4-2016

Categorization of Food Value via Crayfish Aggression

Justin Thanh-Tuan Tran
Grand Valley State University

Categorization of Food Value via Crayfish Aggression

Justin Thanh-Tuan Tran

A Thesis Submitted to the Graduate Faculty of

GRAND VALLEY STATE UNIVERSITY

In

Partial Fulfillment of the Requirements

For the Degree of

Master of Health Sciences

Biomedical Science

April 2016

Acknowledgements

I would like to thank my committee for their guidance and support with this thesis. I especially want to thank Dan Bergman for his mentorship and the assistance he has provided throughout this project. He has helped me from the beginning with planning, building tanks, establishing connections with other labs, statistical analysis, and contributing feedback. I would also like to thank Arthur Martin, Anya Goldina, and their corresponding labs for assisting with trials and data collection. Nicholas Semaan and Max Phillips deserve many thanks for their help with the analysis of my trials. I also thank those Dr. Sango and those at the GVSU Statistical Consulting Center who helped immensely with the statistical analysis. Lastly, I would like to give appreciation to Debra Burg for her guidance during the Master's program. I would not have been able to accomplish this without their help.

Abstract

In numerous species, social interactions play a key role in deciding the allocation of resources. Aggression is a tactic that crayfish utilize to become dominant, which allows them to acquire higher quality resources. Many studies of aggression and agonistic interactions have used crayfish because they are known to be innately aggressive and are quick to become involved in agonistic interactions that may escalate into fighting. The primary objective of this study is to elucidate the relationship between differing food resources and their effect on aggression of crayfish. It is hypothesized that increased desirability for the food resource will induce more aggressive interactions to obtain it. Trials were conducted with two different crayfish species - *Orconectes propinquus* and *Orconectes rusticus* - in collaboration with Saginaw Valley State University. Only male crayfish were used for the trials. They were exposed to six different food sources and allowed to interact to observe their behaviors. Crayfish interactions were analyzed using an ethogram to grade intensity levels. It appeared the crayfish valued Fluker's® turtle diet and Meijer® farm raised tilapia in comparison to the other resources provided based on the average duration spent in contact with the food bag and average duration spent at higher intensity levels. This may be due to the increased crude protein and fat in these foods when compared to the other resources. These two species appear to value more protein and fat and will interact at higher intensity levels during agonistic interactions to obtain them.

Table of Contents

Acknowledgements………………………………………………………………………………3

Abstract…………………………………………………………………………………...4

List of Figures……………………………………………………………………………….7

List of Tables……………………………………………………………………………10

Chapter 1 : Introduction...……………………………………………………………...17

I. Introduction: Dominance and Aggression…………………………………………...17

II. Purpose…………………………………………………………………………….19

III. Scope……………………………………………………………………………19

IV. Assumptions……………………………………………………………………….20

V. Hypothesis…………………………………………………………………………21

VI. Significance………………………………………………………………………..21

Chapter 2: Literature Review………...………………………………………………..22

I. Intrinsic and Extrinsic Factors………………………………………………………22

II. Intrinsic Factors…………………………………………………………………...23

III. Extrinsic Factors…………………………………………………………………..26

Chapter 3: Materials and Methods…………………………………………………31

Chapter 4: Results….……………………………………………………………………...36

Chapter 5: Discussion and Conclusion………………………………………………..49

Appendices………...………………………………………………………………………56

I. Figures……………………………………………………………………………..56

II. Tables………………………………………………………………………………...88

Literature Cited……………………………………………………………………………187

List of Figures

Figure 1: Crayfish Ethogram (Bergman & Moore (2003)) 56

Figure 2: Isolation Tanks 57

Figure 3: Experiment Tank Set up 58

Figure 4: Frequency of Displayed Intensity Levels of Dominate and Subordinate *Orconectes propinquus* Crayfish 59

Figure 5: Frequency of Displayed Intensity Levels of Dominate *Orconectes propinquus* Crayfish 60

Figure 6: Frequency of Displayed Intensity Levels of Subordinate *Orconectes propinquus* Crayfish 61

Figure 7: Frequency of Displayed Intensity Levels of Dominate and Subordinate *Orconectes rusticus* Crayfish 62

Figure 8: Frequency of Displayed Intensity Levels of Dominate *Orconectes rusticus* Crayfish . 63

Figure 9: Frequency of Displayed Intensity Levels of Subordinate *Orconectes rusticus* Crayfish 64

Figure 10: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent at Each Intensity Level 65

Figure 11: Proportion of Time Dominate and Subordinate *Orconectes rusticus* Crayfish Spent at Each Intensity Level 66

Figure 12: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent At Each Intensity Level in the Control Group 67

Figure 13: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent At Each Intensity Level in the Tilapia Group 68

Figure 14: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent At Each Intensity Level in the Rabbit Pellet Group 69

Figure 15: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent At Each Intensity Level in the Bottom Feeder Pellet Group 70

Figure 16: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent At Each Intensity Level in the Pond Stick Group 71

Figure 17: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent At Each Intensity Level in the Fluker Pellet Group.. 72

Figure 18: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent At Each Intensity Level in the Oak Leaves Group 73

Figure 19: Proportion of Time Dominate *Orconectes propinquus* Crayfish Spent at Each Intensity Level 74

Figure 20: Proportion of Time Subordinate *Orconectes propinquus* Crayfish Spent at Each Intensity Level 75

Figure 21: Proportion of Time Dominate and Subordinate *Orconectes rusticus* Crayfish Spent At Each Intensity Level in the Tilapia Group.. 76

Figure 22: Proportion of Time Dominate and Subordinate *Orconectes rusticus* Crayfish Spent At Each Intensity Level in the Rabbit Pellet Group 77

Figure 23: Proportion of Time Dominate and Subordinate *Orconectes rusticus* Crayfish Spent At Each Intensity Level in the Bottom Feeder Pellet Group 78

Figure 24: Proportion of Time Dominate and Subordinate *Orconectes rusticus* Crayfish Spent At Each Intensity Level in the Pond Stick Group.. 79

Figure 25: Proportion of Time Dominate and Subordinate *Orconectes rusticus* Crayfish Spent At Each Intensity Level in the Fluker Pellet Group.. 80

Figure 26: Proportion of Time Dominate and Subordinate *Orconectes rusticus* Crayfish Spent At Each Intensity Level in the Oak Leaves Group 81

Figure 27: Proportion of Time Dominate *Orconectes rusticus* Crayfish Spent at Each Intensity Level 82

Figure 28: Proportion of Time Subordinate *Orconectes rusticus* Crayfish Spent at Each Intensity Level 83

Figure 29: Total Duration of Bag Contact with Different Resources Between Dominate and Subordinate *Orconectes propinquus* Crayfish 84

Figure 30: Average Duration of Bag Contact with Different Resources Between Dominate and Subordinate *Orconectes propinquus* Crayfish 85

Figure 31: Total Duration of Bag Contact with Different Resources Between Dominate and Subordinate *Orconectes rusticus* Crayfish... 86

Figure 32: Average Duration of Bag Contact with Different Resources Between Dominate and Subordinate *Orconectes rusticus* Crayfish.. 87

List of Tables

Table 1: Guaranteed Analysis of The Food Resources 88

Table 2: Frequency, Total duration, and Average Duration *Orconectes propinquus* Spent at Each Intensity Level with Different Resources Present 89

Table 3: Frequency, Total duration, and Average Duration *Orconectes rusticus* Spent at Each Intensity Level with Different Resources Present 90

Table 4: Resources Effect on The Average Time Spent at Each Intensity Level of both *Orconectes propinquus* and *Orconectes rusticus* 91

Table 5: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Control 92

Table 6: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets 93

Table 7: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Meijer® Rabbit Food 94

Table 8: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Tetra Pond® Pond Sticks 95

Table 9: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Oak Leaf Detritus 96

Table 10: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Fluker's® Turtle Diet 97

Table 11: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to API® Bottom Feeder Pellets 98

Table 12: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Control 99

Table 13: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets 100

Table 14: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Meijer® Rabbit Food 101

Table 15: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Tetra Pond® Pond Sticks 102

Table 16: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Oak Leaf Detritus 103

Table 17: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Fluker's® Turtle Diet 104

Table 18: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to API® Bottom Feeder Pellets 105

Table 19: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 0 When Comparing All Resources to Control 106

Table 20: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 0 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets..... 107

Table 21: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 0 When Comparing All Resources to Meijer® Rabbit Food............................ 108

Table 22: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 0 When Comparing All Resources to Tetra Pond® Pond Sticks....................... 109

Table 23: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 0 When Comparing All Resources to Oak Leaf Detritus 110

Table 24: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 0 When Comparing All Resources to Fluker's® Turtle Diet 111

Table 25: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 0 When Comparing All Resources to API® Bottom Feeder Pellets 112

Table 26: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Control 113

Table 27: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets..... 114

Table 28: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Meijer® Rabbit Food............................ 115

Table 29: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Tetra Pond® Pond Sticks....................... 116

Table 30: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Oak Leaf Detritus 117

Table 31: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Fluker's® Turtle Diet 118

Table 32: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to API® Bottom Feeder Pellets 119

Table 33: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Control 120

Table 34: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets..... 121

Table 35: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Meijer® Rabbit Food............................ 122

Table 36: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Tetra Pond® Pond Sticks....................... 123

Table 37: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Oak Leaf Detritus 124

Table 38: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Fluker's® Turtle Diet 125

Table 39: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to API® Bottom Feeder Pellets 126

Table 40: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 5 When Comparing All Resources to Control 127

Table 41: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 5 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets..... 128

Table 42: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 5 When Comparing All Resources to Meijer® Rabbit Food............................ 129

Table 43: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 5 When Comparing All Resources to Tetra Pond® Pond Sticks....................... 130

Table 44: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 5 When Comparing All Resources to Oak Leaf Detritus 131

Table 45: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 5 When Comparing All Resources to Fluker's® Turtle Diet 132

Table 46: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 5 When Comparing All Resources to API® Bottom Feeder Pellets 133

Table 47: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets.................... 134

Table 48: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Meijer® Rabbit Food... 135

Table 49: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Tetra Pond® Pond Sticks 136

Table 50: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Oak Leaf Detritus 137

Table 51: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Fluker's® Turtle Diet 138

Table 52: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to API® Bottom Feeder Pellets 139

Table 53: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level -1 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets.................. 140

Table 54: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level -1 When Comparing All Resources to Meijer® Rabbit Food 141

Table 55: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level -1 When Comparing All Resources to Tetra Pond® Pond Sticks 142

Table 56: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level -1 When Comparing All Resources to Oak Leaf Detritus 143

Table 57: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level -1 When Comparing All Resources to Fluker's® Turtle Diet... 144

Table 58: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level -1 When Comparing All Resources to API® Bottom Feeder Pellets.............................. 145

Table 59: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 1 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets.................... 146

Table 60: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 1 When Comparing All Resources to Meijer® Rabbit Food.. 147

Table 61: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 1 When Comparing All Resources to Tetra Pond® Pond Sticks 148

Table 62: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 1 When Comparing All Resources to Oak Leaf Detritus 149

Table 63: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 1 When Comparing All Resources to Fluker's® Turtle Diet 150

Table 64: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 1 When Comparing All Resources to API® Bottom Feeder Pellets 151

Table 65: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 4 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets.................... 152

Table 66: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 4 When Comparing All Resources to Meijer® Rabbit Food... 153

Table 67: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 4 When Comparing All Resources to Tetra Pond® Pond Sticks 154

Table 68: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 4 When Comparing All Resources to Oak Leaf Detritus 155

Table 69: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 4 When Comparing All Resources to Fluker's® Turtle Diet 156

Table 70: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 4 When Comparing All Resources to API® Bottom Feeder Pellets 157

Table 71: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets.................... 158

Table 72: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Meijer® Rabbit Food... 159

Table 73: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Tetra Pond® Pond Sticks 160

Table 74: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Oak Leaf Detritus 161

Table 75: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Fluker's® Turtle Diet 162

Table 76: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to API® Bottom Feeder Pellets 163

Table 77: Total and Average Duration *Orconectes propinquus* Crayfish Made Contact With the Food Bag Containing Each Resource 164

Table 78: Total and Average Duration *Orconectes rusticus* Crayfish Made Contact With the Food Bag Containing Each Resource 165

Table 79: Resources Effect on The Average Bag Contact Time of both *Orconectes propinquus* and *Orconectes rusticus* 166

Table 80: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration Contacting the Food Bag When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets 167

Table 81: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration Contacting the Food Bag When Comparing All Resources to Meijer® Rabbit Food 168

Table 82: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration Contacting the Food Bag When Comparing All Resources to Tetra Pond® Pond Sticks 169

Table 83: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration Contacting the Food Bag When Comparing All Resources to Oak Leaf Detritus 170

Table 84: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration Contacting the Food Bag When Comparing All Resources to Fluker's® Turtle Diet 171

Table 85: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration Contacting the Food Bag When Comparing All Resources to API® Bottom Feeder Pellets 172

Table 86: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Control 173

Table 87: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets 174

Table 88: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Meijer® Rabbit Food 175

Table 89: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Tetra Pond® Pond Sticks 176

Table 90: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Oak Leaf Detritus 177

Table 91: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Fluker's® Turtle Diet................................. 178

Table 92: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to API® Bottom Feeder Pellets....................... 179

Table 93: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Control..................................... 180

Table 94: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets.. 181

Table 95: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Meijer® Rabbit Food................ 182

Table 96: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Tetra Pond® Pond Sticks 183

Table 97: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Oak Leaf Detritus 184

Table 98: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Fluker's® Turtle Diet 185

Table 99: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to API® Bottom Feeder Pellets 186

Chapter 1: Introduction

I. Introduction: Dominance and Aggression

In numerous species, social interactions play a key role in the allocation of resources. Aggression is a tactic used by many animals, including crayfish to establish social hierarchies where dominant crayfish are able to acquire higher quality resources (Fero, Simon, Jourdie, & Moore, 2007; Herberholz, McCurdy, & Edwards, 2007). Social hierarchies are created and maintained via agonistic interactions, which are aggressive contests between the same species (conspecifics). These types of interactions are often used to enhance the survival and reproduction of individuals involved in the interaction (Bergman & Moore, 2003; Fero et al., 2007; Zulandt-Schneider, & Moore, 2008). Hence, agonistic interactions are generally initiated when resources such as food, shelter, and mates are limited (Ahvenharju & Ruohonen, 2006; Baird, Patullo, & Macmillan, 2006; Davis & Huber, 2007; Fero et al., 2007; Herberholz et al., 2007).

Many studies of aggression and agonistic interactions have used crayfish as a model system. Crayfish are known to be characteristically aggressive and are quick to become involved in agonistic interactions that escalate into intense contests. (Davis & Huber, 2007; Fujimoto, Hirata, & Nagayama, 2011; Hazlett, Rubenstein, & Rittschof, 1975; Herberholz et al., 2007; Tierney, Godleski, & Massanari, 2000). Additionally, these interactions are ritualistic and end in the formation of a dominance hierarchy between the interacting individuals. This makes the fights rather predictable and easily analyzed. In these hierarchies, individuals are able to recognize the identity or status of another conspecific (Gherardi & Daniels, 2003). Moreover, establishment of this hierarchy allows individuals to assess the risks and benefits from an interaction (Bergman et al., 2003).

Achieving a higher social status through aggressive encounters can increase an animal's fitness by often providing the individual with increased access to resources such as shelter, mates, and food (Fero et al., 2007; Herberholz et al., 2007; Wilson, 1975). In fact, both dominant and subordinate individuals can benefit from social hierarchy establishment as individuals typically decrease the energetic cost of aggressive interactions by lowering the intensity of fights displayed future interactions that also reduces the risk of injury (Bergman et al., 2003; Gherardi & Daniels, 2003; Herberholz et al., 2007). Furthermore, subordinate individuals may lose access to some resources but benefit by avoiding costs in energy expenditure, increased predation risk associated with fighting in the open, and injury from those they interact with (Bergman & Moore, 2003; Fero et al., 2007). However, being subordinate is now without its risk, as this role can negatively influence overall fitness since these individuals will often have less access to food and shelter. The establishment of dominance involves multiple influences between individual crayfish and their environment.

Species that exhibit dominance systems demonstrate priority of access to a limited food supply (Wilson, 1975). Although crayfish have a dominance system, they are polytrophic omnivores so food is thought to not likely be a particularly limited resource since they consume multiple foodstuffs (Brown, 1995; Chucholl, 2013; Fero et al., 2007; Johnston, Robson, & Fairweather, 2011). Thus crayfish may not always have a lack of overall food resources, but variable food location could alter the benefits versus risks of engaging in agonistic interactions (Davies, Krebs, & West, 2012). Other research has shown that the quality and abundance of resources can influence agonistic interaction (Corkum & Cronin, 2004). Bergman and Moore demonstrated that agonistic interactions were observed more frequently on detrital food patches, indicating these spatially-defendable food patches were valued resources (2003). The variable quality of foods and shelters has also been shown to increase aggression and agonistic interactions in other animals (Gabor & Jaeger, 1995; Gherardi, 2006). Lastly, seasonal variations in food availability may also lead to increased social contact and activity, favoring an increase in agonistic interactions and intensity (Hazlett et al., 1975). These studies demonstrate that resources such as food can have an impact on crayfish and the agonistic behaviors they display, but this area of research received less attention in the literature.

II. Purpose

The crayfish diet has not been studied extensively since obtaining stomach contents only reveals short periods of foraging history. (Brown, 1995; Ellrott, Ellen Marsden, Fitzsimons, Jonas, & Claramunt, 2007). With crayfish being omnivores, what is consumed varies significantly depending on environmental factors such as season and location (Johnston et al., 2011). At present, there is little research on how food quality and availability influences crayfish aggresive behavior. Thus, this thesis study proposed to determine which food types have the greatest influence upon agonistic interactions and aggression levels toward conspecifics when in the presence of a food resource.

III. Scope

The scope of this research pertains to male *Orconectes propinquus* and *Orconectes rusticus* crayfish in an aggressive context. The research attempts to evaluate the agonistic interactions within a lab setting between sized-matched males of the same species while in the presence of various foods. Our goal was to evaluate crayfish preferences for the various foods presented based on changes in aggressive behaviors. There were no comparisons between females or interactions between the two species. Each species agonistic interacts were analyzed by two different analysts under the same protocol and with no knowledge of the experimental setup. Data involving *Orconectes rusticus* was analyzed by myself and the majoirty of the data involving *Orconects propinquus* was analyzed by a colleague. Data analysts were instructed on video analysis by using a stereotypical fight while using a behavioral ethogram for aggression. While we believe our data are applicable to crayfish in a broader context, it is perhaps worth noting that the behavior observed was within a confined space with no shelter availability. Moreover, the food resources presented in our study do not fully reflect the complex diets observed in nature. Our food choices used in the study had varying amounts of protein, fat, and fiber that should be reflective of food resources available to crayfish in the wild.

IV. Assumptions

The primary objective of this study was to elucidate the relationship between differing food resources and their effect on aggression of crayfish. To determine the possible effect of certain food resources on aggression, we examined aggression levels of agonistic interactions using a crayfish ethogram (Figure 1 (Bergman & Moore, 2003)). The establishment of dominance in interactions and the alterations in aggressive intensity when different foods were presented was analyzed. Behaviors of both the dominant and subordinate crayfish in interactions were also assessed. It was assumed that if crayfish find one of the presented food resources more valuable, then will be a corresponding increase in the intensity of fights and the average duration spent fighting at high intensity levels. Moreover, if a resource is considered valuable, crayfish would be more likely to spend an increased time in contact with the bag containing the resource.

