwit'en and Gitskan people of British Columbia, seasonal gathering binds together families through a system of usufruct and family-dependent gathering. Gathering of fish, plant and game was traditionally carried out across a wide territory according to the seasonal availability of different foods. This method of traveling from area to area in order to gather is called a seasonal round. Richard Daly describes how "the seasonal round [today] still involves a flexible system of seeking and granting use permission from the House group's...chiefs and the reciprocal use of territories by neighbouring chiefs, who often have kinship or marriage links with one another."¹⁴ Usufruct rights to harvest at certain locations are tied to complex family networks. Daly also describes how "due to the flexible system of sharing and reciprocating with seasonal use rights to hunting territories, [community] members...had the option of spending

the bulk of the winter with either a set of in-laws, with their father's kin... or simply with their own chief."¹⁵ These seasonal gathering rights and relationships show how familial ties were established and maintained through mutual access to first foods; family is expressed through peoples' dependence on first foods. The act of gathering first foods binding families together is not unique to British Columbia, as cultural practices of salmon fishing on the Columbia River demonstrate.

Traditionally, salmon were an integral part of determining and maintaining family on the Columbia River, both because of family-owned fishing spots, and because of the unique cultural space provided by those fishing places. Salmon were key to survival for people on the Columbia; having access to productive fishing spots was necessary to maintain one's family. A system of inherited fishing spots ensured that families would have continued security in their access to the precious salmon.¹⁶ At culturally important fishing places, such as Celilo Falls, these inherited fishing spots brought together distant relatives from all along the Columbia. The impact that Celilo and other central fishing spots had on tribal people cannot be overstated. Nez Perce tribal member Leroy Smith states that "We didn't just go to Celilo to catch fish. Celilo was the place to go to be with your relatives, to trade for other goods, to play games, gamble, and it was a good place to find a mate."¹⁷ Celilo Falls was a culturally unique place that facilitated not only traditional fishing, but also brought together native families. As Smith noted, these inherited fishing spots also dictated, in part, marriages along the Columbia.¹⁸ Marriages between families with access to different fishing areas allowed people to extend their family trees, and in doing so guaranteed a larger security blanket for both families. Salmon, in a way, dictated marriages on the Columbia River through inherited fishing access. More broadly, "marriages-for-salmon" maintained strong inter-tribal/inter-community relationships that provided cohesion and strength

along the river. As the fishing spots have historically played a strong role in determining marriages along the Columbia, so they continue to play a role in defining what it means for a person to be someone's relative. In other words, sharing fishing rights is a unique expression of family along the Columbia.

Salmon is so integral to Columbia River people that many identify the fish as their kin.¹⁹ In a video testimony of salmon's importance on the Columbia River, one tribal fisher states that "salmon was presented to me, my family, through our religion as our brother, the same with the deer. And our sisters are the roots and the berries. And you would treat them as such, their life is just as valuable to you as another person would be. And you treat them with that respect for their life and in return they're going treat you the same with their life. That's the way I was told. You know, it's faith. It's a faith that I believe in, it's a faith that I try to instill into my children... that can't go away, there's no way out of it. It's a way of life."²⁰ In many ways, then, first foods are actively shaping indigenous conceptions of family. Including salmon in one's family mandates that the fish be treated with respect and gratitude. On the Columbia, family can also mean all of one's relations, not just those of the same species. Salmon, who are related to native people through legends and by their mutual dependence on the Columbia River, form part of an extended family that exists outside the current Western definition of the word family.²¹ A loss of salmon, therefore, represents a loss of the vehicle by which indigenous Northwest people express their love and relation to other beings, as well as a loss of community. Although this would not necessarily be considered an issue of family in the West, it is an entirely different situation on the native Columbia River.

Viewing both historical and current threats to salmon in light of their status as native family sheds light on what is at stake with climate change

and indigenous people. The struggle of native people to maintain the health and integrity of salmon can be understood as the obligation of one family member to another. When viewed in this light, preservation of salmon and native peoples' relationship to salmon is not merely about access to a quantity of salmon; it is about the quality of access. Having a healthy relationship to a family member depends just as much on having culturally meaningful spaces and activities to bring family together as it does on having an allotted amount of time to spend with one another. Native people depend on the upkeep of traditional fishing spots and practices to maintain a strong relationship to salmon, both for its cultural benefits to native family and because salmon are kin. Colonization, however, has diminished the strong relationship between native people and salmon on the Columbia. The link between colonization and climate change exposes how changes to climate can create new problems for the native family as well as amplify existing problems.

The traditional importance of salmon to family on the Columbia was not something that halted after colonization. However, colonization dealt devastating blows to salmon fishing. For example, construction of the Dalles Dam permanently submerged Celilo Falls, destroying a central fishing place and rallying point for native families.²² The important role of Celilo and the cultural loss resulting from its destruction demonstrate how first foods provide unique cultural spaces that express what native family means. As the cultural devastation caused by the loss of Celilo shows, it is not just access to salmon that determines native family, but also the existence of traditional gathering spaces. These spaces are filled with tradition and history; coming together in these spaces connects native people to their ancestral culture and continues a culturally meaningful activity that shapes family. Despite efforts of colonization to destroy these culturally important fishing places, salmon has continued to play a central

role in both family practices and the concept of kinship on the Columbia River. However, the legacy of this relationship is rife with oppression and struggle.

Columbia River salmon have faced an increasingly degraded home since European colonization. Commercial fishing in the 19th and early 20th centuries decimated once plentiful salmon runs, crippling the runs of salmon up the river.²³ Construction of dams on the Columbia and its tributaries has restricted access of salmon to their spawning grounds, further damaging their ability to thrive. Today there are 219 dams on the Columbia and its tributaries, with over 40 on the Columbia itself.²⁴ These dams have meant a serious reduction of the wild fishery. The pre-contact salmon fishery on the Columbia and its tributaries has been estimated at 15-20 million salmon migrating annually, compared to a low of 500,000 in the late 1970s, and to approximately 1.5 million in 2011.²⁵ Since colonization, wild salmon runs have been crippled and make up only a minuscule fraction of the total runs.²⁶ In addition to a dramatic decline in salmon numbers, native people must now compete with commercial and recreational fishers for access to fish, which further reduces the amount of salmon available when compared to ancestral rates and harvesting practices. A major component in maintaining salmon runs in the face of declining wild salmon populations has been the proliferation of hatcheries, which account for the large majority of salmon spawned on the Columbia and its tributaries. While hatcheries have managed to keep salmon runs at viable levels, they come with their own set of problems, such as lack of genetic diversity in hatchery populations.²⁷ In other words, hatcheries are far from a perfect solution and have been a point of increasing contention in salmon restoration.²⁸ Despite these challenges, native people continue to fish for salmon, although at a highly diminished level.

For native people the systematic denial of access to salmon on

the Columbia remains a major problem for families on the river. The construction of dams, unequal access to fishing during colonization, and the overharvesting of the salmon fishery depleted the number of fish running up the river and reduced native access to salmon.²⁹ Lowering the number of salmon is an obvious blow to indigenous access. In addition, the monopolization of productive fishing spots and the devastating effects of such projects as the Dalles Dam destroyed important traditional gathering spaces. Taken together, colonization and industrialization have simultaneously attacked salmon health, restricted the ability of native people to access what salmon remain, and undermined the continuation of critically important, traditional gathering spaces. However, those negative aspects have been met with continued resistance. Families that had once inherited fishing spots and bonded over salmon fought throughout the 20th century to keep their rights to fish.³⁰ These legal battles eventually led to the enforcement of the legal rights of native fishers on the Columbia, ensuring their continued access to salmon.³¹ Additionally, the proliferation of hatcheries has helped to ensure that salmon fishing will continue for future generations.³² The continuous struggle of native Columbia River people to protect their relationship to salmon demonstrates how integral it is to their way of life and their concept of family. However, declining salmon health and fishing shows that the relationship between native people and sacred salmon is already in danger. The effects of climate change stand to exacerbate this already stressed relationship.

Just as colonization altered river conditions to make rivers less welcoming to salmon, climate change threatens to make the Columbia and other rivers in the Northwest inhospitable for salmon. River temperatures, rising at dangerous rates for salmon, cause a wide variety of challenges for them. As fish migrate up rivers, they rely on temperature signals that are unique to their migratory route to guide them.³³ Changing water