V. Hypothesis

It was hypothesized that increased attractiveness for a food resource would induce more intense and perhaps longer aggressive interactions when the food and/or its odor was present in the tank.

VI. Significance

Examining the effect of food types on aggressive behaviors could help in ascertaining what crayfish value in a food resources and how it effects their behavior. Moreover, it could help with maximizing crayfish growth by simultaneously minimizing the crayfish aggressive response when in the presence of certain foods. Obtaining new information on aggression behaviors may help in reducing damaging aggressive behaviors displayed during agonistic interactions, keeping crayfish intact for industries such as aquaculture for farming thus increasing quality of the crayfish being raised and sold (Brown, 1995; Patullo, Baird, & Macmillan, 2009). In addition, research on factors that influence aggression provide better understanding of crayfish dominance hierarchies, which could be applicable to many other animals and help explain the behaviors displayed during social interactions.

Chapter 2: Literature Review

I. Intrinsic and Extrinsic Factors

Many factors have been shown to affect aggression in agonistic interactions between crayfish. These factors include, size, sex, hunger states, social experience, resource availability, and shelter presence (Bergman & Moore, 2003; Davis & Huber, 2007). These same factors that influence aggression between crayfish, such as size, sex, resource presence, and social experience contribute greatly to the outcome of agonistic interactions and have been shown to be accurate predictors of dominance (Davis & Huber, 2007). Even increased habitat complexity seems to have an effect and reduces aggressive encounters between crayfish as well as providing shelters (Baird et al., 2006; Corkum & Cronin, 2004; Patullo et al., 2009). These factors are divided into what are known as intrinsic factors and extrinsic factors.

Intrinsic factors are dependent on the individual crayfish and extrinsic factors are more dependent on the environment. Intrinsic factors mainly pertain to the physical and physiological aspects of the crayfish such as sex, carapace size, chelae size, social experience, neurochemistry, and physiological state (Bergman et al., 2003; Bovbjerg, 1956; Daws, Grills, Konzen, & Moore, 2002; Hazlett et al., 1975; Rutherford, Dunham, & Allison, 1995). Extrinsic factors include chemical signaling, visual signaling, mechanical signaling, and resources (Bergman et al., 2003; Bergman, Martin, & Moore, 2005; Bergman & Moore, 2003; Bruski & Dunham, 1987; Capelli & Hamilton, 1984). Resources include food, shelter, and mates.

II. Intrinsic Factors

Carapace and Chela Size

Size is one of the strongest determinants of whether an individual is likely to achieve dominance (Davis & Huber, 2007; Hazlett et al., 1975). If the carapace length and chela size difference is less than 10% the outcome of the interaction is random (Daws et al., 2002; Pavey & Fielder, 1996). If the difference is greater than 10%, the larger crayfish generally becomes dominant. Crayfish with larger chelae, when carapace length is similar, also tend to become dominant (Rutherford et al., 1995). During agonistic interactions, crayfish use their chela as a signal of aggression during meral spreads (Bruski & Dunham, 1987). During meral spread, a crayfish will spread its major chelae, displaying carapace size and chelae size. If crayfish continue to escalate their interactions after meral spread their interaction may lead to more intense use of chelae (Lisa Schroeder & Huber, 2001). While fighting they may continue to assess their opponent to reduce the risk of injury. Male crayfish lacking one chela have fewer aggressive displays, initiate fewer agonistic encounters, and ultimately rank lower in hierarchies than do crayfish with intact chelae (Gherardi et al., 1999).

Sex

Another important intrinsic factor that determines aggression and dominance is the sex of the crayfish. Male crayfish are typically dominant over females but maternal females have been shown to have increased aggression leading to higher placement in social hierarchies when compared to nonmaternal females (Figter, Finkelstein, Twum, & Peeke, 1995; Peeke, Sippel, & Figler, 1995). Generally, males will have larger carapace length and chelae size when compared to females. In social communities of crayfish, males are typically on the top of the hierarchy even if older females are larger. This is again most likely due to the overall size differences between males and females although there may be other unknown underlying factors contributing to this as well.

Previous Social Experience

Previous social experience is also a determinant of an individual's success in agonistic interactions. Crayfish lacking social interaction for seven days appear to interact as if they are socially naïve (R. A. Schneider, Zulandt, Schneider, S, & Moore, 1999). Repeated previous social interactions contribute to the level of aggression and influences the outcome of future interactions (Bergman et al., 2003; Daws et al., 2002). Individuals that experience a win during an agonistic interaction are more likely to win the next encounter against familiar and naïve opponents. This increased tendency of winning is called the "winner effect." The opposite of this effect also applies for the loser. The loser of the encounter is more likely to lose the next encounter. This is termed the "loser effect." Winner and loser effects influence on subsequent interactions is strong enough to overcome size differences in opponents that would otherwise accurately predict the outcome (Daws et al., 2002).

These winning and losing effects can result after a single encounter that varies in duration, intensity, and repetition. Short term effects were produced from a single short encounter lasting no longer than 30 seconds (Bergman et al., 2003). The effects were strengthened with repeated encounters over extended periods of time. These effects are dependent on reinforcement through repeated encounters as the effect was observed to decrease after an hour (Bergman et al., 2003). The largest influence appeared within the first 20 minutes after the first encounter. In an experiment performed by Hsu and Wolf on the winner and loser effects of *Rivulus marmoratus*, the effect lasted for at least 48 hours (1999).

The mechanism of the winner and loser effect is not clear and there are a few theories in regard to an individual's change in behavior. It does not appear as if these changes are due to long-term intrinsic physiologic changes as the effect could be demonstrated after a single encounter of 30 seconds (Bergman et al., 2003). The change could also be related to motivation to engage in interactions. Changes in motivation and behavior could be related to changes in the neurochemistry of the individuals as the effects are short-term. Short-term neurochemical changes would be consistent with the short-term changes in behavior which could also be reinforced through repeated encounters. These effects may also alter how a crayfish perceives the fighting ability of its opponent or itself, influencing their interaction. This was not observed in the study performed by Bergman et al. as there was no significant change in the length of interactions or time to reach different intensity levels (2003). This again seems to indicate the change is more likely related to a neurochemical change.

Neurochemistry

It has been speculated that the behavioral differences in aggression and dominance influences nervous systems neurochemistry. Biogenic amines have been shown to influence behavior of decapod crustaceans. These include serotonin, octopamine, norepinephrine, and dopamine (Bergman et al., 2003; Edwards & Kravitz, 1997; Yeh, Fricke, & Edwards, 1996; Yeh, Musolf, & Edwards, 1997). It is thought that changes in social status as a result of previous social interactions alter the function of serotonin in the nervous system of crayfish. These changes in neurochemistry in turn affect social behavior by altering levels or aggression and dominance (Yeh et al., 1997). Increased serotonin levels are closely associated with increased aggression or dominant behaviors (Edwards & Kravitz, 1997). Changes in serotonin receptor excitability have been observed as a consequence of achieving dominance (Yeh et al., 1996, 1997). Serotonin was shown to react differently in subordinate and dominate individuals. Increased serotonergic function through injections decreased the likelihood of retreat in crayfish (Huber, Smith, Delago, Isaksson, & Kravitz, 1997). Neurons associated with the tailflip mechanism for retreat exhibit reduced responsiveness in the presence of serotonin (Edwards & Kravitz, 1997). Thus, those with increased serotonergic function are more likely to become dominant in agonistic interactions.

Motivational state

Different physiological states such as hunger also alter the level of aggression and outcomes of agonistic interactions in crayfish (Hazlett et al., 1975). Starvation decreases the potential for survival leading to an increase in motivation to engage in agonistic encounters over valuable resources (Capelli & Hamilton, 1984). Hazelett et al. found that starved crayfish engaged in more aggressive interactions than crayfish that were fully fed (1975). Starved crayfish also had an increased rate of escalation of interactions, possibly indicating their willingness to take more risks involved in agonistic interactions.

III. Extrinsic Factors

Chemical communication

Communication is used by crayfish during agonistic interactions to provide information to conspecifics about an individual's social status. Information is transferred during interactions using various methods involving visual, chemical, and mechanical signals to communicate. Decapods, such as crayfish, rely heavily on olfactory signals during social interactions. Olfaction is important for recognition and determination of dominance in crayfish (Bergman et al., 2003; R. A. Z. Schneider, Huber, & Moore, 2001; R. A. Schneider et al., 1999). Crayfish create and control water currents during social interactions to actively send urine or to sample urine from opponents (Bergman et al., 2005). Urine is released through nephropores and is almost exclusively released during social interactions. Urine likely contains social pheromones in crayfish (Bergman et al., 2005; R. A. Z. Schneider et al., 2001). Antennules are one of the most important chemosensory organs of crayfish. Antennules are involved in sending and receiving chemical signals during interactions, sex recognition, and dominance status (Bruski & Dunham, 1987; Gherardi & Daniels, 2003; Pavey & Fielder, 1996; R. A. Z. Schneider et al., 2001; R. A. Schneider et al., 1999).

Recognition of social status in crayfish is perceived through their antennae and antennules via chemical signals (Ann Jane Tierney, Thompson, & Dunham, 1984). Information perceived through the antennules may alter the crayfish's behavior during an interaction. If chemical information is blocked, agonistic interactions are longer in duration and take longer to escalate to higher levels of intensities (R. A. Z. Schneider et al., 2001). When crayfish with a winning experience fought against chemoreceptor blocked individuals, the winner effect was eliminated, indicating that chemicals signals are necessary in the detection of previous social interactions (possibly through recognition of individuals or status) (Bergman et al., 2003). The chemical signals involved in recognition are released in the urine of crayfish (Bergman et al., 2003, 2005; R. A. Z. Schneider et al., 2001; R. A. Schneider et al., 1999). Crayfish will create currents, called information currents, using maxillipeds, pleopods, and gills, along with nephropore propulsion to communicate past social experience. They will use these currents to project or draw an opponent's urine toward their antennules (Bergman et al., 2005; BREITHAUPT, 2001). Crayfish primarily release urine during social interactions, suggesting that urine is used as a social signal (Bergman et al., 2005; BREITHAUPT, 2001). Urine released during these interactions shows differences in the number of times urine was released and duration of release between dominant and subordinate crayfish (Bergman et al., 2005).

The presentation of chemical signals alone is able to bring about a threat display (R. A. Schneider et al., 1999). Hence, chemical signals appear to play a role in the outcomes of social interactions as well as fighting dynamics. Crayfish exposed to dominant or subordinate odors adapted a social status that is contrary to the odors to which they were exposed (Bergman & Moore, 2005). Crayfish exposed to odors from naïve crayfish did not alter behavior. It appears previous odor exposure through urinary signals alter subsequent interactions. Communication using urine demonstrates that chemical signaling plays a large role in agonistic interactions between crayfish.

Visual communication

Visual signals also contribute to crayfish aggression, particularly during the initial stages of fighting (Bruski & Dunham, 1987). During encounters crayfish will exhibit signals such as meral spread, heightened and lowered body posture, and approach and retreat behaviors. These signals communicate information about an individual to influence another conspecific they have encountered. This relayed information will allow individuals to adjust their behaviors for further interaction and can provide benefits to both crayfish. It appears that visual signals are important in agonistic interactions as crayfish exhibited changes in their fight dynamics under differ light conditions (Bruski & Dunham, 1987). Behaviors such tailflipping and retreat were performed by subordinate crayfish when dominant crayfish approached in well-lit conditions. In darker conditions, these behaviors were observed less frequently, suggesting visualization of the dominant crayfish is an important factor for subordinate crayfish (Bruski & Dunham, 1987).

Mechanical Communication

Mechanical signals such as antennal whipping and chelae contact are observed during agonistic interact and are thought to convey tactile information between opponents (Bergman et al., 2005; Bruski & Dunham, 1987). The use of information currents during agonistic interactions can also be considered mechanical communication. Although these mechanical signals have been observed, it is unclear what information is exchanged during antennal whips and chelae grasps.

Resources

Resources also have a large role influencing aggression and social behaviors. The ability to acquire and protect resources (resource holding potential, RHP) can be fined by an individual's likelihood to win a fight (Parker, 1974). The ultimate consequence of attaining dominance is access to resources such as mates, shelter, and food (Fero et al., 2007, Wilson 1975). In agonistic interactions, resources may be acquired through dominance establishment or through allocation with respect to relative dominance rank within a hierarchy.

The presence of shelter and food has been shown to increase aggression in crayfish (Capelli & Hamilton, 1984). Ownership of a resource is more likely to increase aggression to defend the resource against other conspecifics (Peeke et al., 1995). Crayfish have been observed to occupy and defend shelters (Capelli & Hamilton, 1984; Martin & Moore, 2007; Peeke et al., 1995). Crayfish spend a significant amount of time away from shelters in search of food (Davis & Huber, 2007). Agonistic encounters are more intense and last longer on resources that are considered more valuable. Starvation of crayfish has also been shown to increase aggressive interaction and change their behaviors such as foraging (Hazlett et al., 1975; Pecor & Hazlett, 2008). A field study showed the presence of shelters resulted in longer and more intense interactions than those involving available food resources (Bergman & Moore, 2003). Fights on detritus patches exhibited higher overall intensities and ended with more tailflips from an opponent than when on macrophyte beds. It was concluded that fight intensity and duration correlated with resource availability. In summary, fighting intensity and levels of aggression are increased when fights occur over valuable resources.

Chapter 3: Materials and Methods

Robust behavioral trials using different crayfish species were conducted at two sites. Trials involving *Orconectes propinquus* were performed at Grand Valley State University, Allendale, MI, while *Orconectes rusticus* were used at Saginaw Valley State University, University Center City, MI. The two species studied at different sites as a collaboration. The experiment only used male crayfish as males are more aggressive and moreover collecting females reduces the ability of the crayfish to repopulate the collection site. It should be noted that this does not affect *Orconectes rusticus* as they are an invasive species. *Orconectes propinquus* was collected from a local river.

Trial Preparation

Fully intact crayfish were isolated from the general population tanks to reduce past social influences. Crayfish were placed in their own individual plastic containers for isolation. Male crayfish were then weighed and measured. An electronic balance was used to obtain weight and calipers were used to measure the length of the cephalothorax of each crayfish. Previous studies have shown that fight outcomes are predictable by relative size of opponents (Pavey & Fielder, 1996). Therefore, crayfish were matched to a similarly sized crayfish for the trial. Matching consisted of no more than a maximum of a 10% difference in both weight and cephalothorax length. Crayfish were then placed into isolation tanks (Figure 2). Isolation tanks contained 1 L of de-chlorinated water, an airstone, and the airstone's tubing. All crayfish were then fed one Meijer® rabbit food pellet the day they were isolated and then deprived of food thereafter. Crayfish were isolated for a minimum five days before a trail was run. Trials were performed on the fifth day since isolation. If crayfish appeared soft or molted during isolation, they were eliminated from the trial. If trials were not run on the fifth day due to any circumstances, the pair was still used, just at a later date. They were fed another pellet and put through another five-day starvation period and then they would be used on the fifth after being fed again for a trial.

Tanks were divided into three sections, using removable barriers made from plastic (Figure 3). The plastic barriers contained holes that allowed crayfish to observe one another, as well as allowed for the movement of odors provided from the various food types. The tank used at Grand Valley State University had colorless, opaque plastic material wrapped around the tank to reduce visual disturbances from outside the tank for crayfish within the tank (Figure 3). In the two outermost sections a matched pair of crayfish would be placed on the opposite ends. The middle section would contain the differing food resources within a food bag.

The selected food sources included Tetra Pond® Pond sticks, Meijer® rabbit food, Fluker's® turtle diet, API® bottom feeder (premium shrimp pellets), Meijer® farm raised tilapia fillets, and leaf detritus. A control involving no food being presented was also used for trials involving *Orconectes propinquus*. There was no control group involving *Orconectes rusticus* as the this was later thought to be included in the procedure after the conclusion of trials at Saginaw Valley State University. Each food contains differing amounts of protein, carbohydrates and fats which may help explain the possible changes in aggression. Table 1 shows the guaranteed analysis of the dry foods used in this experiment. The tilapia data was obtained assuming the filets were originally from fish weighing greater than 30 grams but less than 300 ("FAO: FAQs," n.d.).

Experimental Trials

The experimental tank was filled with approximately 5L of de-chlorinated water using a 1 L graduated cylinder. One randomly selected crayfish from the previously made pairs was marked on its cephalothorax using a non-toxic paint so that it could be differentiated during analysis of the interactions. The marked crayfish and its matched opponent were arbitrarily placed on either side of the experimental tank, opposite of each other. The food being presented was weighed out (~.07g - .13g depending on the food) and placed within a mesh bag made from window screening. Once the food was placed in the center portion of the tank separated by the barriers, the crayfish were allowed to acclimate to the tank for 15 minutes. The 15 minutes of acclimation were used to control for possible effects from handling the crayfish. After 15 minutes the barriers were removed and recording on the video camera situated above the tank was started. The recording was stopped after approximately 10 minutes at the trials end. Crayfish were placed back into their isolation tanks and the food from the fight tank was removed. The tank was cleaned out and rinsed to prepare for the next trial.

Data Analysis

Recordings of the trials were analyzed for the frequency spent at each intensity level, duration of time spent at each intensity level, average duration at each intensity level, duration of time spent in contact with the food bag, and average duration of time spent in contact with the food bag. Video analysis underwent blind analysis. Trials performed by myself at Grand Valley State University involving *Orconectes propinquus* were analyzed by two undergraduate students that were unaware of the food presented in each trial. Trials run by the lab at Saginaw Valley State University involving *Orconectes rusticus* were analyzed by myself. The food presented in the trials involving *Orconectes rusticus* was revealed after the trials were analyzed.

When comparing data between both species it should be noted that there is some difference between analysts and what was observed. While analyzing the data for *Orconectes* *rusticus*, I did not feel the crayfish displayed any threat displays while approaching an opponent so an intensity level of 2 was not observed in any of the trials involving that species. This could be due to differences in the analysts or a possible difference in species, but the latter is less likely.

Interactions were analyzed using an ethogram for grading agonistic interactions in crayfish previously used by Bergman and Moore (Figure 2) (2003). An interaction begins when one individual approaches the other within the tank (intensity 1). The encounter than may progress with agonistic threat displays (intensity 2). If neither individual retreats, the interaction may escalate to fighting starting with chelae contact and progress into pushing with closed chelae (intensity 3). The fight may further escalate when the chelae were open and used to grab an opponent (intensity 4). The most intense interactions will have periods of unrestrained fighting involving grasping at chelae, legs, or antennae (intensity 5). An interaction is concluded if one individual retreats by slowly backing away (intensity -1) or retreats by tailflipping away (intensity -2). During retreats the other individual may attempt to continue fighting. An individual that consistently retreats is considered subordinate.

Marked and unmarked crayfish were labeled as dominant or subordinate based on the number of retreats and tailflips displayed during the trial. The crayfish with the least retreat behaviors was considered dominant. If neither crayfish displayed any retreat behaviors during the trial, the crayfish that spent more overall time at higher intensity levels was considered dominant for analysis. Bag contact time was recorded once any physical contact with the bag was made either with their chelae or walking legs. Contact time was considered stopped when there was no longer any physical contact with the food bag.

A total of 139 trials were analyzed involving *Orconectes propinquus,* where each food presented, including the control group in which no food was presented, consisted of 20 trials except for tilapia (n=19). A total of 57 trials were analyzed involving *Orconectes rusticus*, where each food presented consisted of 10 trials except for Tetra Pond® Pond sticks (n=7). The average duration that dominant and subordinate crayfish spent at each intensity and contacting the food bag was analyzed with one-way variance with post hoc analysis using the Mixed Procedure in SAS 9.4 to account for the variability of the different crayfish from trial to trial. The significant results are represented by a P value <0.05 (Table 4). If analysis found there was a significant difference between the different resources presented, post hoc analysis was performed.

Chapter 4: Results

The frequency of behaviors displayed by both dominant and subordinate crayfish at each intensity level of both species as well as the total duration and average duration spent at each intensity level can be viewed in Table 2 and Table 3.

Frequency of Displayed Intensity Levels

In both *Orconectes propinquus* and *Orconectes rusticus*, the subordinate crayfish would display more retreat behaviors than the subordinate crayfish in all food groups, as would be expected and by definition (Figure 4 and Figure 7). Comparison of the dominate and subordinate frequencies when the same food is presented appear similar for both species (Figure 4 and Figure 7). All the dominant crayfish of *Orconectes propinquus* displayed similar frequencies between the differing food resources presented (Figure 5). The similarity also applies to the subordinate *Orconectes propinquus* and the dominant and subordinate *Orconectes rusticus* (Figure 6, 8, 9).

The subordinate *Orconectes propinquus* crayfish in the control, oak leaves, and tilapia food group appear to have displayed an intensity level of -1 more than the other three foods (Figure 6). The control group also had reached an intensity level of 3 more often than the other food groups (Figure 6). It appears overall, the control group in *Orconectes propinquus* has more interactions than the other food groups (Figure 5).

In dominant *Orconectes rusticus* an intensity level of level 3 was observed more frequently when API® bottom feeder pellets were present than the other food groups (Figure 8). In subordinate *Orconectes rusticus* an intensity level of 0 was more prevalent when API® bottom feeder pellets and oak leaf detritus was present (Figure 9). All other intensity levels between the foods appear similar.

Proportion of Time Spent at Each Intensity Level

In both species, it is observed that the subordinate crayfish will spend more time at an intensity level of -2 and -1, as would be suspected of the subordinate crayfish (Figure 10 and Figure 11).

In *Orconectes propinquus*, the proportion of time dominant and subordinate crayfish spent at different intensity levels appear similar when presented with different resources, with slight variation between the different resources (Figure 10). The proportion of time spent at different intensity levels between dominate and subordinate crayfish within each food group also appears very similar after taking into account the increased retreat displays of the subordinate crayfish (Figures 12-18). The proportion of time dominant crayfish spent at different intensity levels between the different food groups does not appear to vary much (Figure 19). It is noted that a little more time is spent at an intensity level 5 when Fluker's® turtle diet was present. Time spent at intensity level 4 appears similar between the control group and the bottom feeder group with slightly less time spent when the other resources are present. The proportion of time subordinate crayfish spent at different intensity levels appear very similar in all groups except for the control group (Figure 20). The control group appears to spend more time at intensity levels 3 and 4.

In *Orconectes rusticus*, the proportion of time spent at different intensity levels between dominate and subordinate crayfish within each food group also appears very similar after taking into account the increased retreat displays of the subordinate crayfish, except in the tilapia group (Figures 11,21-26). In the tilapia group, the subordinate crayfish spent more time at intensity level 3 and less time at an intensity level of 0 than when compared to the dominate crayfish in that group and when the other foods were presented (Figure 11 and Figure 21). It also appears that the subordinate crayfish spent more time at an intensity level 5 when compared to the dominant crayfish and all other groups. When tilapia was present, both the dominate and subordinate crayfish spent more time at intensity level 5 when compared to the other foods. Comparing the proportion of time the dominant crayfish spent with the different resources present appears similar between all groups, except the slight increase of time spent at intensity level 5 when tilapia is present as previously discussed (Figure 27). When comparing the proportion of time subordinate crayfish spent at different intensity levels, again all groups appear similar except tilapia (Figure 28). It seems subordinate crayfish spent slightly more time at intensity level 4 when Meijer® rabbit food, Fluker's® turtle diet, and Tetra Pond® Pond sticks when compared to the other three foods.

Resource Effect on Average Duration at Different Intensity Levels

The average duration dominate and subordinate crayfish of both species spent at each intensity level when each resource was presented can be found in Table 2 and Table 3.

There was no significant difference in the average time spent at intensity level -2 (p=0.8810), -1 (p=0.2737), 0 (p=0.0716), 1 (p=0.3009) ,4 (p=0.2202), or level 5 (p=0.0681) between the different groups of resources with the dominate *Orconectes propinquus* crayfish (Table 4).

The average duration spent at intensity level 2 when the control was present (7 secs) differed significantly when compared to the average duration when API® bottom feeder pellets (14 sec, p=0.0399), Tetra Pond® Pond sticks (14 sec, p=0.0147), Meijer® rabbit food (13 sec, p=0.0090), Meijer® farm raised tilapia fillets (14 sec, p=0.0038) (Table 5). The average duration at intensity level 2 when Meijer® farm raised tilapia fillet was present (14 sec) differed significantly to the average duration when no food (7 sec, p=0.0038) and Fluker's® turtle diet (11 sec, p=0.0477) was present (table 6). Meijer® rabbit food (13 sec, p=0.0090), API® bottom feeder pellets (14 sec, p=0.0399), and Tetra Pond® Pond sticks (14 sec, p=0.0147) average duration at intensity level 2 only significantly differed when compared to the control (Table 7, Table 11, Table 8). There was no significant difference in the average time spent at intensity level 2 compared to the other groups when oak leaf detritus (10 sec) was presented (Table 9).

The average duration spent at intensity level 3 for dominant *Orconectes propinquus* when the control was present significantly (21 sec) differed from the average time when Meijer® rabbit food (32 sec, p=0.0223) was present (Table 12). Average duration when API® bottom feeder pellets (30 sec, p=0.0093) and Meijer® rabbit food (32 sec, p=0.0028) differed significantly when compared to Meijer® farm raised tilapia (15 sec) (Table 13). The average duration when Meijer® rabbit (32 sec) was present differed significantly to no food (21 sec, p=0.0204), oak leaf detritus (18 sec, p=0.0156), Tetra Pond® Pond sticks (22 sec, p=0.0491), and Meijer® farm raised tilapia (15 sec, p=0.0028) (Table 14). The average duration at intensity level 3 when Tetra Pond® Pond sticks (22 sec) only significantly differed when compared to Meijer® rabbit food (32 sec, p=0.0491) (Table 15). The average duration when oak leaf detritus was present (18 sec) significantly differed to when API® bottom feeder pellets (30 sec, p=0.0440) and Meijer® rabbit food (32 sec, p=0.0156) was presented (Table 16). The average duration of intensity level 3 when Fluker's® turtle diet (18 sec) was presented significantly differed when Meijer® rabbit food (32 sec, p=0.0204) was present (Table 17). The average duration when API® bottom feeder pellets (30 sec) was placed differed significantly to the duration when oak leaf detritus (18 sec, p=0.0440) and Meijer® farm raised tilapia fillets (15 sec, p=0.0093) was presented (Table 18).

There was no significant difference in the average time spent at intensity level -2 (p=0.0517), -1 (p=0.6303), 1 (p=0.5574), and level for 4 (p=0.3763) between the different groups of resources with the subordinate *Orconectes propinquus* crayfish (Table 4).

At intensity level 0 the average duration was 20 seconds with the subordinate *Orconectes propinquus* crayfish which differed significantly when compared to when API® bottom feeder pellets (41 sec, p=0.0041), Fluker's® turtle diet (38 sec, p=0.0064), Meijer® rabbit food (41 sec, p<.0001), and Meijer® farm raised tilapia (29 sec, p=0.0480) was presented (Table 19). The average duration at intensity level 0 in subordinate *Orconectes propinquus* crayfish when Meijer® farm raised tilapia (29 sec) differed significantly when compared to the control (20 sec, p=0.0480) and Meijer® rabbit food (41 sec, p=0.0353) group (Table 20). The average duration of at intensity level 0 when Meijer® rabbit food (41 sec) was present significantly differed to no food (20 sec, p<.0001), oak leaf detritus (28 sec, p=0.0031), Tetra Pond® Pond sticks (33 sec, p=0.0208), and Meijer® farm raised tilapia fillets (29 sec, p=0.0353) (Table 21). The average duration at an intensity of 0 when Tetra Pond® Pond sticks (33 sec) and oak leaf detritus (28 sec) was presented only significantly differed to when Meijer® rabbit food (41 sec, p=0.0208, p0.0031) was present. (Table 22 and Table 23). At an intensity of 0 the average duration when Fluker's® turtle diet (38 sec) and API® bottom feeder pellets (41 sec) only differed significantly to when no food was present (20 sec, p=0.0064, p=0.0041) (Table 24 and Table 25).

There were significant differences in the average duration of subordinate *Orconectes propinquus* at intensity level 2 as well. When no food was present the average duration was 6 seconds which differed when API® bottom feeder pellets (16 sec, p=0.0070), Tetra Pond® Pond sticks (17 sec, p=0.0391), Meijer® rabbit food (14 sec, p=0.0042), and Meijer® farm raised tilapia fillets (19 sec, p=0.0061) was provided (Table 26). The average duration when Meijer® farm raised tilapia (19 sec) was significant when compared to no food (6 sec, p=0.0061) and oak leaf detritus (10 sec, p=0.0329) (Table 27). The average duration at this intensity level when Meijer® rabbit food was provided was 14 seconds, which differed significantly to the control (6 sec, p=0.0042), Fluker's® turtle diet (12 sec, p=0.0440), and the oak leaf detritus (10 sec, p=0.0247) group (Table 28). The average duration when Tetra Pond® Pond sticks (17 sec) only differed significantly when compared to the control group (Table 29). The average duration when oak leaf detritus (10 sec) was presented significantly differed to when API® bottom feeder pellets (16 sec, p=0.0377), Meijer® rabbit food (14 sec, p=0.0247), and Meijer® farm raised tilapia fillets (19 sec, p=0.0329) were present (Table 30). The average duration when Fluker's® turtle diet (12 sec) was present only significantly differed to the Meijer® rabbit food (14 sec, p=0.0440) group (Table 31). Average duration differed significantly when API® bottom feeder pellets (16 sec) was compared to the control (6 sec, p=0.0070) and oak leaf detritus (10 sec, p=0.0377) groups (Table 32).

Significant differences in the average duration spent at intensity level 3 of the subordinate *Orconectes propinquus* were also observed. The average duration when API® bottom feeder pellets (33 sec) and Meijer® rabbit food (36 sec) was presented differed significantly to the control (22 seconds, p=0.0261, p=0.0081 respectively) and Meijer® farm raised tilapia (19 sec, p=0.0049, p=0.0013 respectively) (Table 33 and Table 34). The average duration when Meijer® rabbit food (36 sec) was in the food bag differed significantly to when no food (22 sec, p=0.0081), Fluker's® turtle diet (22 sec, p=0.0091), oak leaf detritus (21 sec, p=0.0076), Tetra Pond® Pond sticks (25 sec, p=0.0293), and Meijer® farm raised tilapia fillets (19 sec, p=0.0013) was present (Table 35). When Tetra Pond® Pond sticks were presented the average duration spent at intensity level 3 was 25 seconds, which significantly differed only to the Meijer® rabbit food (36 sec, p=0.0293) group (Table 36). The average duration when oak leaf detritus (21 sec) and Fluker's® turtle diet (22 sec) was present differed significantly when API® bottom feeder pellets (33 sec, p=0.0248, p=0.0293 respectively) and Meijer® rabbit food (36 sec, p=0.0076, p=0.0091 respectively) was present (Table 37 and Table 38). The average duration when API® bottom feeder pellets (33 sec) differed significantly when compared to the control (22 sec, p=0.0261), Fluker's® turtle diet (22 sec, p=0.0293), oak leaf detritus (21 sec, p=0.0248), and Meijer® farm raised tilapia fillets (19 sec, p=0.0049) group (Table 39).

Significant differences in the average duration subordinate *Orconectes propinquus* spent at the highest intensity level, 5, were noted as well. The average duration when Fluker's® turtle diet (16 sec) was present significantly differed to when API® bottom feeder pellets (0 sec, p=0.0049), oak leaf detritus (0 sec, p=0.0049), Meijer® rabbit food (0 sec, p=0.0049), and Meijer® farm raised tilapia fillets (0 sec, p=0.0055) was present as the subordinate crayfish were not observed reaching this intensity level (Table 41, 42, 44, 45, 46). The average duration subordinate *Orconectes propinquus* when no food (11 sec) and Tetra Pond® Pond sticks (9 sec) did not differ significantly when compared to the other resource groups (Table 40 and Table 43).

In the dominate *Orconectes rusticus* crayfish there was no significant difference in the average time spent at intensity levels -2 (p=0.4832), -1 (p=0.3840), 0 (p=0.4255), 1 (p=0.2765), 2 (p=0.4666), 3 (p=0.1301), and 4 (p=0.1942) between the six food resources presented (Table 4). The only intensity level in which there were significant differences was at the highest intensity level (5). The average duration spent at intensity level 5 when Meijer® farm raised tilapia fillets was present was 7 seconds. This average duration differed significantly to when

API® bottom feeder pellets (4 sec, p=0.0047), oak leaf detritus (3 sec, p=0.0163), Tetra Pond® Pond sticks (4 sec, p=0.0080), and Meijer® rabbit food (5 sec, p=0.0473) was presented (Table 47, 48, 49, 50, 52). The average duration spent at intensity level 5 was found to be 5 seconds when Fluker's® turtle diet was presented. This was not significant when compared to all the other resources presented (Table 51).

In the subordinate *Orconectes rusticus* crayfish there was no significant difference in the average time spent at intensity levels -2 (p=0.4732), 0 (p=0.0786), 2 (p=0.4666), and 3 (p=0.3278) between the six different resources used in this experiment (Table 4).

At an intensity level of -1 subordinate *Orconectes rusticus* crayfish spent an average of 5 seconds when Meijer® farm raised tilapia was presented (Table 3). This average duration differed significantly to when API® bottom feeder pellets (2 sec, p=0.0028), Fluker's® turtle diet (3 sec, p=0.0312), oak leaf detritus (2 sec, p=0.0156), and Meijer® rabbit food (2 sec, p=0.0134) was presented (Table 53, 54, 56, 57, 58). The only resource in which the average duration at intensity level -1 when Meijer® farm raised tilapia was present did not significantly differ from was Tetra Pond® Pond sticks (3 sec), which had no significant differences in the average duration when compared to all the other resource groups (Table 55).

At intensity level 1, it appears Meijer® farm raised tilapia again is the only resource that has significant difference in the average duration spent at this level. The average duration for 1 subordinate *Orconectes rusticus* crayfish when Meijer® farm raised tilapia was presented was 2 seconds. This value differed significantly when compared to all the other food resources which had an average time of 1 second spent at intensity level 1. The P-values of the average duration at intensity 1 for the API® bottom feeder pellets, Fluker's® turtle diet, oak leaf detritus, Tetra Pond® Pond sticks, and Meijer® rabbit food are p=0.0025, p=0.0059, p=0.0199, p=0.0268, and p=0.0220 respectively when compared with the average duration when Meijer® farm raised tilapia is present (Table 59-64).

At intensity level 4 API® bottom feeder pellet group was the only resource that had a significant effect on the average duration subordinate *Orconectes rusticus* crayfish spent at this level when compared to the other resources. The crayfish spent an average of 5 seconds when API® bottom feeder pellets was presented. This value significantly differed when compared to the average duration when Fluker's® turtle diet (7 sec, p=0.0061), Meijer® rabbit food (6 sec, p=0.0388), and Meijer® farm raised tilapia fillets (8 sec, p=0.0063) was presented (Table 65, 66, 69, 70). The average duration subordinate *Orconectes rusticus* crayfish spent at intensity level 4 when Tetra Pond® Pond sticks and oak leaf detritus was present was found to be 5 and 6 seconds respectively (Table 3). There were no significant differences in average duration when these two resources were compared to the other resources (Table 67 and Table 68).

At intensity level 5, the average duration subordinate *Orconectes rusticus* crayfish spent at this level had significant differences when the food groups were compared to Meijer® farm raised tilapia and API® bottom feeder pellets. The average duration crayfish spent at intensity level 5 when Meijer® farm raised tilapia was presented was 9 seconds. This differed significantly to the average duration when API® bottom feeder pellets (4 sec, p=0.0009), oak leaf detritus (4 sec, p=0.0100), Tetra Pond® Pond sticks (4 sec, p=0.0044), Meijer® rabbit food (4 sec, p=0.0226) was presented (Table 71, 72, 73, 74, 76). The average duration of Fluker's® turtle diet (5 sec) was the only resource that did not differ significantly when compared to Meijer® farm raised tilapia (Table 71 and Table 75). However, the average duration spent at this intensity when API® bottom feeder pellets was present did differ significantly to when Fluker's® turtle diet was present (Table 75 and Table 76).

Resource Effect on Average Duration of Bag Contact

The average and total durations that both *Orconectes propinquus* and *Orconectes rusticus* made contact with the food bag when different resources were presented can be viewed in Table 77 and Table 78 respectively.

Dominate *Orconectes propinquus* spent the greatest total of time contacting the food bag when it contained Fluker's® turtle diet (111:21) while subordinate crayfish spent the greatest total time contacting API® bottom feeder pellets (Table 77). Both dominate and subordinate *Orconectes propinquus* spent the least amount of total time in contact when the bag contained no food (13:46 and 10:25 respectively)(Figure 29). Dominate *Orconectes propinquus* spent more time on average when Fluker's® turtle diet (2:15) was present when compared to the other food resources (Figure 30). Both dominate and subordinate crayfish spent the lowest average of time contacting the food bag when no food was present (27 sec and 19 sec respectively). Subordinate crayfish spent the greatest amount of time on average when API® bottom feeder pellets was present (1:40) (Table 77).

Both dominate and subordinate *Orconectes rusticus* spent the greatest total of time contacting the food bag when it contained Meijer® rabbit food (31:45 and 12:47 respectively) (Table 78 and Figure 31). Subordinate *Orconectes rusticus* spent less total time when compared to dominate crayfish contacting the food bag in all food groups (Table 78 and Figure 31). Dominant *Orconectes rusticus* spent the highest average time in contact with the food bag when containing Tetra Pond® Pond sticks (2:29) and the lowest average when the bag contained oak leaf detritus (15 sec) (Table 78). Subordinate *Orconectes rusticus* spent more time on average contacting the food bag when Meijer® farm raised tilapia (3:51) is present and the lower average of time when oak leaf detritus is present (5 sec) (Table 78 and Figure 32). Unlike in *Orconectes propinquus*, subordinate *Orconectes rusticus* spent more time on average contacting the food bag when Meijer® farm raised tilapia API® bottom feeder pellets was present. This significantly increased average bag contact time when tilapia is present can partially be explained by two outliers in which two different subordinate crayfish spent over seven minutes contacting the bag during their individual trials.