temperatures disrupt temperature signals, making it more difficult for salmon to migrate. Additionally, salmon rely on patches of cool water to rest during their migration.³⁴ Without the cool patches, more salmon perish during migration, as they waste more energy traveling, reducing the health of each run. For Nisqually people, serious concern about declines in salmon runs because of increasing river temperatures has led to massive efforts, such as rechanneling sections of the river system in an effort to provide more low current, cool water eddies and decreasing water temperature in the Nisqually watershed.³⁵ Warmer water causes other problems as diseases become more prevalent with rising water temperatures.³⁶ Even changes in ocean temperature are playing a role. Salmon migrations are affected by ocean temperature increases, which discourage runs from moving up river.³⁷ Furthermore, extreme weather events such as floods and landslides are projected to increase and cause even more stress to freshwater salmon.³⁸ These forces are acting to deplete the salmon fishery, further lowering the numbers of running salmon. These changes create even more concern because hatcheries will be unable to compensate for the loss of salmon. Although hatcheries care for fry salmon and nourish salmon runs, they do not protect salmon from environmental changes. A growing body of scientific evidence is showing that the escalating changes to the hydrological system will spell disaster for salmon and other native fish throughout the Northwest.³⁹ While these changes to climate are new and emerging, they have many similarities to colonization and fishery loss in the past.

The effects of climate change are similar to the past destruction of traditional fishing sites. Colonial depletion of salmon fisheries occurred in two ways: overfishing and the construction of dams. Overfishing has depleted salmon numbers, just as warming waters have lowered the survival rates of young fish. Dams have led to changes in distribution of

sediment along the river beds, altering the physiology of rivers in ways similar to changes brought on by changing precipitation levels and glacial melting. If salmon were to stop running up certain tributaries, for example, once-critical fishing spots would become barren. In many ways, these changes would have the same effects that colonization did; they would deplete salmon runs and destroy culturally meaningful fishing places. Given the unique role that each fishing spot can play for certain families, this would certainly be a disaster for native people. Taken together, these effects would mean a permanent loss of access to salmon for some native peoples and a loss of culturally significant spaces that enable native families to bond. Moreover, many treaties limit fishing rights to “usual and accustomed places.”⁴⁰ This means that in addition to geographical limits to fishing, native people would face policy restrictions in trying to adapt to climate change. More importantly, those restrictions go beyond an issue of simple access to threaten traditional, culturally meaningful access to salmon. Therefore, the threats include the ability to maintain family networks through inherited fishing spots and the ability to come together in places where salmon are supposed to be gathered in accordance with one’s culture.

Many native communities identify the loss of salmon as a major concern. As part of an intertribal salmon restoration project entitled *W̓y-Kan-Ush-Mi-Wa-Kish-Wit* (Spirit of the Salmon), the Umatilla, Warm Springs, Yakama, and Nez Perce nations state that “without salmon returning to our rivers and streams, we would cease to be Indian people.”⁴¹ These words show how salmon is a dear family member, a way for native families to come together in the face of cultural assimilation, and a part of what it means for these tribes to continue their existence. Similar to the historical oppression of Columbia River people, climate change has the potential to impact native communities by denying their

relationship to their salmon kin. In the past, this denial has been used as a tool to degrade indigenous kinship (including kinship between salmon and people). Climate change, although not an intentional effort to colonize or assimilate native people, has the potential to further alienate native kinship networks by pushing salmon outside of their historical ranges and denying native access to this sacred fish. Columbia River native people are unfortunately not alone in this dilemma. Struggles of peoples north of the Columbia further demonstrate how gathering first foods is a powerful tool in bringing family together, as well as the role that colonization and climate change play in disrupting those relationships.

As the Huna Tlingit of Southeast Alaska and Gitga'at of British Columbia struggle to access first foods in the face of unhelpful state policies and climate change, members of these communities articulate how important it is to tribal families to maintain access to these resources. Furthermore, their experience offers an excellent case to view how climate change can immediately impact cultural practices that help to hold indigenous families together. Comparing the legal issues that affect gathering by the Huna Tlingit with the threat that climate change poses for Gitga'at and other British Columbia First Nations further demonstrates how colonial impacts and climate change parallel one another by disrupting traditional families and removing cultural spaces that bring family together.