Between dominate *Orconectes propinquus* crayfish there was a significant difference in the average bag contact time when all the resources were compared (p<.0001) (Table 79). The average bag contact time for dominate *Orconectes propinquus* when no food was present was 27 seconds (Table 77). This significantly differed when compared to all the other resources (API® bottom feeder pellets feeder (1:43, p<.0001), Fluker's® turtle diet (2:15, p<.0001), oak leaf detritus (38 sec, p=0.0353), Tetra Pond® Pond sticks (1:10, p<.0001), Meijer® rabbit food pellets (1:14, p=0.0001), and Meijer® farm raised tilapia fillets (1:45, p<.0001)) (Table 86). The average bag contact time when Meijer® farm raised tilapia (1:45) was present significantly differed when compared to Fluker's® turtle diet (2:15, p=0.0114), oak leaf detritus (38 sec, p<.0001), and Meijer® rabbit food pellets (1:14, p=0.0002) (Table 87). The average bag contact time of the dominant *Orconectes propinquus* when Meijer® rabbit food present was 1:14, which differed significantly to the API® bottom feeder pellets (1:43, p=0.0019), control (27 sec, p<.0001), Tetra Pond® Pond sticks (1:28 sec, p=0.0153), Meijer® farm raised tilapia groups (1:45, p=0.0002) (Table 88). The average bag contact time when Tetra Pond® Pond sticks (1:28) was presented differed significantly when compared to the average contact time when no food (27 sec, p<.0001), oak leaf detritus (38 sec, p<.0001), and Meijer® rabbit food pellets (1:14, p=0.0153) was present (Table 89). There was a significant difference in the average bag contact time when oak leaf detritus (38 sec) when compared to the presence of API® bottom feeder pellets (1:43, p<.0001), no food (27 sec, p=0.0353), Fluker's® turtle diet (2:15, p=0.0044), Tetra Pond® Pond sticks (1:28, p<.0001), and Meijer® farm raised tilapia fillets (1:45, p<.0001) (Table 90). When Fluker's® turtle diet (2:15) was present, the average bag contact differed significantly when API® bottom feeder pellets (1:43, p=0.0451), no food (27 sec, p<.0001), oak leaf detritus (38 sec, p=0.0044), and Meijer® farm raised tilapia fillets (1:45, p=0.0114) were present (Table 91). The average bag contact time when API® bottom feeder pellets (1:43) differed to all the other resources except for Meijer® farm raised tilapia (Table 99).

There were also significant differences in the average bag contact time of subordinate *Orconectes propinquus* when these durations were compared between resources (p<.0001) (Table 79). The average bag contact time for *Orconectes propinquus* when no food was present was 19 seconds. This duration differed significantly to all resources except oak leaf detritus (API® bottom feeder pellets feeder (1:40, p<.0001), Fluker's® turtle diet (1:01, p=0.0013), Tetra Pond® Pond sticks (1:10, p=0.0007), Meijer® rabbit food (52 sec, p=0.0054), Meijer® farm raised tilapia fillets (44 sec, p=0.0014)) (Table 93). The average bag contact time subordinate *Orconectes propinquus* when Meijer® farm raised tilapia (44 sec) was provided differed significantly to when API® bottom feeder pellets (1:40, p=0.0007), no food (19 sec, p=0.0014), and oak leaf detritus (32 sec, p=0.0293) was presented (Table 94). The average bag contact time when Meijer® rabbit food was provided was 52 seconds, which differed significantly only to when API® bottom feeder pellets (1:40, p<.0001) and no food (19 sec, p=0.0054) was presented (Table 95). There was a significant difference in the average bag contact time when Tetra Pond® Pond sticks (1:10) was provided when compared to API® bottom feeder pellets (1:40 sec, p=0.0023), the control (19 sec, p=0.0007), and oak leaf detritus (32 sec, p=0.0135) (Table 96).

The average bag contact time when oak leaf detritus (32 sec) was presented differed significantly to when API® bottom feeder pellets (1:40, p<.0001), Fluker's® turtle diet (1:01, p=0.0293), Tetra Pond® Pond sticks (1:10, p=0.0135), and Meijer® farm raised tilapia fillets (44 sec, p=0.0293) was presented (Table 97). The average bag contact time of subordinate *Orconectes propinquus* when Fluker's® turtle diet was provided was 1:01. This differed significantly to the average bag contact time when API® bottom feeder pellets (1:40, p=0.0005), no food (19 sec, p=0.0013), and oak leaf detritus leaves (32 sec, p=0.0293) was present (Table 98). The average bag contact time when API® bottom feeder pellets (1:40) was presented differed significantly to all the other resources (Table 99).

Between dominate *Orconectes rusticus* crayfish there was a significant difference in the average bag contact time when all the resources were compared (p=0.0302) (Table 79). There was no significant difference between the average bag contact times of subordinate crayfish between the resources (p=0.1898) (Table 79). The average bag contact time of dominate *Orconectes rusticus* when oak leaf detritus (15 sec) was presented significantly differed when compared to when Tetra Pond® Pond sticks (2:29, p=0.0061) and Meijer® rabbit food pellets (1:43 sec, p=0.0048) were presented (Table 81, 82, 83). Average bag contact time of Meijer® farm raised tilapia (1:46), Fluker's® turtle diet (46 sec), API® bottom feeder pellets (53 sec) did not significantly differ to the other food groups (Table 80, 84, 85).

Chapter 5: Discussion and Conclusions

Contrary to my predictions, none of the provided resources created a significant increase in aggressive behaviors displayed. It was hypothesized if the crayfish found the provided resource valuable, they would spend a greater proportion of time at higher intensity levels as was similarly observed by Bergman and Moore (2003). Trials rarely escalated to an intensity level 4 and 5 as previously expected. *Orconectes propinquus* crayfish had more interactions overall in the control group when no food was presented than when any of the other resources were provided (Table 2). It was also found that both dominate and subordinate *Orconectes propinquus* spent less time ignoring their conspecifics (intensity level of 0) during the trials than when any resources were presented. Those in the control group also were found to spend more time in agonistic interactions than the other food groups. They spent more total time at an intensity level 3 than the other resource groups (Table 2). Although in terms of average time spent at intensity level 3, both subordinate and dominate *Orconectes propinquus* spent more time on average when API® bottom feeder and Meijer® rabbit food was presented. Between dominate *Orconectes propinquus* only the average time spent at intensity level 3 between no food (21 sec) and Meijer® rabbit food (32 sec) was found to be significant (Table 12). In subordinate *Orconectes propinquus* the average time spent at intensity level 3 of both API® bottom feeder pellets (33 sec, p=0.0261), Meijer® rabbit food (36 sec, p=0.0081) significantly differed to the control group (Table 33). Similar findings cannot be compared with *Orconectes rusticus* as no trials containing no food were not obtained.

In both *Orconectes rusticus* and *Orconectes propinquus*, the proportion of time spent at different intensity levels between dominate and subordinate crayfish within each food group appears very similar after taking into account the increased retreat displays of the subordinate crayfish, except in the tilapia group of *Orconectes rusticus* (Figures 10-26). When looking at the total time spent during all trails both dominate and subordinate *Orconectes rusticus* spent more total time during the trials at intensity level 5 when Meijer® farm raised tilapia was presented than when the other resources were presented. The average time spent at intensity level 5 in subordinate *Orconectes rusticus* was nine seconds. This was significantly increased when compared to all other food groups, excluding Fluker's® turtle diet, which had an average duration of four seconds (Table 71). When Fluker's® turtle diet was presented, the average time spent at intensity level 5 for subordinate *Orconectes propinquus* was five seconds. In dominate *Orconectes rusticus* the average time spent at intensity level 5 was seven seconds and this was significantly different to again, all food resources excluding Fluker's® turtle diet (Table 47). The average time dominate *Orconectes rusticus* spent at intensity level 5 was between three to five seconds for the other resources (Table 3). The increased time spent at intensity level 5 was not observed with *Orconectes propinquus*. When tilapia was present *Orconectes propinquus* did not escalate interactions to intensity level 5 within this experiment (Table 2). When Fluker's® turtle diet was present both dominate and subordinate *Orconectes propinquus* spent more time at an intensity level 5 but the average time spent at this intensity level but this did not significantly differ when compared to all the other foods with the dominate crayfish. In subordinate *Orconectes propinquus* the average time spent at intensity level 5 was 16 seconds which was significantly different from all the other food resources except Tetra Pond® Pond sticks (9 sec) and the control group (11 sec) (Table 2, 40, 43, 45).

As stated earlier, an intensity level 4 was rarely seen. In dominate *Orconectes propinquus* the most time was spent at this level when Meijer® farm raised tilapia was present. In subordinate crayfish the most time on average spent at this intensity level was when API®

bottom feeder pellets. The average time both dominate and subordinate *Orconectes propinquus* crayfish spent at this intensity level did not differ significantly when one resource was presented when compared to the other resources (Table 4). In both dominate and subordinate *Orconectes rusticus* the most time was spent at an intensity level 4 was when API® bottom feeder pellets was present (Table 3). When the average time spent at this intensity level was compared between the resources presented, there was only a significant difference found with the subordinate crayfish. There was a significant difference between the average time spent at intensity level 4 when API® bottom feeder pellets was present when compared to all the other resources except for Tetra Pond® Pond sticks and Oak leaf detritus (Table 70). API® bottom feeder pellets had the lowest average of five seconds while the other resources ranged from 6-8 seconds with crayfish spending the most time on average at intensity level 4 when Meijer® farm raised tilapia was present (Table 3).

Looking at the average duration spent at intensity level 3, there were no significant differences found with *Orconectes rusticus*. In dominate *Orconectes propinquus* more time was spent total at intensity level 3 when no food was present but on average when intensity level 3 was achieved, it was spent for longer periods of time when Meijer® rabbit food (32 sec) and API® bottom feeder pellets (30 sec) was presented (Table 2). The average duration spent at intensity level 3 when Meijer® rabbit food was present was significantly different when compared to the control group (21 sec), oak leaf detritus (18 sec), Tetra Pond® Pond sticks (22 sec), and Meijer® farm raised tilapia fillets (15 sec) (Table 14). The average duration when API® bottom feeder pellets was present significantly differed to oak leaf detritus (18 sec) and Meijer® farm raised tilapia fillets (15 sec) (Table 18). The same was observed with subordinate *Orconectes propinquus* with the average duration spent at intensity level 3 when Meijer® rabbit food was 36 seconds. This differed significantly from all the other resources presented (Table 35). The average duration at intensity level 3 when API® bottom feeder pellets was 33 seconds, which differed significantly to when no food (22 sec), Fluker's® turtle diet (22 sec, p=0.0293), oak leaf detritus (21 sec), and Meijer® farm raised tilapia fillets (19 sec) was presented (Table 39).

Just using the data discussed above regarding the average duration spent at higher intensity levels (4 and 5), it appears that Meijer® farm raised tilapia and Fluker's® turtle diet may contribute to increased duration spent at higher intensities. Although it is noted only a small proportion of time was spent at these higher intensity levels when these foods were present. This also varied depending on if crayfish were subordinate or dominant. In both species subordinate crayfish spent increased time at intensity level 4 and 5 when Fluker's® turtle diet was present (Table 65, 69, 71,75). In dominate *Orconectes rusticus* had a significant increase in the average duration spent at these higher intensity levels when Meijer® farm raised tilapia was present, but not when Fluker's® turtle diet was present (Table 47 and Table 51). In dominate *Orconectes propinquus* there was no significant increase in the average duration spent at intensity levels 4 and 5 (Table 4).

The average duration crayfish spent making contact with the food bag containing each resource could also help provide insight for what these crayfish find valuable. It was noted previously that it was expected the crayfish would spend a greater proportion of time at higher intensity levels if the resource was thought to be more valuable. In *Orconectes propinquus* very little time was spent contacting the bag in all the trials when no food was present when compared to when resources were present (Table 77). This could help explain the decreased proportion of time spent at higher intensity levels that was observed in *Orconectes propinquus.* More agonistic interactions were observed within the control group but also less time was spent interacting with the provided resource within the food bag. The lack of a resource present may have provided more incentive for interactions and agonistic bouts as there was no higher priorities such as shelter or mates.

Dominate crayfish spent more time total than their subordinate conspecifics contacting the food bag in both species (Table 77 and Table 78). Similar results were found by Herberholz et al. (2007). In dominate *Orconectes propinquus* the most time spent contacting the food bag was when Fluker's® turtle diet and Meijer® farm raised tilapia was present (Table 77). They spent an average of 1:45 when Meijer® farm raised tilapia was present and 2:15 when Fluker's® turtle diet was provided (Table 77). The average time spent contacting time contacting the food bag when Meijer® farm raised tilapia was present differed significantly compared to when no food (27 sec), Fluker's® turtle diet (2:15), oak leaf detritus leaves (38 sec), and Meijer® rabbit food pellets (1:14) was present (Table 87). The average time when Fluker's® turtle diet was provided differed significantly to when API® bottom feeder pellets (1:43), no food (27 sec), oak leaf detritus (38 sec), and Meijer® farm raised tilapia (1:45) was present. In subordinate *Orconectes propinquus* crayfish spent the most time contacting the bag when API® bottom feeder pellets were present. The average time subordinate *Orconectes propinquus* crayfish spent contacting the bag when API® bottom feeder pellets were present was 1:40 (Table 77). This differed significantly to all the other resources presented (Table 99). It was found that dominate *Orconectes rusticus* spent the most time on average contacting the food bag when Tetra Pond® Pond sticks (2:29) and Meijer® rabbit food (1:43) were presented (Table 78). These values only significantly differed to the average time spent contacting the bag when oak leaf detritus (15 sec) was presented (Table 81 and Table 82). There was no significant difference in the average time s dominate *Orconectes rusticus* spent contacting the food bag when comparing the presence of the other food resources when accounting for how often the crayfish contacted the food bag (Table 80, 84, 85). Subordinate *Orconectes rusticus* spent the most time on average contacting the food bag when Meijer® farm raised tilapia was presented (Table 78). Despite the average time subordinate *Orconectes rusticus* spent contacting the food bag totaling 3:51, there were no significant differences found when compared to the other average values after taking into account how often the crayfish contacted the food bag (Table 79). This elevated value occurred when two subordinate *Orconectes rusticus* crayfish contacted the food bag for over seven minutes during two trials when Meijer® farm raised tilapia was presented, which highly skewed the average.

Again it appears both Fluker's® turtle diet and Meijer® farm raised tilapia seem somewhat favorable to the *Orconectes propinquus* that were considered dominate based on the average bag contact time. When both Fluker's® turtle diet was present both dominate and subordinate *Orconectes propinquus* also spent more total time at an intensity level of 4 and 5 when compared to the other resources except when no food was present. In both dominate and subordinate *Orconectes rusticus*, more total time was spent at intensity level 5 when Meijer® farm raised tilapia was present and at intensity level 4 more total time was spent at intensity level 5 when Fluker's® turtle diet pellets were presented. Comparing the crude protein, crude fat, and crude fiber of the resources show that both Fluker's® turtle diet and Meijer® farm raised tilapia have more crude protein and crude fat in comparison to the other resources which could explain the possible increase in value (Table 1). In a review of crayfish diet, Brown noted that crayfish had preference for plant feedstuffs containing high levels of nitrogen-free extract (1995). In *Procambarus clarkii* mean consumption in terms of body percent were compared involving many different food resources. On comparison of consumption to the crude protein percentage, there did not appear to be a significant correlation between increased crude protein and consumption (Brown 1995). This could indicate that crude fat or other factors that have yet to be evaluated have an effect what crayfish find valuable in food.

It should be noted that less trials were run and analyzed involving *Orconectes rusticus* in comparison to *Orconectes propinquus*, especially trials presenting Tetra Pond® Pond sticks (n=7). This lowered number of trials could affect the significance of the results and makes comparison between the species difficult. To further analyze the possibility that crude fat and protein may have an effect on both species categorization of food value, future research food focus on comparing food resources with varying amounts of crude fat and proteins.

Appendices

Figure 1: Crayfish Ethogram (Bergman & Moore (2003))

Table 1

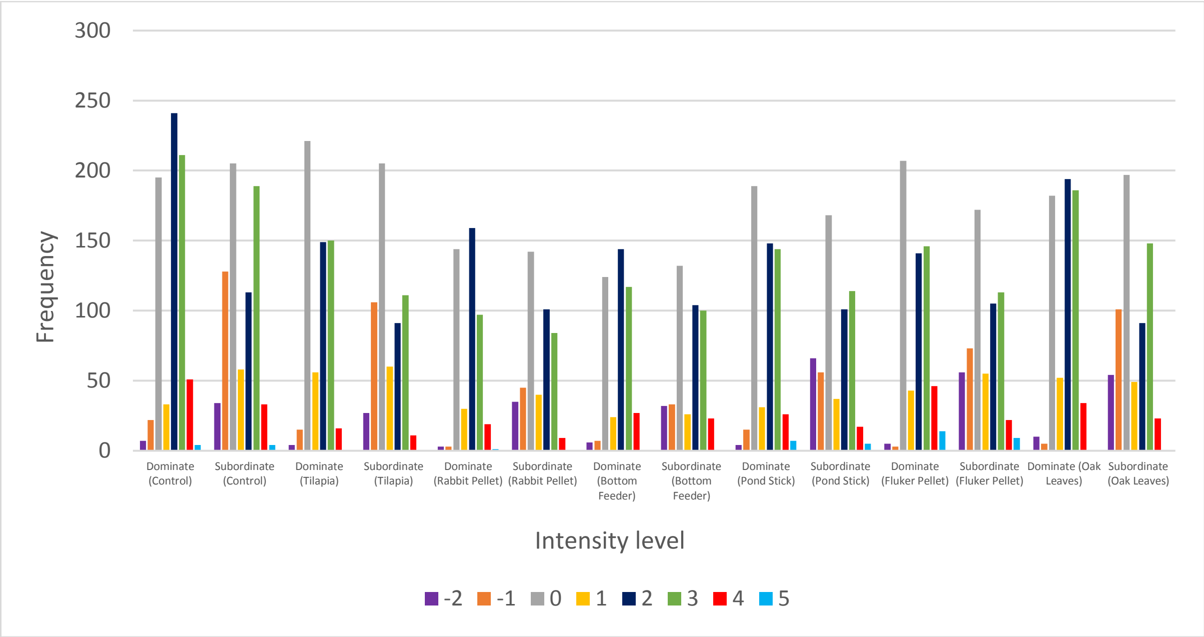
Crayfish ethogram codes

Intensity Level	Description
−2	Tailflip away from opponent or fast retreat
−1	Slowly back away from opponent
0	Ignore opponent with no response or threat display
1	Approach without a threat display
2	Approach with threat display using meral spread and/or antennal whip
3	Initial claw use by boxing, pushing, or touching with closed claws
4	Active claw use by grabbing opponent with open claws
5	Unrestrained fighting by grasping and pulling opponent's claws or appendages

Figure 2: Isolation Tanks

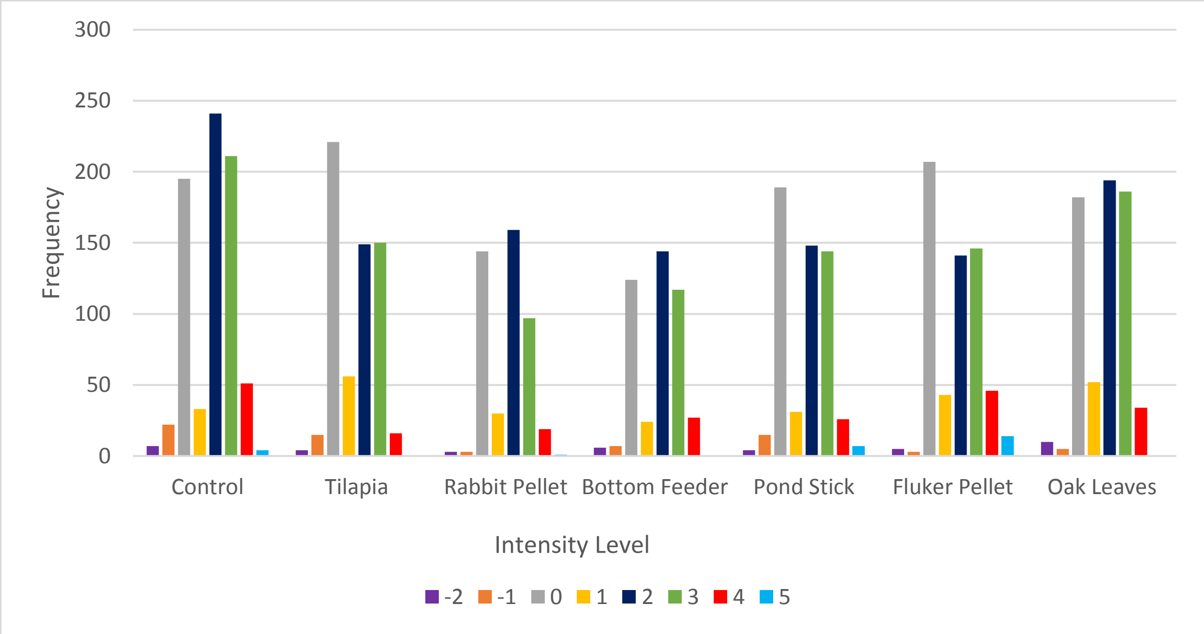
Figure 3: Experiment Tank Set up

Figure 4: Frequency of Displayed Intensity Levels of Dominate and Subordinate *Orconectes propinquus* Crayfish



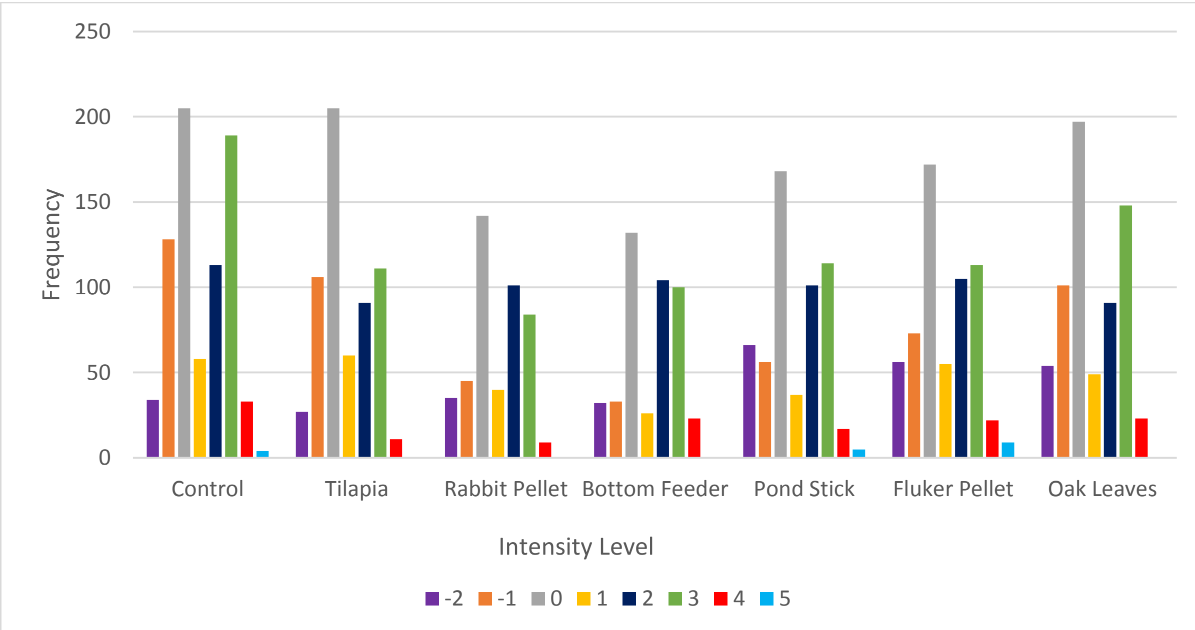
The figure displays how frequent dominate and subordinate *Orconectes propinquus* crayfish would reach each intensity level between all trials of each resource presented.

Figure 5: Frequency of Displayed Intensity Levels of Dominate *Orconectes propinquus* Crayfish



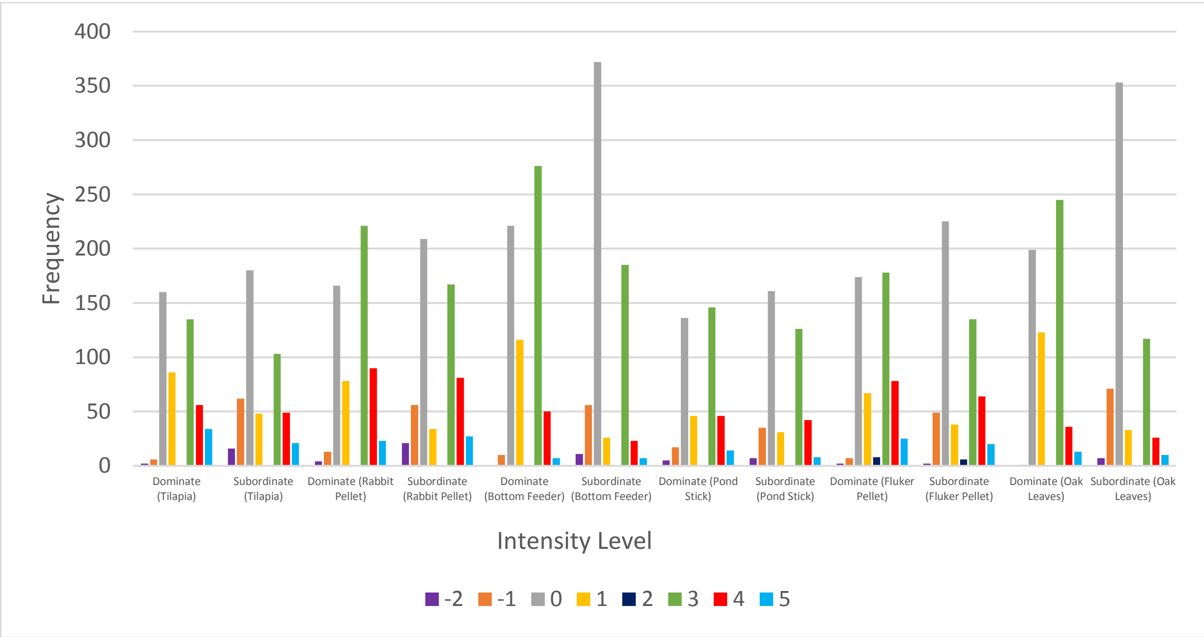
The figure displays how frequent dominate *Orconectes propinquus* crayfish would reach each intensity level between all trials of each resource presented.

Figure 6: Frequency of Displayed Intensity Levels of Subordinate *Orconectes propinquus* Crayfish



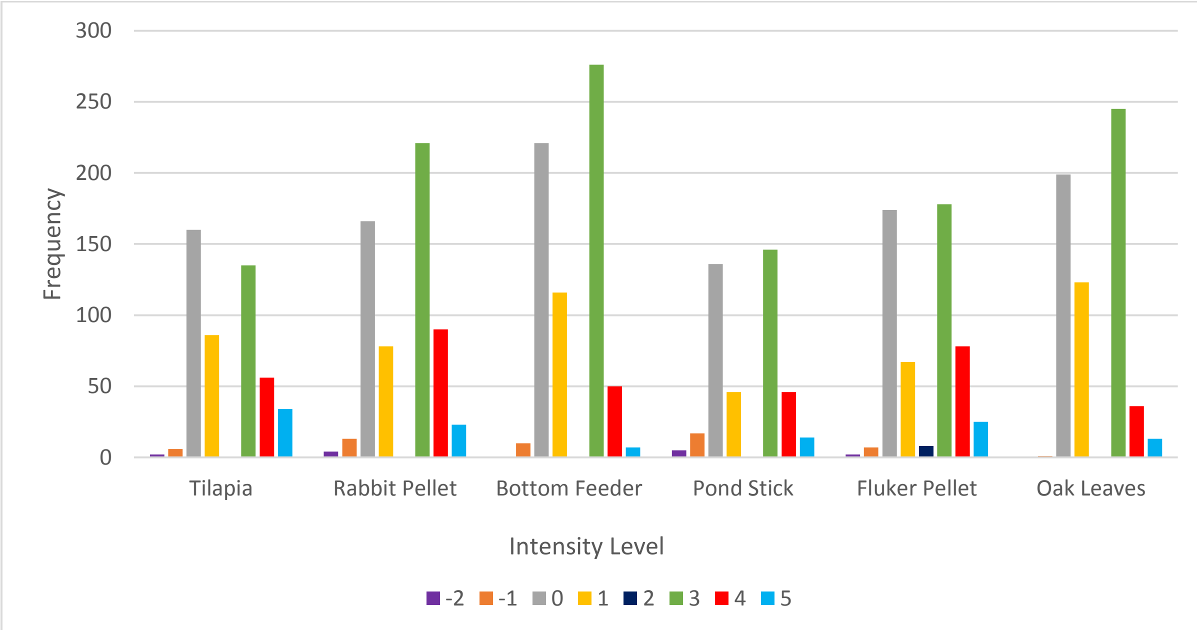
The figure displays how frequent subordinate *Orconectes propinquus* crayfish would reach each intensity level between all trials of each resource presented.

Figure 7: Frequency of Displayed Intensity Levels of Dominate and Subordinate *Orconectes rusticus* Crayfish



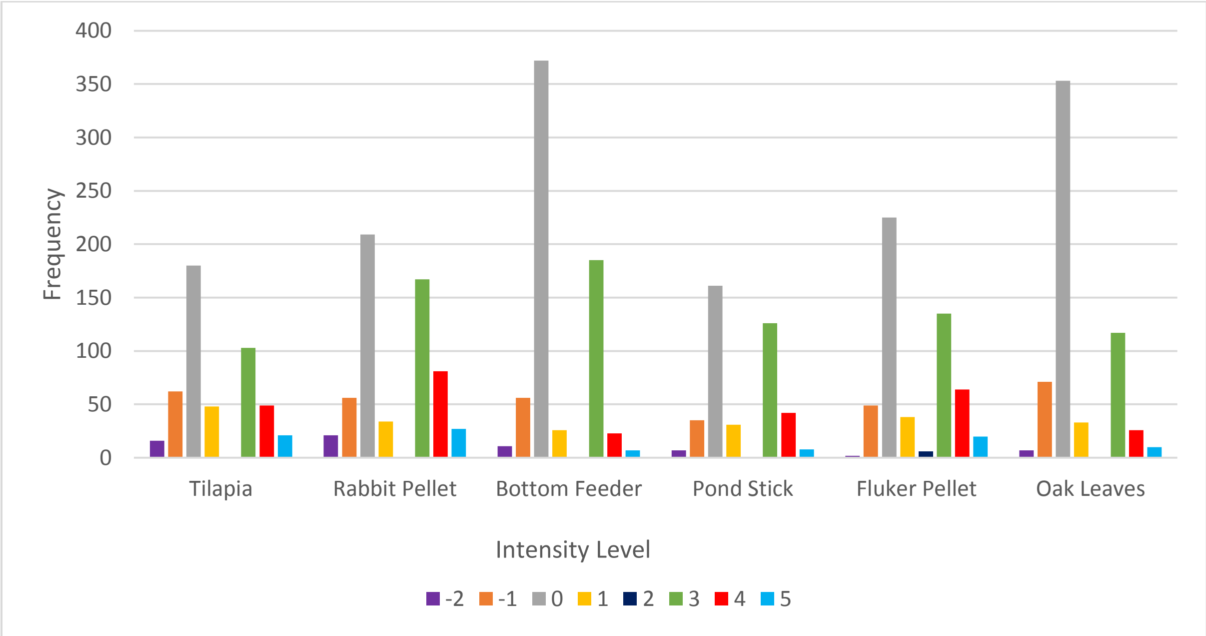
The figure displays how frequent dominate and subordinate *Orconectes rusticus* crayfish would reach each intensity level between all trials of each resource presented.

Figure 8: Frequency of Displayed Intensity Levels of Dominate *Orconectes rusticus* Crayfish



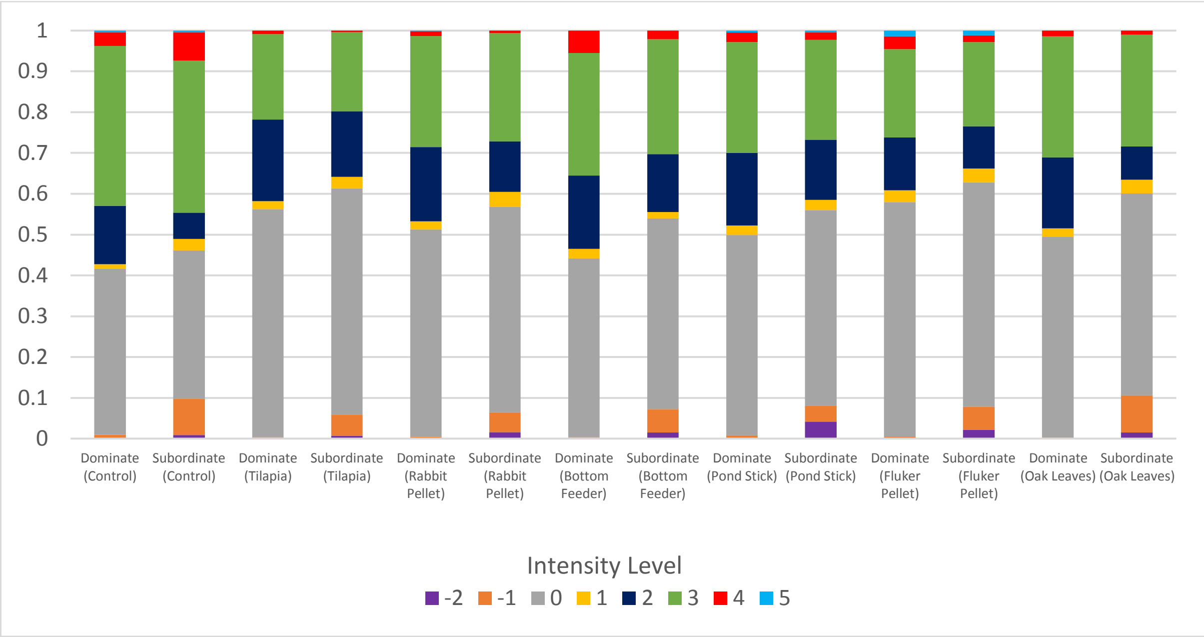
The figure displays how frequent dominate *Orconectes rusticus* crayfish would reach each intensity level between all trials of each resource presented.

Figure 9: Frequency of Displayed Intensity Levels of Subordinate *Orconectes rusticus* Crayfish



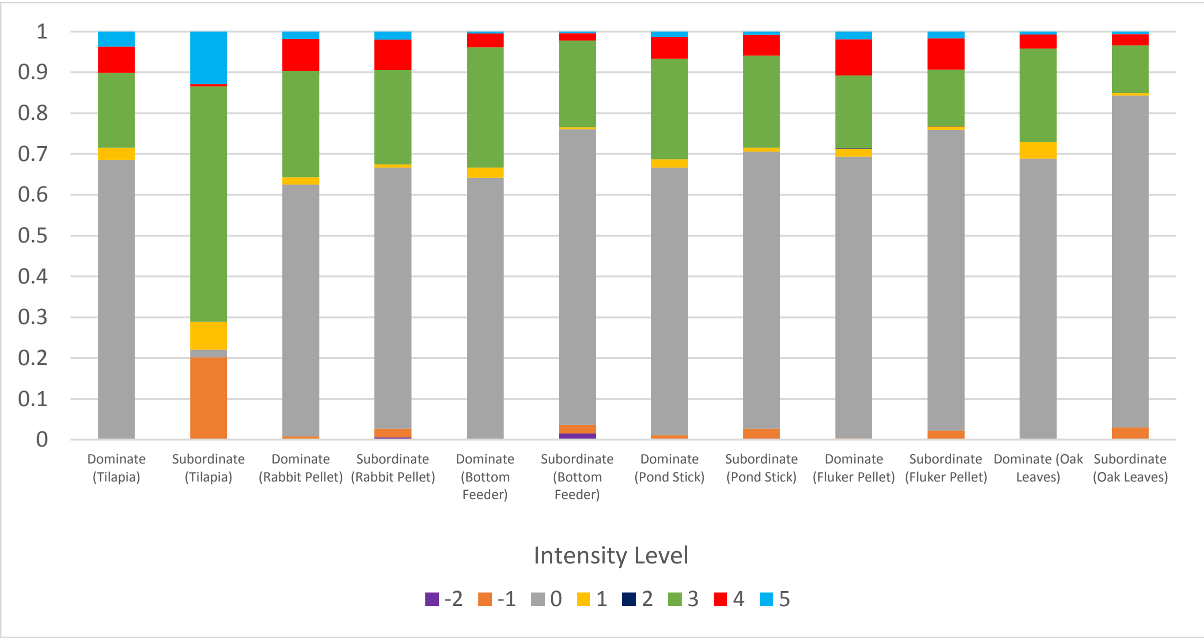
The figure displays how frequent subordinate *Orconectes rusticus* crayfish would reach each intensity level between all trials of each resource presented.

Figure 10: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent at Each Intensity Level



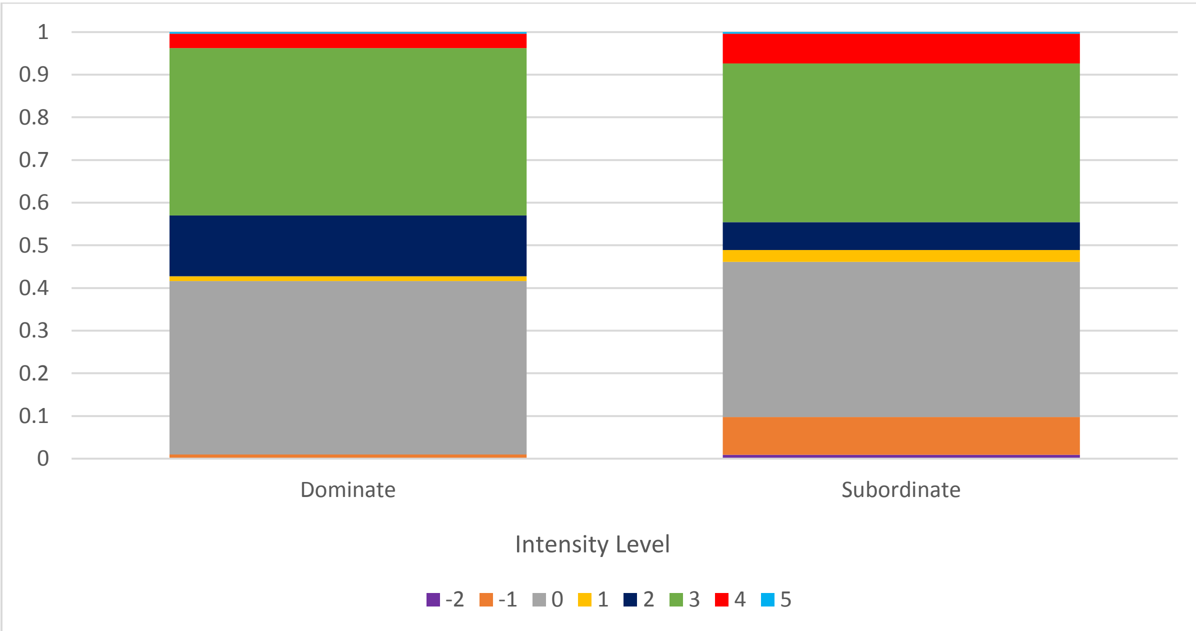
The figure displays the proportion of time of spent between all trials with the different food resources of the dominate and subordinate crayfish of the *Orconectes propinquus* species.