The Huna Tlingit historically gathered massive amounts of seagull eggs on the coast of southeast Alaska. For these people, gathering eggs has traditionally been a way to bring families together. Eugene Hunn notes that, while seagull eggs were “not notable” in terms of their proportion of traditional diet, or of “outstanding...ritual significance,” they are highly regarded by Huna people because of how they “brought families together.”⁴² The right to gather eggs is limited by one's relation to a Huna

community member. Friends and relatives from other tribal communities may come and harvest, as long as they come with their Huna relations.⁴³ This creates both a literal and cultural space in which only members of an extended kinship network and their friends are spending time together. Gathering eggs traditionally could be a week-long excursion, in which children learned skills and families reconnected as they gathered and prepared food.⁴⁴ Numerous elders recounted to Hunn how gathering eggs was a family event and an opportunity to teach and bond with children. One elder, Lily White, commented that it was “like Easter.”⁴⁵ Therefore, gathering seagull eggs is a way to raise, strengthen, and nurture Tlingit families. As Huna elder Pat Mills noted, “this is the way we came to love our country as our fathers and uncles did. We also felt that we were a part of somebody and somebody special when our families took us on these trips. We were taught this is who we are and this is how it’s going to be.”⁴⁶ This sentiment describes exactly the importance of gathering in lifting up native families. Exercising cultural practices in a family setting is a way for people not only to gather food, but to maintain their identity, culture and self-esteem.

Huna Tlingit egg gathering has dwindled, in part because of the rocky relationship between Huna people and the National Park Service (NPS) that administers Glacier Bay National Park where North and South Marble Islands and other favored egg gathering sites are located.⁴⁷ The NPS enforces restrictions on which first foods within the park may be harvested, and seagull eggs are prohibited from being gathered. While the relationship between the NPS and Huna Tlingit is not overtly colonialist, the fact remains that traditional Huna Tlingit gathering land is now under control of a US federal agency. The ability of the NPS to declare gathering practices illegal and enforce these restrictions has decreased egg gathering considerably in Huna country.⁴⁸ For Huna people, gathering eggs on the

Marble Islands is a unique bonding experience for families. Similar to the traditional fishing spots of people on the Columbia, these islands provided a unique and culturally significant space to bring family together. Therefore, NPS gathering restrictions damage the capacity of Huna people to teach their traditions to their children and maintain their cultural heritage as Huna families. The fact that some Huna people have access to other egg gathering sites is irrelevant because gathering is not a simple matter of access or quantity. Instead, it is about the traditional connection Huna people have to certain gathering places, and the connection these places have to their families. Restrictions to gathering at these places damage the ability of Huna Tlingit people to continue gathering eggs in a way that is culturally meaningful.

For many peoples of British Columbia and Southeast Alaska, including Tsimshian, Tlingit, Gitga'at, and Kwakwaka'wakw, seaweed is an important first food. Nancy Turner notes that in addition to providing valuable nutrition, seaweed harvesting "brings families and communities together" to practice their culture.⁴⁹ Similar to Tlingit egg gathering, seaweed harvests are a time to bond with family. Turner also notes evidence that seaweed brought people together across cultural groups. A linguistic analysis of the diverse peoples who gather seaweed, i.e. across languages, showed that common terms exist for this type of seaweed.⁵⁰ This cross-linguistic commonality is an excellent example of how seaweed not only immediately binds families together but also reaches across language groups and tribes to form links and bonds. Those links create opportunities to strengthen extended family and kinship networks. For these people, summer months have traditionally been dedicated to gathering seaweed. For the Gitga'at, even the name for the month of May translates to "month for getting seaweed."⁵¹ During this time, families gather together and move to seaweed gathering camps to harvest and

process the valuable first food.⁵² Similar to Huna egg gathering, seaweed gathering provides a time for families to bond together while harvesting a food. Traditional Knowledge, a critical aspect of Gitga'at culture, is used to determine how and when seaweed will be harvested. These harvests are vital for this important knowledge to pass from one generation to another through practice. Unfortunately, seaweed provides another example of how gathering, an important aspect of indigenous family life, is affected by climate change.

Warming and unpredictable temperatures have resulted in drastic changes in seaweed availability on the British Columbia coast. Gathering times have become increasingly unpredictable because of previously unheard of changes in weather patterns.⁵³ These changes have made it difficult for elders and experienced gatherers to anticipate when to gather and preserve seaweed. For example, unpredictable rainy seasons make it hard to dry seaweed, a process that demands good weather for many consecutive days. This unpredictability is a significant obstacle to the continued use of seaweed for Gitga'at people. Because gathering is less predictable, it is more difficult to decide correctly when and how to gather. In the past, families could accommodate variations in weather by falling back on other foods.⁵⁴ However, today's changes are much more drastic. Hence, they affect multiple foods at once, making it more difficult for families to rely on a different resource, such as halibut, when the seaweed harvest is bad.⁵⁵ Additionally, given that today the majority of young people depend on wage labor,⁵⁶ unpredictable conditions make gathering even less realistic for these families, who also have obligations of nine-to-five jobs. Climate change, therefore, can be thought of as the last straw in making gathering not feasible. Turner notes a growing concern in British Columbia and Southeast Alaskan communities that climate change may be one change too many, one that will exaggerate the effects of young

peoples' alienation from traditional culture and make the continuation of seaweed gathering an unlikely scenario.⁵⁷