Figure 11: Proportion of Time Dominate and Subordinate *Orconectes rusticus* Crayfish Spent at Each Intensity Level



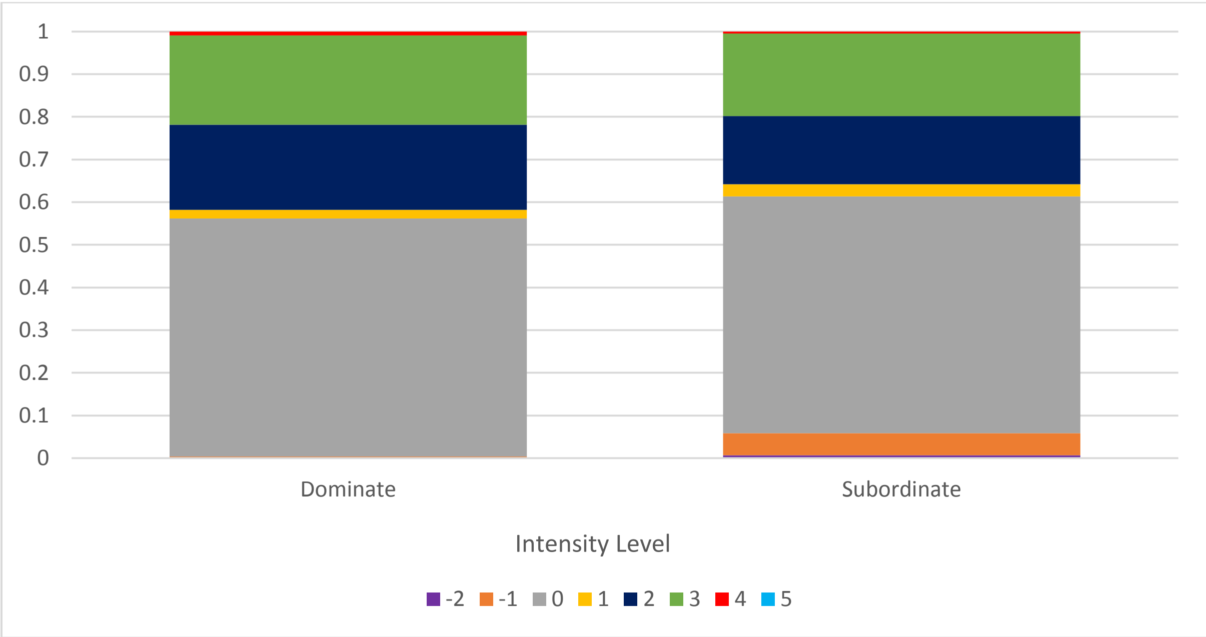
The figure displays the proportion of time of spent between all trials with the different food resources of the dominate and subordinate crayfish of the *Orconectes rusticus* species.

Figure 12: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent At Each Intensity Level in the Control Group



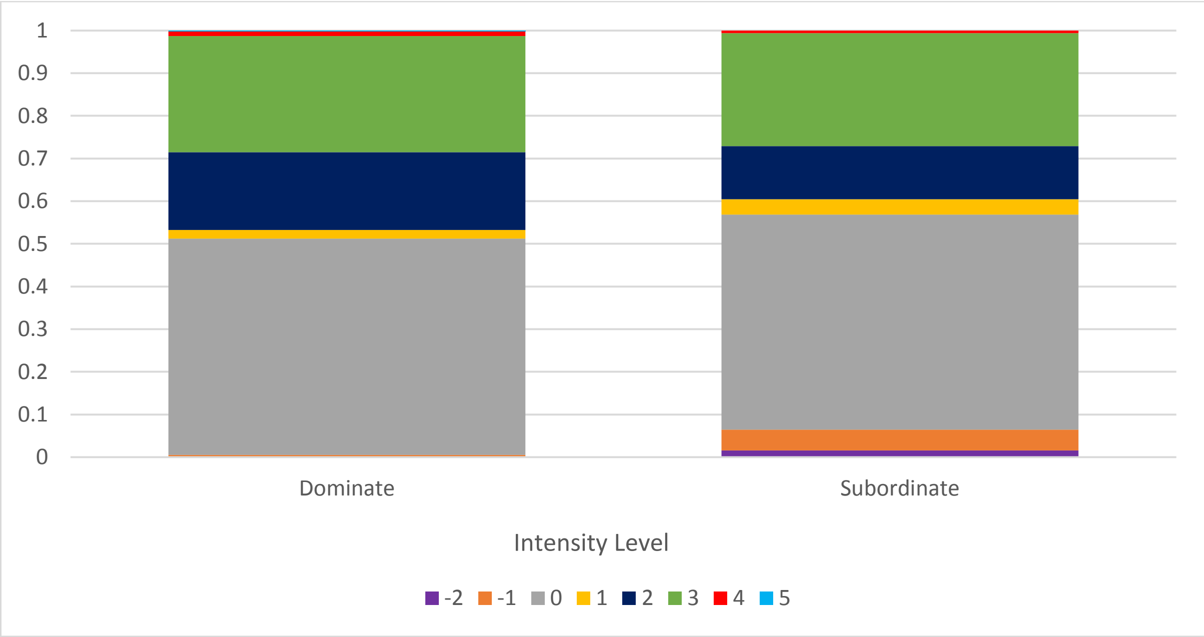
The figure displays the proportion of time of spent between all trials when no food is present (control) between the dominate and subordinate crayfish of the *Orconectes propinquus* species.

Figure 13: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent At Each Intensity Level in the Tilapia Group



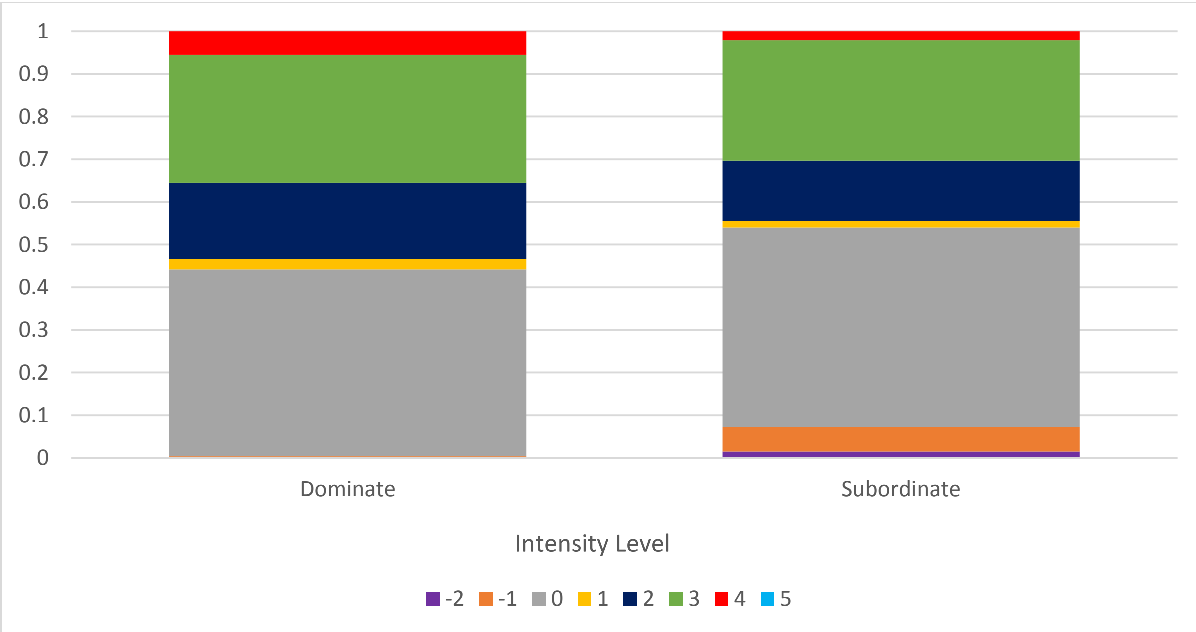
The figure displays the proportion of time of spent between all trials when Meijer® farm raised tilapia fillets was presented between the dominate and subordinate crayfish of the *Orconectes propinquus* species.

Figure 14: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent At Each Intensity Level in the Rabbit Pellet Group



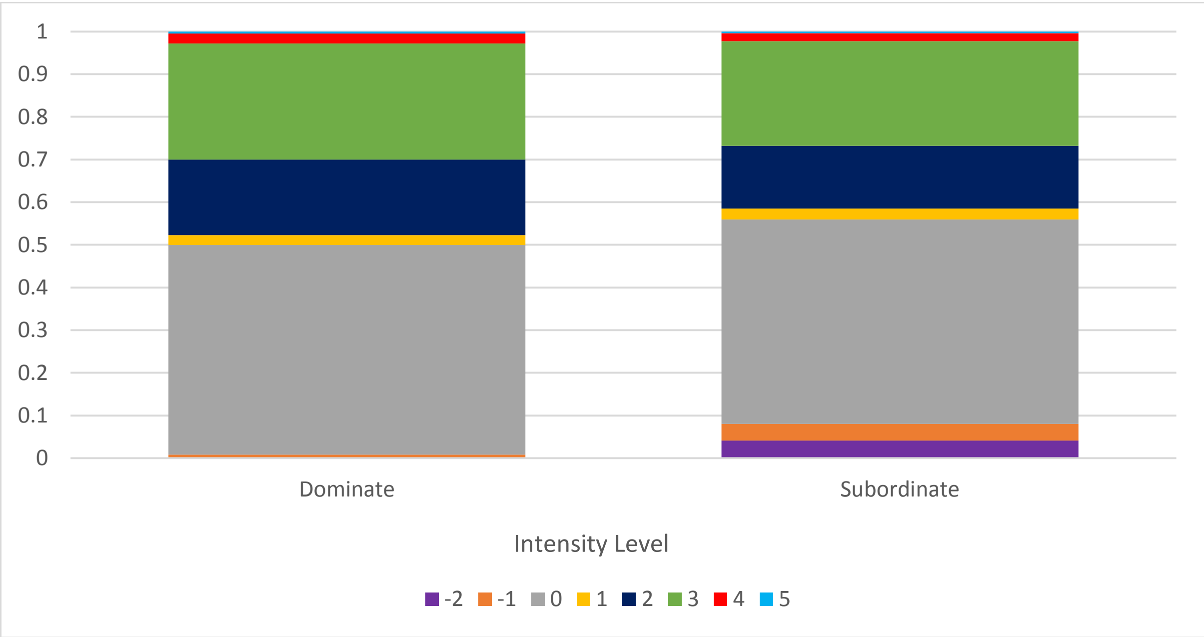
The figure displays the proportion of time of spent between all trials when Meijer® rabbit food was presented between the dominate and subordinate crayfish of the *Orconectes propinquus* species.

Figure 15: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent At Each Intensity Level in the Bottom Feeder Pellet Group



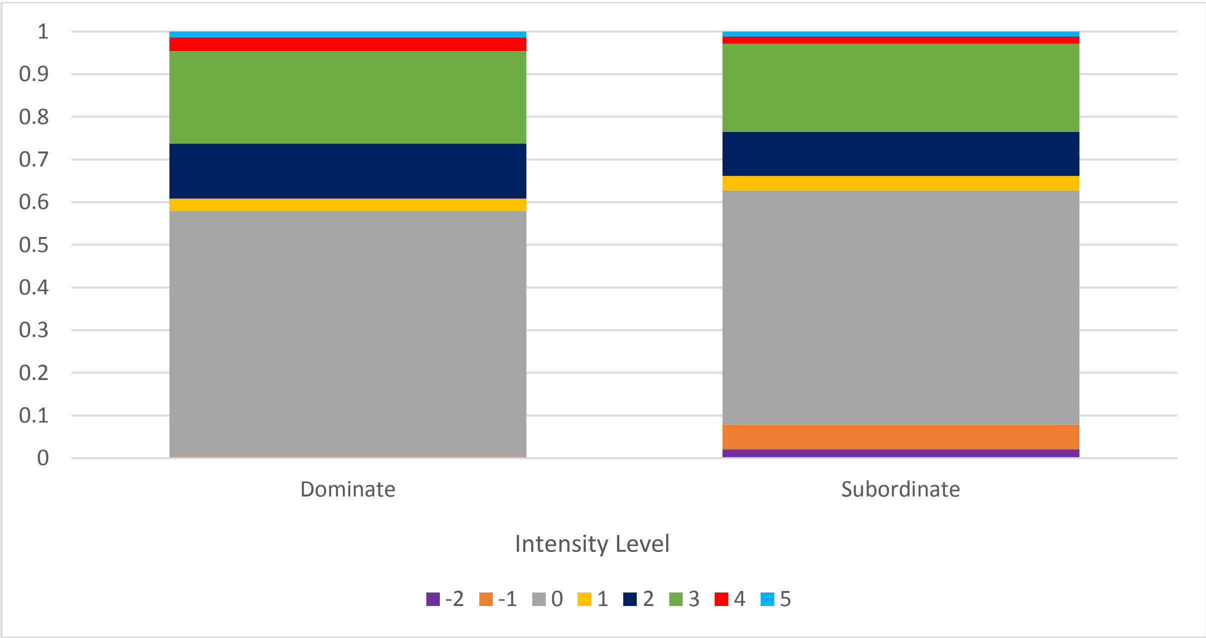
The figure displays the proportion of time of spent between all trials when API® bottom feeder (premium shrimp pellets) was presented between the dominate and subordinate crayfish of the *Orconectes propinquus* species.

Figure 16: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent At Each Intensity Level in the Pond Stick Group



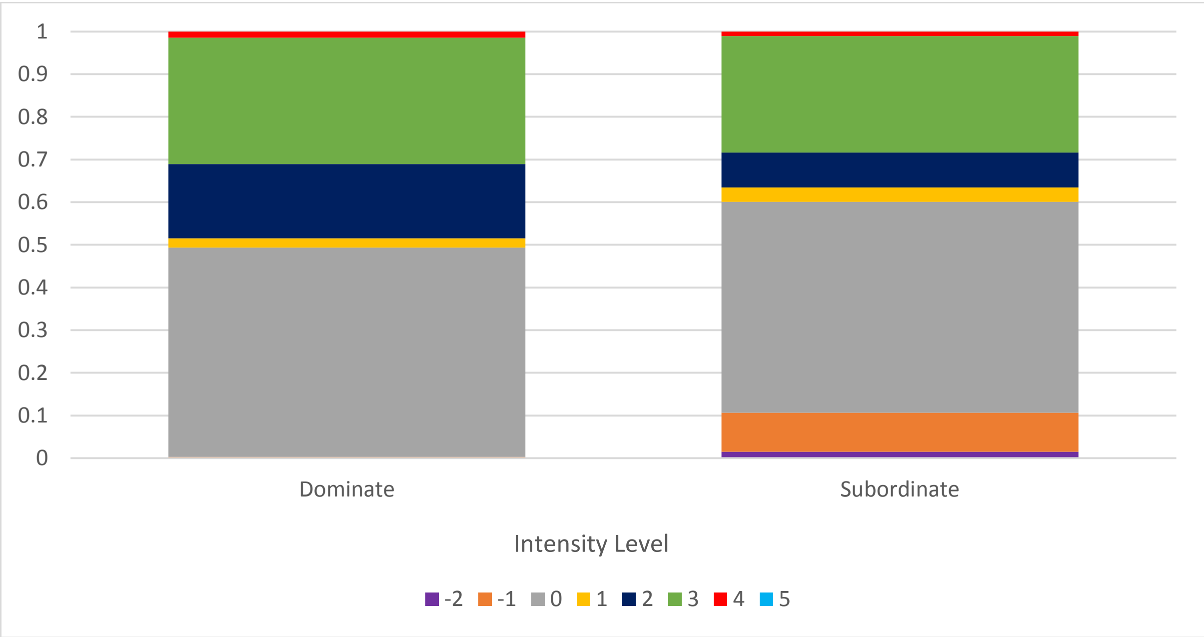
The figure displays the proportion of time of spent between all trials when Tetra Pond® Pond sticks were presented between the dominate and subordinate crayfish of the *Orconectes propinquus* species.

Figure 17: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent At Each Intensity Level in the Fluker Pellet Group



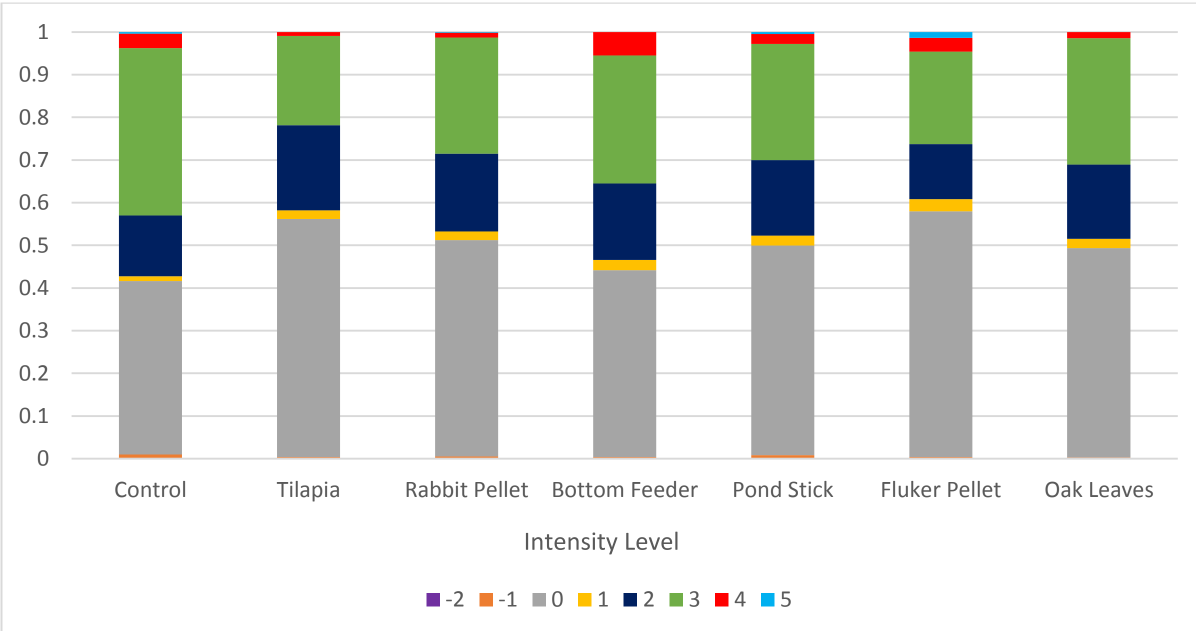
The figure displays the proportion of time of spent between all trials when Fluker's® turtle diet was presented between the dominate and subordinate crayfish of the *Orconectes propinquus* species.

Figure 18: Proportion of Time Dominate and Subordinate *Orconectes propinquus* Crayfish Spent At Each Intensity Level in the Oak Leaves Group



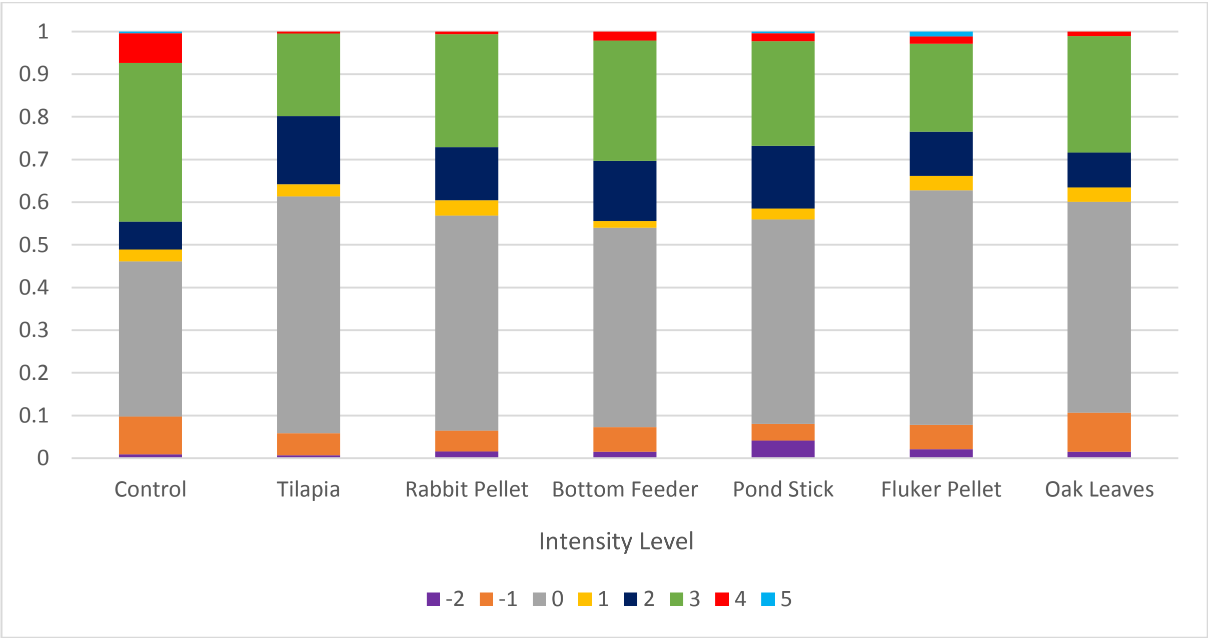
The figure displays the proportion of time of spent between all trials when oak leaves were presented between the dominate and subordinate crayfish of the *Orconectes propinquus* species.

Figure 19: Proportion of Time Dominate *Orconectes propinquus* Crayfish Spent at Each Intensity Level



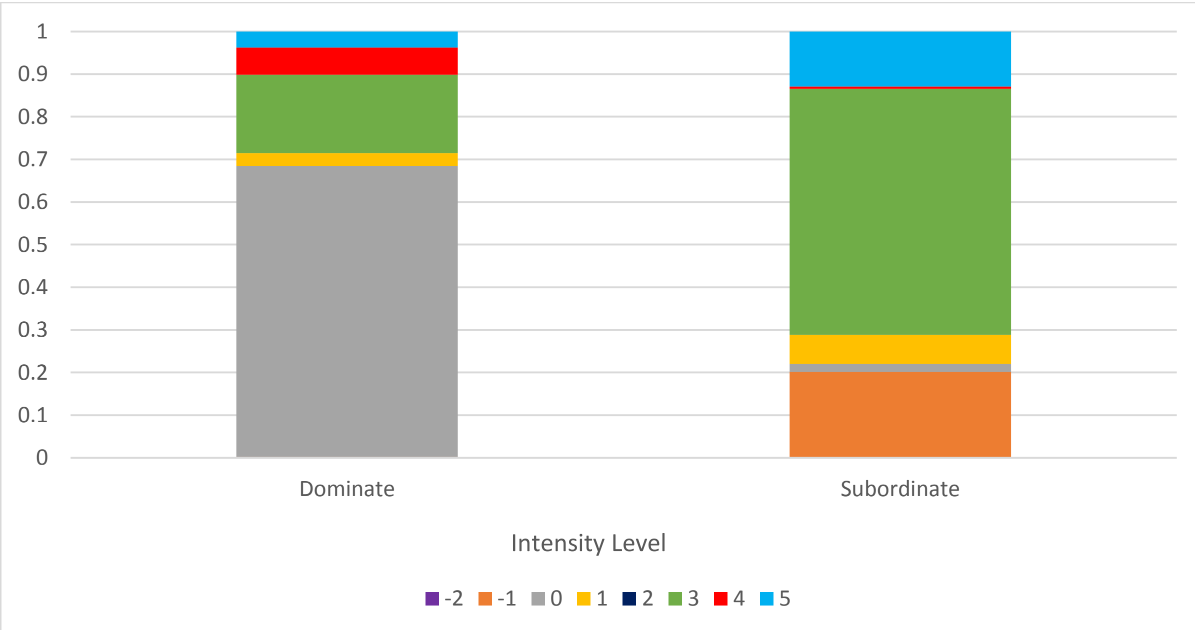
The figure displays the proportion of time of spent between all trials with the different food resources of the dominate crayfish of the *Orconectes propinquus* species.

Figure 20: Proportion of Time Subordinate *Orconectes propinquus* Crayfish Spent at Each Intensity Level



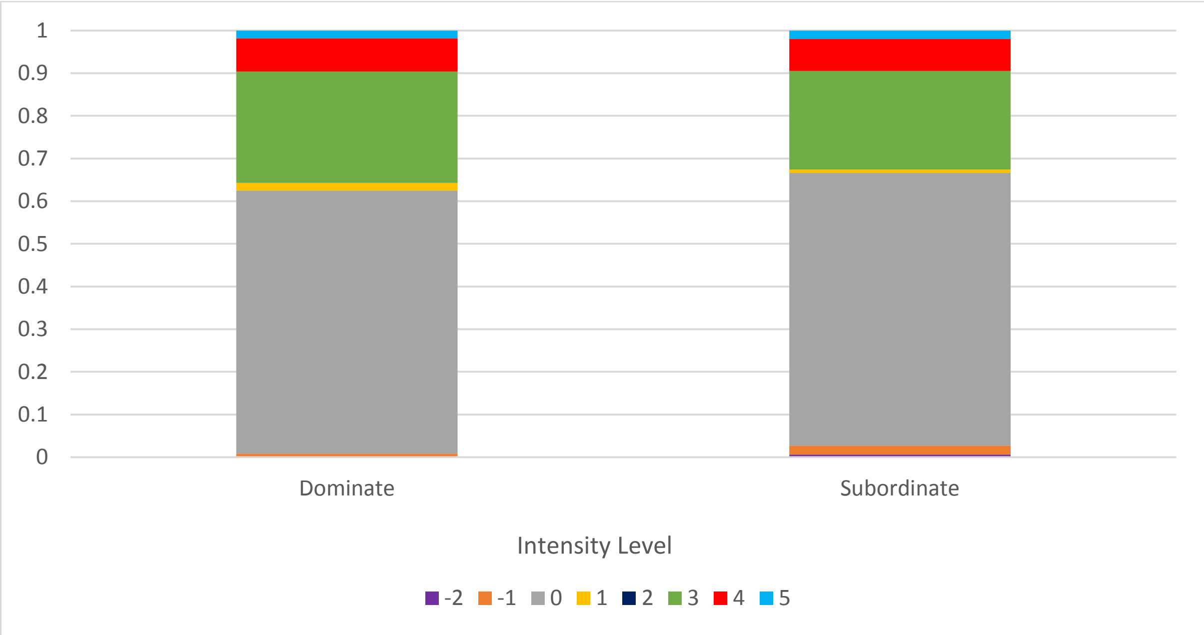
The figure displays the proportion of time of spent between all trials with the different food resources of the subordinate crayfish of the *Orconectes propinquus* species.

Figure 21: Proportion of Time Dominate and Subordinate *Orconectes rusticus* Crayfish Spent At Each Intensity Level in the Tilapia Group



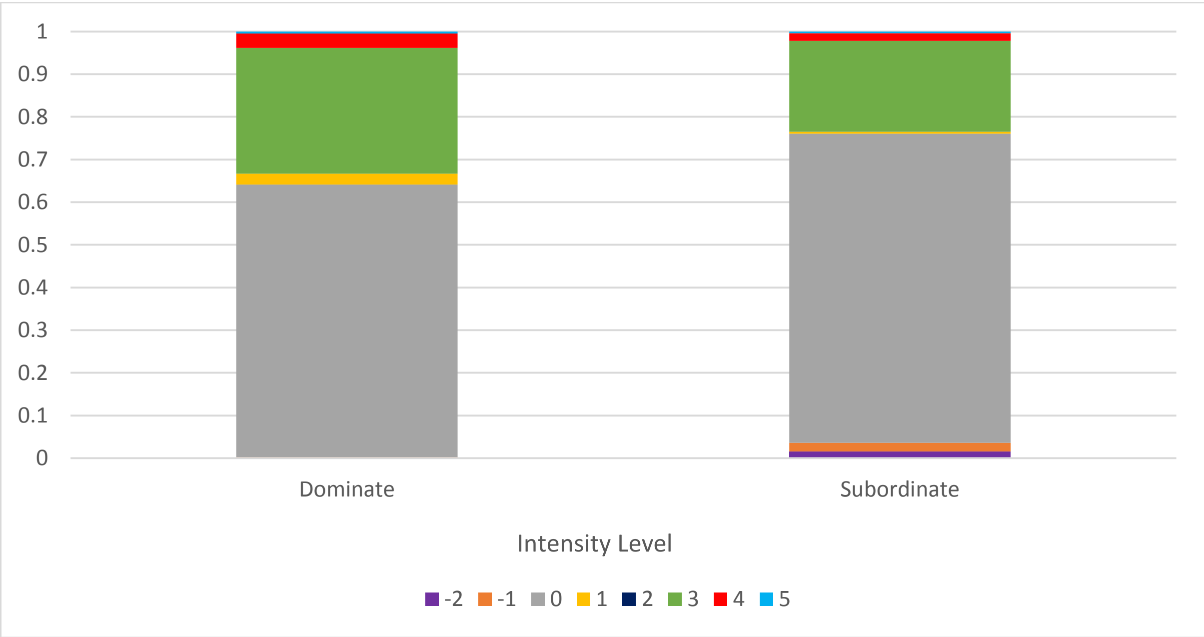
The figure displays the proportion of time of spent between all trials when Meijer® farm raised tilapia fillets was presented between the dominate and subordinate crayfish of the *Orconectes rusticus* species.

Figure 22: Proportion of Time Dominate and Subordinate *Orconectes rusticus* Crayfish Spent At Each Intensity Level in the Rabbit Pellet Group



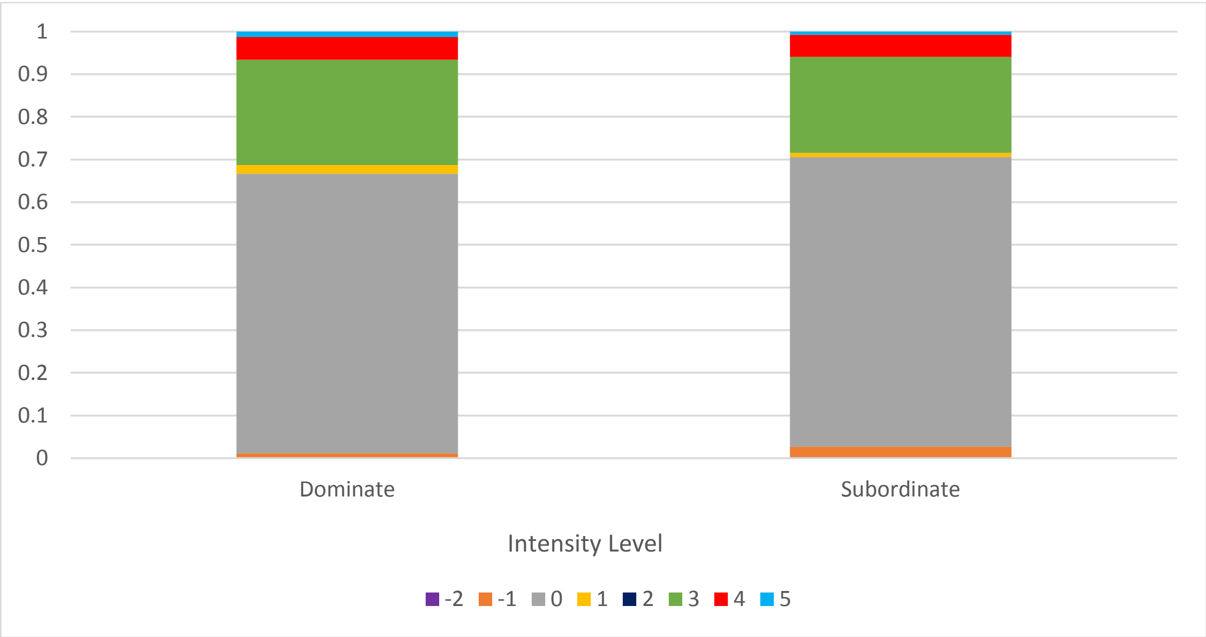
The figure displays the proportion of time of spent between all trials when Meijer® rabbit food was presented between the dominate and subordinate crayfish of the *Orconectes rusticus* species.

Figure 23: Proportion of Time Dominate and Subordinate *Orconectes rusticus* Crayfish Spent At Each Intensity Level in the Bottom Feeder Pellet Group



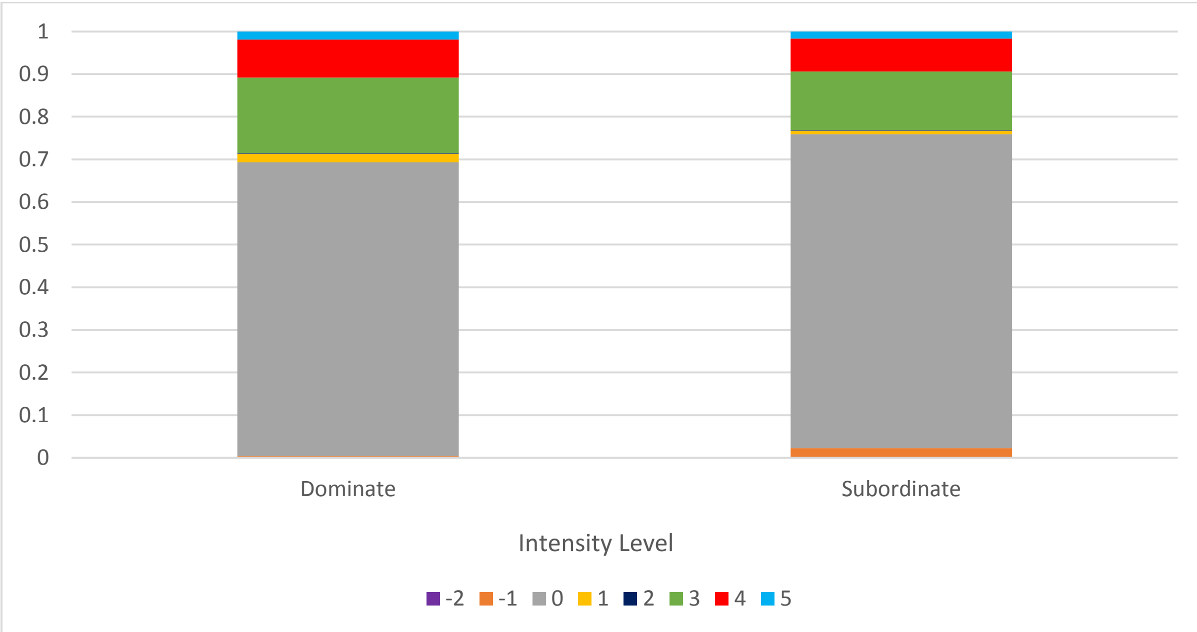
The figure displays the proportion of time of spent between all trials when API® bottom feeder (premium shrimp pellets) was presented between the dominate and subordinate crayfish of the *Orconectes rusticus* species.

Figure 24: Proportion of Time Dominate and Subordinate *Orconectes rusticus* Crayfish Spent At Each Intensity Level in the Pond Stick Group



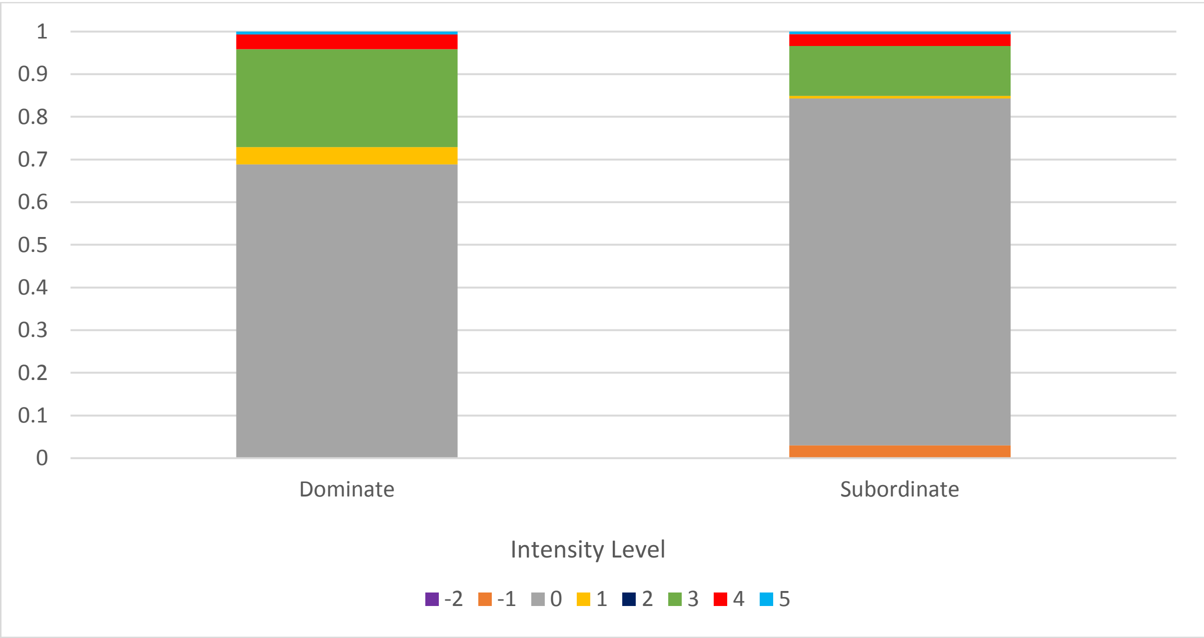
The figure displays the proportion of time of spent between all trials when Tetra Pond® Pond sticks were presented between the dominate and subordinate crayfish of the *Orconectes rusticus* species.