Comparing Huna egg gathering to Gitga'at seaweed use demonstrates how climate-induced changes to first foods and colonial impacts on the indigenous family have similar effects. As with egg gathering, the changing conditions of gathering seaweed make it hard for families to bring in younger generations to continue this culturally important process, and colonization removes spaces that bring families together. For Gitga'at seaweed, both forces make gathering unpredictable and therefore less feasible. For Huna people, colonial bureaucracy has restricted access to important cultural spaces. While NPS restriction of egg gathering is a legal barrier, and climate change damage to seaweed gathering is an environmental barrier, these cases expose a parallel between climate change and colonialism. The processes deny native people access to culturally important places that traditionally bring families together. Taken in concert, these impacts sap strength from the capacity of first foods to maintain native families, as they have done for thousands of years.

First Foods and Their Role in Sovereignty

Since colonization began, first foods have played a central role in wars for the rights of indigenous people. From early conquest and settlement of traditional gathering territories, to industrial monopolization of native land, to modern legal battles for fishing and gathering rights, first foods have been at the center of the contentious battle for native sovereignty in the Northwest.⁵⁸ For the purposes of this paper, sovereignty means 1) having access to resources that enable cultural autonomy, 2) maintaining primary responsibility for the care of these resources, and 3) the ability to continue cultural practices through a continued relationship to these cultural resources. This definition of sovereignty is concerned primarily

with the ability of people to maintain and control their own culture and the factors (e.g., species, land, practices, people, knowledge) that enable their culture to exist in today's world. Comparing the effects of climate change to past struggles against colonization reveals how the relationship between first foods and native people is a central aspect in maintaining indigenous sovereignty. Key issues of access to first foods, ecosystem changes, policy restrictions, and the social stability of native communities factor into both historical struggles for sovereignty and the impacts of climate change on sovereignty. First foods have historically been a cornerstone of indigenous autonomy; climate change represents a challenge to this autonomy because of its varied and negative impacts on native access to first foods. Current changes in climate also represent potential harm to the status of indigenous sovereignty in the Northwest.

To explore how colonialism targeted first foods and in doing so reduced indigenous sovereignty, let us return to salmon along the Columbia. Traditionally, salmon played not only an important role in family life, but also in determining status and wealth on the Columbia River. In pre- and early-contact times, salmon represented the single largest influx of energy available to people along the River.⁵⁹ Logically, salmon became central to native economy and society. Fishing rights were the responsibility of headmen and chiefs, as they both regulated the fishing of others and inherited important and prestigious fishing rights.⁶⁰ European settlers also quickly identified that salmon meant wealth along the Columbia. Colonial commercial fishing diminished indigenous sovereignty on the Columbia in unprecedented ways by displacing native fisherman, removing a centerpiece of native leadership and responsibility, and marginalizing the role of both fishers and leaders along the river. An excellent example of this clash can be found in a dispute brought to court in 1895. The Winans, a white fishing family, pursued a dogged and ruthless policy of

excluding Indians from access to fishing on property they had purchased. They fenced in miles of riverbank that was traditionally fished by native people, and employed thugs to rough up Indians who tried to make it through.⁶¹ Additionally, families such as the Winans ruined native fishing grounds to make way for massive fish wheels that quickly depleted salmon runs.⁶² Fisheries that once granted powerful social capital to the chiefs and headmen who managed them were destroyed by fishing practices ill-suited to the seasonal runs of salmon. The loss of access to salmon was as much a political undermining as it was a cultural loss. Native fishers had some of their most important property—their fishing rights—taken from them without recourse. Native political and social autonomy was crippled as salmon runs declined. Salmon not only fed native people, they also supplied wealth and a means to coordinate and direct political action. Therefore, a loss of salmon was a loss of cultural autonomy. Modern relationships to salmon continue to show how fishing rights are a key component of indigenous sovereignty.

For Nimiipu (Nez Perce) people, salmon have always been a cornerstone of culture. This is reflected in stories, the economic and social importance of salmon in pre-colonial times, as well as the continued dedication of the Nimiipu to maintaining a strong relationship with salmon (in part through involvement with the Columbia River Intertribal Fishing Commission).⁶³ Although salmon runs are a fraction of what they once were, Nimiipu people strive to continue their relationship with the fish. As with much of the Northwest, colonialism has damaged this relationship by reducing the size and health of salmon runs. However, many people work diligently to ensure that Nimiipu culture is still structured around salmon. B.J. Colombi writes that “sovereignty in land and salmon gives Nimiipu a base of power.”⁶⁴ Salmon have done this by providing a cultural base for Nimiipu people that in turn grants Nimiipu people the ability to adapt to changes

and be resilient. Colombi argues that for Nimiipu people, culture, not institutions, is the key to resiliency and, by extension, the ability to retain cultural and political sovereignty.⁶⁵ Salmon give themselves to Nimiipu, and in doing so provide the people with means to adapt and maintain their culture in the face of changes. At the same time, the relationship to salmon gives Nimiipu people cultural, economic and political strength.⁶⁶ In short, salmon maintain the sovereignty of Nimiipu people. The culture formed around salmon has shaped a unique knowledge system that aids Nimiipu in adapting to changes, while the actual presence of salmon provides both the ability to practice culture (such as ceremonies) and the security of a continued relationship with valued salmon. Although this relationship is formed around the ability of both salmon and Nimiipu people to adapt to changes, the capacity of either to adapt is finite.⁶⁷ Therefore, climate change presents a challenge for Nimiipu people. Their relationship to salmon, and with it the continued independence of their culture, relies on how Nimiipu and salmon adapt to the changes in front of them.

For the Nimiipu, climate change brings with it a troubling set of questions regarding sovereignty and salmon. What effects will climate change have on salmon? Can the Nimiipu and salmon adapt to these changes? In the worst case, is it possible for Nimiipu sovereignty and autonomy to continue without the fish who have given them so many tools to adapt and be resilient, both materially and culturally? These are questions without definite answers. Just as Nimiipu people have relied on salmon to provide them with a path for sovereignty in the past, they will continue to do so in the face of climate change. Colombi states that “Just as salmon has been key to native society, culture necessitates that it play a central role in native nation building.”⁶⁸ He dubs the continued use of salmon to lift the Nez Perce nation as “Salmon Nation building.” Nimiipu people are already proactively addressing Salmon Nation building in a

climate change era. They have, for example, developed a climate change adaptation plan for a watershed in their traditional homeland, developed a carbon sequestration effort, and continue to work with the Columbia River Intertribal Fishing Commission (CRTIFC) to protect salmon.⁶⁹

Salmon is central to Nimiipu sovereignty in the context of climate change. As climate change alters riparian systems and salmon health, it may harm the relationship between Nimiipu and salmon. Climate induced glacial melting, increasing temperatures, and erosion all present immediate threats to salmon health. These challenges will undermine Nimiipu sovereignty by distancing Nez Perce people from salmon. In *Salmon and His People*, many of the interviewees offered variations of the statement that “if we lose salmon, it will cripple our people.”⁷⁰ This sentiment hints at a complex, underlying dynamic. Salmon have, over time, developed a rich capacity to adapt to environmental changes. Nimiipu people have learned from salmon and come to depend upon them to provide a basis for cultural health, sovereignty, and resiliency in the face of change. Stories about salmon, sustenance provided by salmon, and the centrality of salmon to Niimipu religion and tradition all demonstrate how salmon holds a key to Nimiipu sovereignty. Even as Nimiipu depend on salmon, both salmon and Nimiipu adapt together to changes in their shared home. However, some changes threaten both the basis of Nez Perce adaptability and the autonomy of salmon. Climate change is one such challenge. While Nimiipu and salmon have adapted to changes such as dam building and commercialized fisheries, the changes have come at a cost. Salmon runs are a fraction of what they used to be. Moreover, the land and autonomy that Nimiipu people lost from colonization and decimation of salmon populations are incalculable. Modern climate change poses a major challenge to the adaptive capacity of the Nimiipu and salmon peoples. In doing so, it threatens the basis of Nimiipu cultural autonomy. Nimiipu

struggles to maintain sovereignty during climate change are not an isolated event in the native Northwest. Instead, they are part of a long effort by native people to maintain their autonomy in the face of externally imposed changes.

In western Canada, as along the Columbia, colonialism severely weakened native sovereignty by destroying traditional gathering places. Settlers drastically altered the landscape as they came into native-controlled areas. During the colonization of the Tsawataineuk Kwakwaka'wakw people around Kingcome Inlet, for example, settlers quickly claimed what was once productive gathering land and converted it to agriculture and pasture.⁷¹ As Nancy Turner has noted, attempts to mitigate the influx of settlers were ignored. The testimony of Chief Chesaholis provided evidence about the destruction caused by livestock to the roots of first foods. "[We] asked them to keep their cattle at home, but they never pay any attention to whatever we say to them."⁷² The lack of regard for native rights and sovereignty over their traditional gathering places was systemic throughout British Columbia and resulted in widespread loss of valuable gathering spots.⁷³ Moreover, it impacted the health of first-foods species, many of which depended on active management by native peoples. In effect, colonization reduced the health of first-foods species and destroyed the infrastructure that allowed First Nations people to gather. More broadly, destroying gathering places badly damaged cultural and societal independence by undermining the foods and land that function to maintain cultural health and autonomy in the native Northwest.

The Swinomish Tribe of the Puget Sound is facing effects similar to those experienced by the Tsawataineuk in the past. Swinomish people have identified that the health of their first-foods species and the security of tribal gathering sites are threatened and that important cultural gatherings and practices that are part of what it means to be Swinomish are also at

risk. However, there is an important difference in cause for the Swinomish people: the threats come from climate change. In response to these threats, the Swinomish tribal government has created a climate change impact assessment, and from it the Swinomish Tribal Climate Change Adaptation Action Plan, to ensure that the threats caused by climate change are both well understood and prepared for.⁷⁴ A major emphasis of the Adaptation Action Plan is identifying how climate change poses threats to the Swinomish community as a whole, i.e., to its sovereignty and ability to autonomously exist. A second emphasis is determining the direction to take moving forward in order to adapt to these changes and preserve the health of the community. The Swinomish have identified first foods as important for community cohesion, food security, ceremonial use, knowledge transmission, and self determination. In short, first foods are vital for sovereignty. The Swinomish Plan also has broader applicability as a model for tribal and First Nations communities to identify current challenges to sovereignty brought on by climate change and to plan for the future. The emphasis on first foods within the report demonstrates how critical traditional food use is to the continued sovereignty of native Northwest peoples and shows that the use of first foods will be a central issue for maintaining sovereignty in the face of climate change. The anticipated and ongoing effects of climate change described by the Swinomish Climate Change Adaptation Action Plan are similar to earlier, colonial effects on first foods. Comparing climate change impacts on the Swinomish people to earlier colonial impacts on people in British Columbia demonstrates how weakening first-food health and native ceremonies conspired to reduce native sovereignty. Undermining gathering, whether by colonial action, changes to the ecosystem, or declines in species health, reduces community cohesion and self-determination as it weakens native culture and reduces native sovereignty.

Climate change is quickly threatening traditional fishing and shellfish gathering sites of the Swinomish people. Just as colonial impacts on salmon were a struggle for political control of the Columbia, Swinomish struggles to retain their fishing sites are an issue of community sovereignty. Specifically, sea level rise and ocean acidification are eroding the ability of Swinomish people to fish.⁷⁵ Sea level rise is quickly threatening the Swinomish reservation, as up to 15% of reservation uplands are at risk of inundation, including valuable gathering sites.⁷⁶ Shellfish, an important traditional food, are unable to live in overly acidic ocean water. As the Puget Sound becomes more acidic because of climate change, shellfish may not be able to adapt, as young shellfish cannot calcify their shells in water that is too acidic.⁷⁷ In effect, the Swinomish are dealing with a wholesale attack on their capacity to provide themselves with traditional foods. While limits to traditional foods have economic and dietary impacts, they also pose a threat to the ability of the Swinomish people to exercise self-determination. The Adaptation Action Plan identifies self determination as one of five indicators of community health. The report notes that self determination is “unique in that, unlike the four previous indicators, asserting self-determination was not necessary until externally imposed trauma occurred.”⁷⁸ In other words, colonization and climate change share in their ability to disrupt indigenous self determination. Both fall under the definition given of “externally imposed trauma.” The document makes the more subtle point that self determination becomes a necessary component of community health precisely because traditional sources of self-determination and sovereignty are being threatened. Thus, self determination is no longer a given when the basis of self sufficiency, first foods, is threatened. The rapid loss of shellfish gathering and seining sites because of sea level rise is, in this light, an erosion of the basis of Swinomish authority and ability to self determine. For that reason, the

Adaptation Plan must explicitly identify self-determination as a factor that must be maintained moving forward. Until recently, the intact culture and ecosystem guaranteed continued access to first foods, which in turn formed the bedrock upon which Swinomish sovereignty was based. Only with the damage done to first foods has self determination become a necessary concern for Swinomish people.

Additionally, with declines in the health of first foods, Swinomish people may lose the ability to practice important traditions. Ceremonial use is another of the five indicators of community health. The majority of people interviewed for the Adaptation Plan felt strongly that “gatherings and ceremonies... *would be changed or impossible without natural resources such as Seafood*” [emphasis in original].⁷⁹ Without being able to practice traditional ceremonies and gatherings, such as the First Salmon ceremony celebrating the arrival of the first salmon of each major run, the very identity of the Swinomish people becomes threatened.⁸⁰ This problem is not limited to Swinomish people, but instead, is important for gatherings throughout the Northwest that depend upon first foods. From British Columbia south along the coast to the Columbia River, First-foods ceremonies are conducted to honor certain foods for their role in allowing the continuation of native culture and life.⁸¹ Today, Nez Perce and Swinomish people are now experiencing climate changes threatening their ability to gather and continue to exercise their cultural heritage, just as they and others have throughout colonial history in the Northwest.

Moving Forward in an Age of Climate Change

As climate change becomes ever more a part of the public consciousness, an increasing number of narratives are emerging to describe climate.⁸² Among these narratives is a discourse of native peoples and climate change. In this discourse, there is an emphasis on first foods and their vulnerability to climate change. Underrepresented

in this discourse, however, are cultural understandings of climate change impacts on native peoples and first foods. Instead, first foods are largely treated as a quantity to be maintained and preserved in the face of climate change. Although this view is helpful in moving forward with policy and adaptation efforts, it fails to justify the importance of first foods to native peoples and stops short of examining issues of traditional foods in a culturally appropriate context. In contrast, by using examples of historical and current roles that first foods play in native cultures in the Northwest, it is possible to gain a stronger understanding of how climate change will affect indigenous people. This understanding extends beyond the loss of quantifiable resources and begins to explore the cultural ramifications of climate change.

The cultural importance of first foods in the Pacific Northwest is broad and multifaceted. Family and sovereignty are two fruitful examples of the cultural importance of first foods, while also highlighting the negative impacts climate change can have on native culture. However, they are just that: examples. First foods are integral in many aspects of native Northwest peoples' societies, including religion, economy and the passing of inter-generational knowledge. For example, many nations continue to rely on salmon for economic well-being.⁸³ First foods are important for indigenous well-being precisely because they occupy so many roles in native communities. This makes it critically important to understand exactly how climate change will impact first foods and how cultures can act to adapt to and mitigate these effects. Without exploring how the changes will impact native economy as well as the native family and sovereignty, it will be difficult for native communities to prepare themselves.

In addition to drawing comparisons between aspects of native culture and society, it is necessary to look to the past in order to inform the future. Changes brought on by colonization can illuminate current struggles with

a changing climate. Looking back gives perspective on how impacts to first foods affect community health. Changes to first-foods use that could be presented as new challenges, such as the loss of culturally important gathering places, are better understood in light of past loss of land and gathering rights. Colonization contextualizes first-foods use and climate change. Without discussing both the residual effects of colonization, and the similarities between colonization and climate change, indigenous struggles to maintain first-food use cannot properly be understood. Taken out of context, the gravity of these issues is difficult to appreciate.

Additionally, spreading awareness to the public at large that the stakes for native communities includes both a cultural and a natural resource issue may be necessary to drive public support to protect first foods. For these reasons, viewing first foods and climate change in light of cultural significance is critical to the continued well-being of native communities. Presenting first foods only as a quantity or resource does nothing to explain why and how first foods are important to native cultures. Although it is unfair, native communities today must jostle with other narratives and agendas within the climate change discourse. Both drawing from the past and explaining parts of the cultural importance of first foods strengthen native claims that first foods must be protected from climate change. Efforts like the Swinomish Climate Change Adaptation Action Plan give a strong model for other tribal and First Nations communities moving forward. To protect the critical relationships between first foods and indigenous people, First Nations and tribes are planning for effects of climate change on all aspects of their culture. Native people must be recognized for their important leadership roles both in confronting past abuses of traditional food and land, and in their groundbreaking work preparing and adapting for another set of changes to the Northwest.

Notes

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