Figure 25: Proportion of Time Dominate and Subordinate *Orconectes rusticus* Crayfish Spent At Each Intensity Level in the Fluker Pellet Group



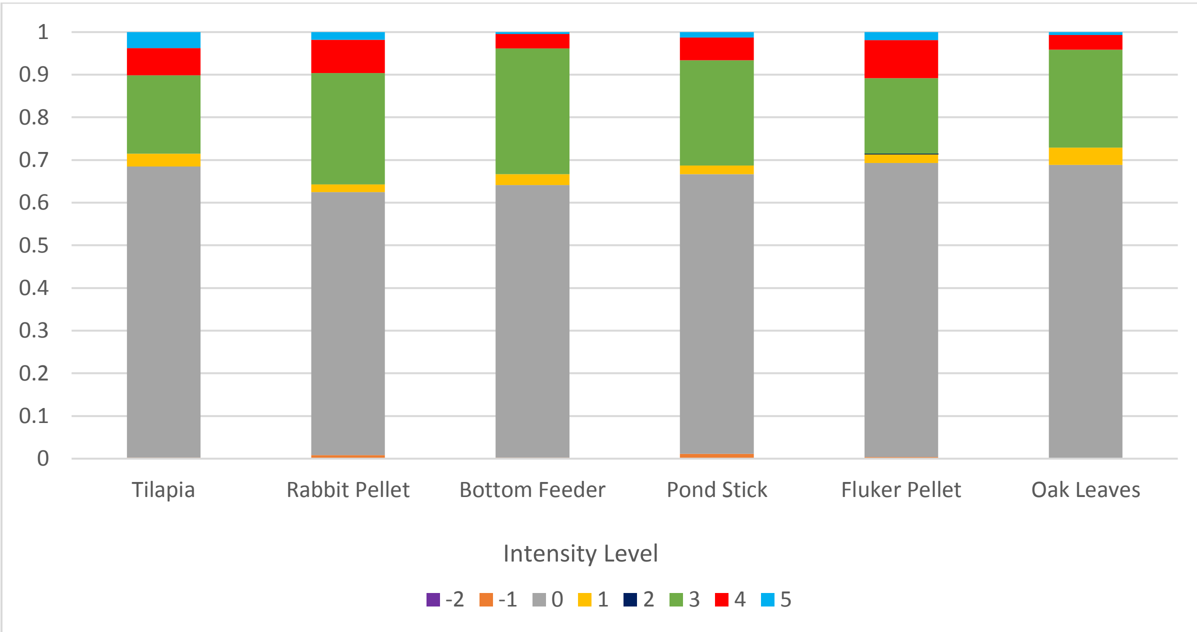
The figure displays the proportion of time of spent between all trials when Fluker's® turtle diet was presented between the dominate and subordinate crayfish of the *Orconectes rusticus* species.

Figure 26: Proportion of Time Dominate and Subordinate *Orconectes rusticus* Crayfish Spent At Each Intensity Level in the Oak Leaves Group



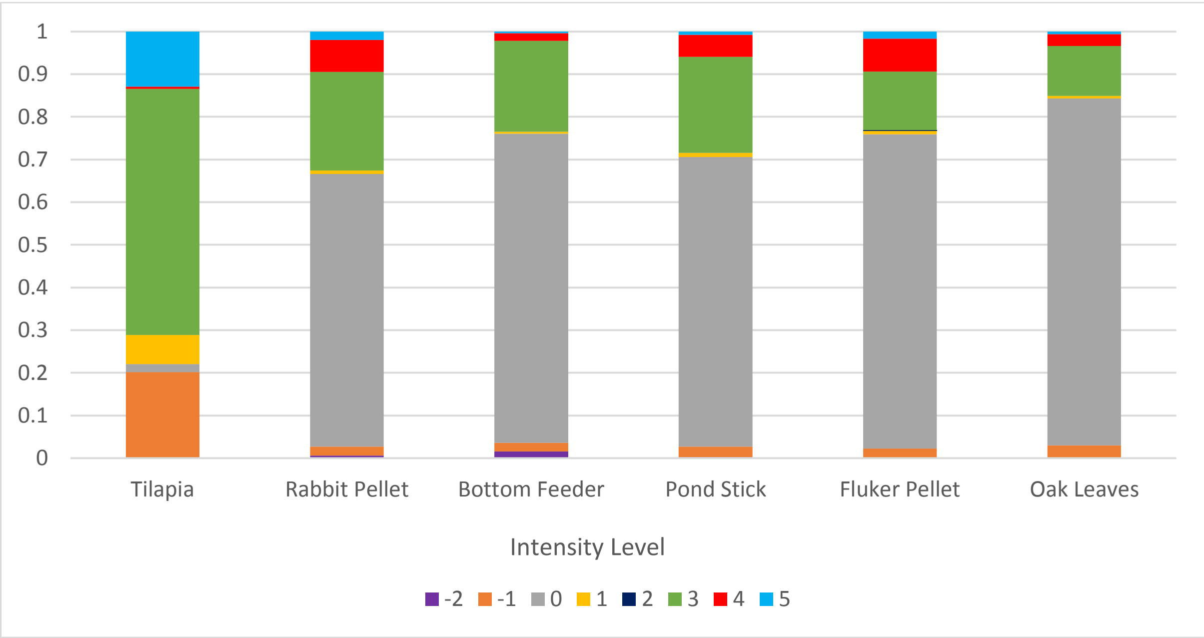
The figure displays the proportion of time of spent between all trials when oak leaves were presented between the dominate and subordinate crayfish of the *Orconectes rusticus* species.

Figure 27: Proportion of Time Dominate *Orconectes rusticus* Crayfish Spent at Each Intensity Level



The figure displays the proportion of time of spent between all trials with the different food resources of the dominate crayfish of the *Orconectes rusticus* species.

Figure 28: Proportion of Time Subordinate *Orconectes rusticus* Crayfish Spent at Each Intensity Level



The figure displays the proportion of time of spent between all trials with the different food resources of the subordinate crayfish of the *Orconectes rusticus* species.

Figure 29: Total Duration of Bag Contact with Different Resources Between Dominate and Subordinate *Orconectes propinquus* Crayfish

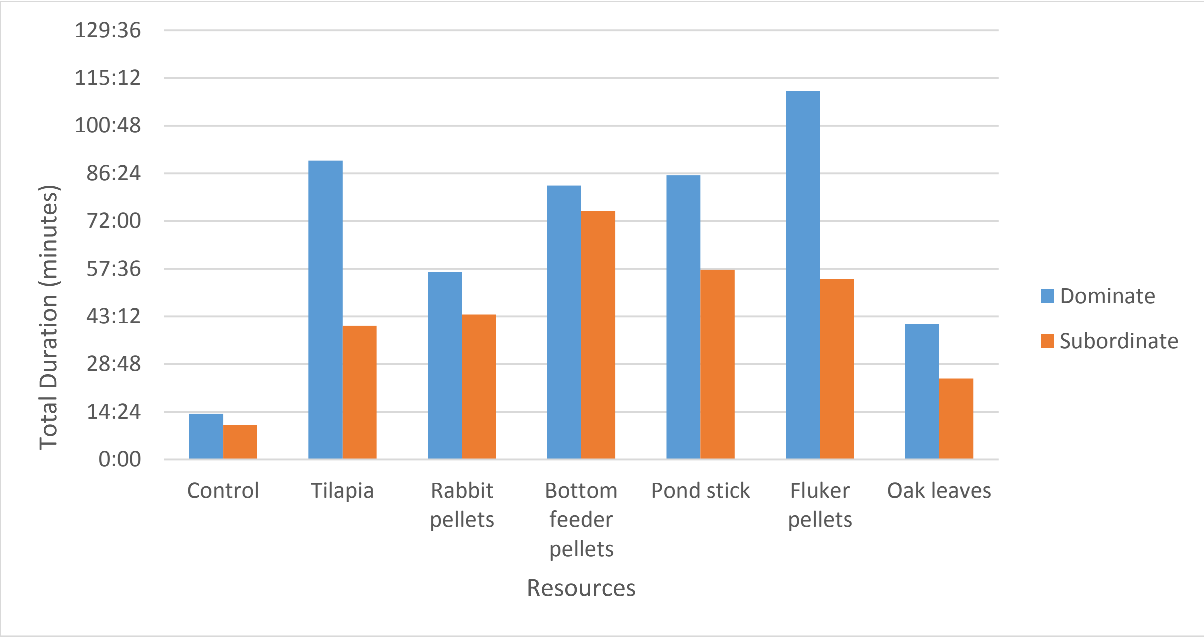


Figure 30: Average Duration of Bag Contact with Different Resources Between Dominate and Subordinate *Orconectes propinquus* Crayfish

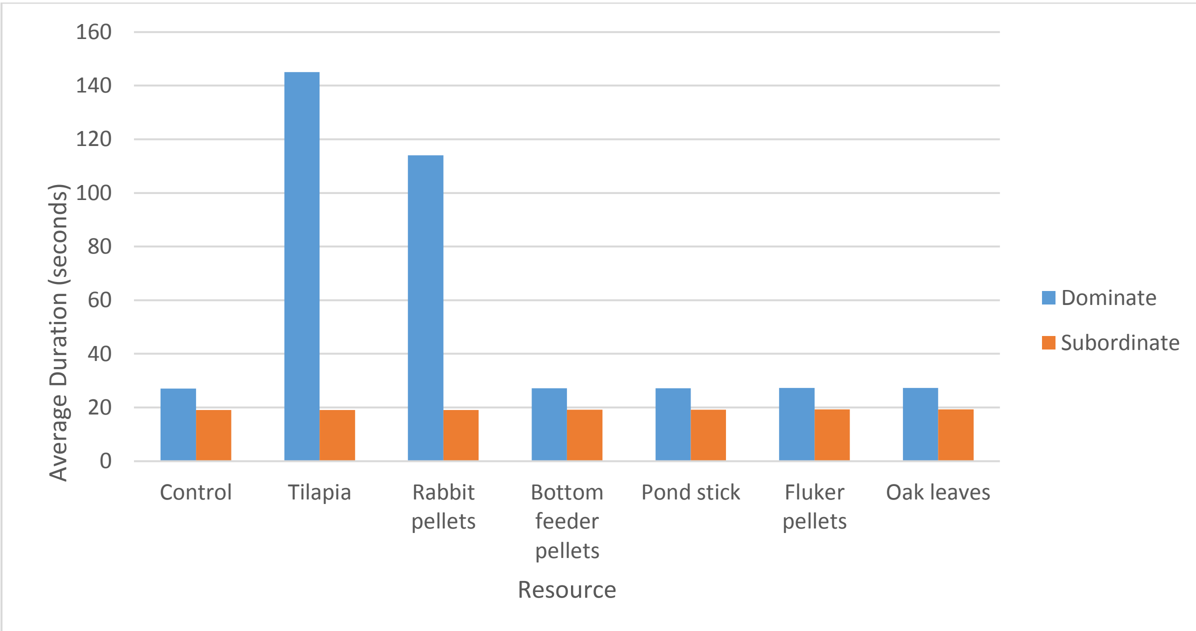


Figure 31: Total Duration of Bag Contact with Different Resources Between Dominate and Subordinate *Orconectes rusticus* Crayfish

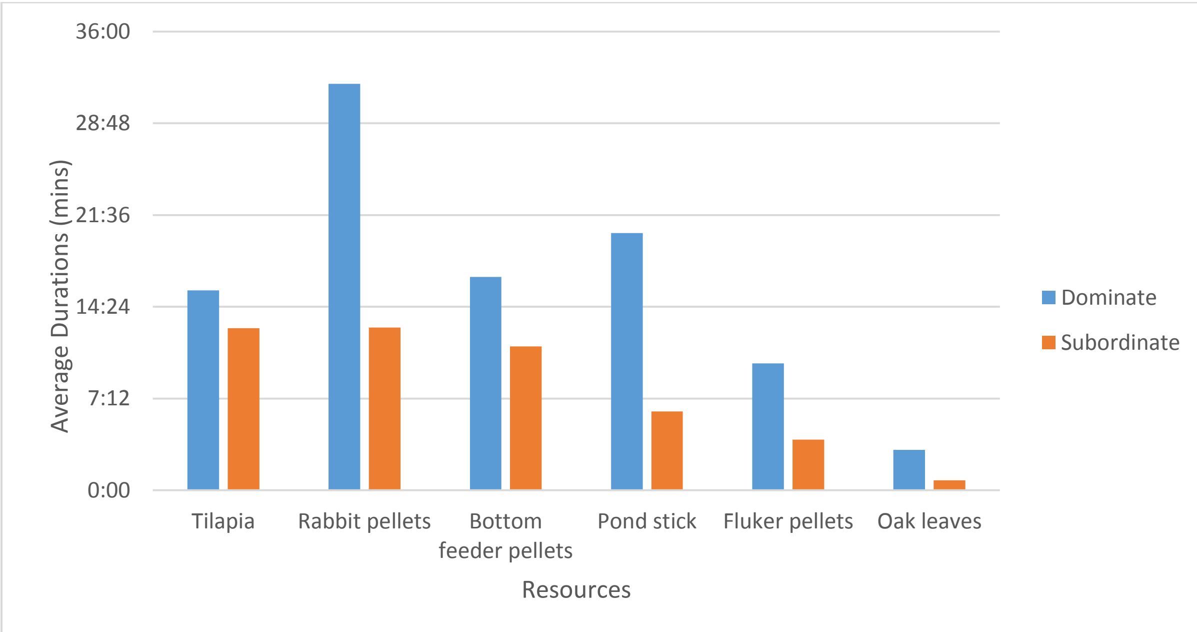


Figure 32: Average Duration of Bag Contact with Different Resources Between Dominate and Subordinate *Orconectes rusticus* Crayfish

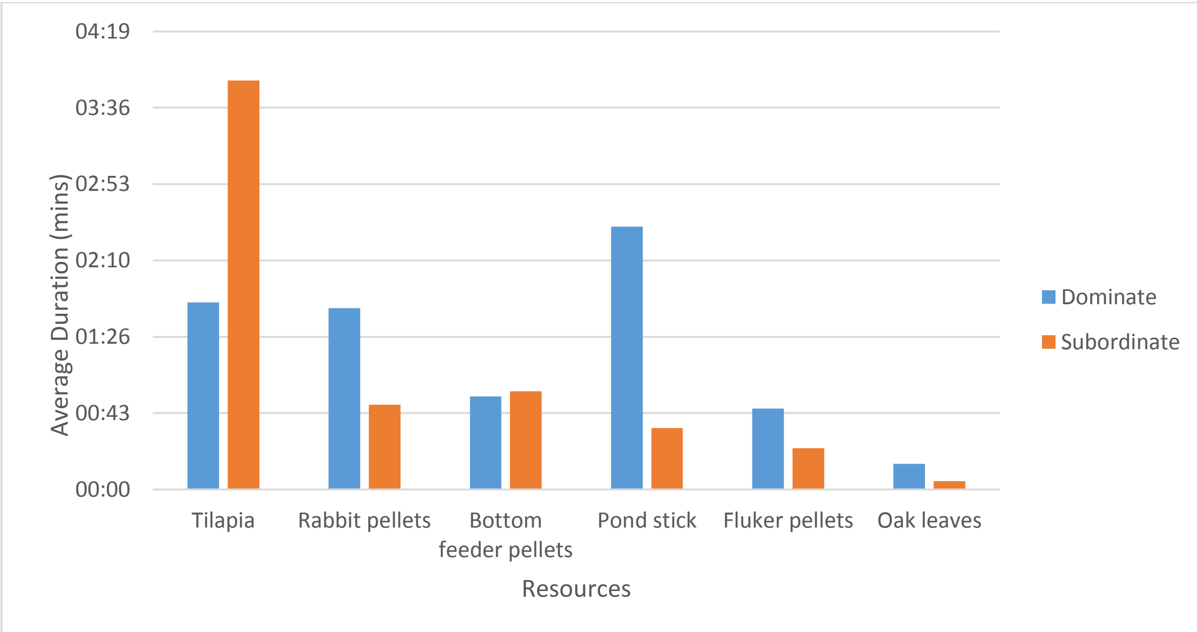


Table 1: Guaranteed Analysis of The Food Resources

Food	Crude Protein	Crude Fat	Crude Fiber	Moisture
Tetra Pond Pond sticks	Min. 28.0%	Min. 3.5%	Max. 2.0%	Max 7.0%
Fluker’s turtle diet	Min. 40.0%	Min. 10.0%	Max. 5.0%	_
API Bottom Feeder	Min 36.0%	Min 7.8%	Max. 5.0%	Max 5.0%
Meijer rabbit pellet	Min 17.0%	Min 2.3%	Max. 22.0%	Max 12.0%
Meijer Tilapia	25-30%	6-13%	<8%	<10%
Oak Leaf Detritus	Low	Low	High	_

Table 2: Frequency, Total duration, and Average Duration *Orconectes propinquus* Spent at Each Intensity Level with Different Resources Present

	Dominant Crayfish				Subordinate Crayfish			
Resource	**Intensity Level**	**Frequency**	**Total Duration at Level (min:sec)**	**Average Duration (min:sec)**	**Intensity Level**	**Frequency**	**Total Duration at Level (min:sec)**	**Average Duration (min:sec)**
Control	-2	7	0:12	0:02	-2	34	1:40	0:03
	-1	22	1:36	0:04	-1	128	16:40	0:08
	0	195	76:21	0:23	0	205	68:21	0:20
	1	33	2:07	0:04	1	58	5:13	0:05
	2	241	26:48	0:07	2	113	12:10	0:06
	3	211	73:44	0:21	3	189	69:55	0:22
	4	51	6:20	0:07	4	33	13:09	0:24
	5	4	0:43	0:11	5	4	0:43	0:11
Tilapia	-2	4	0:06	0:01	-2	27	1:18	0:03
	-1	15	0:32	0:02	-1	106	9:20	0:05
	0	221	100:43	0:27	0	205	100:00	0:29
	1	56	3:38	0:04	1	60	5:06	0:05
	2	149	35:58	0:14	2	91	28:51	0:19
	3	150	37:43	0:15	3	111	34:55	0:19
	4	16	1:38	0:06	4	11	0:48	0:04
	5	0	0:00	0:00	5	0	0:00	0:00
Meijer® Rabbit Food	-2	3	0:13	0:04	-2	35	3:03	0:05
	-1	3	0:46	0:15	-1	45	9:26	0:13
	0	144	97:51	0:41	0	142	97:04	0:41
	1	30	3:48	0:08	1	40	7:02	0:11
	2	159	35:07	0:13	2	101	23:57	0:14
	3	97	52:30	0:32	3	84	51:02	0:36
	4	19	2:15	0:07	4	9	1:14	0:08
	5	1	0:18	0:18	5	0	0:00	0:00
API® Bottom Feeder Pellets	-2	6	0:13	0:02	-2	32	2:54	0:05
	-1	7	0:30	0:04	-1	33	11:06	0:20
	0	124	84:28	0:41	0	132	90:04	0:41
	1	24	4:32	0:11	1	26	3:05	0:07
	2	144	34:35	0:14	2	104	27:14	0:16
	3	117	57:48	0:30	3	100	54:22	0:33
	4	27	10:37	0:24	4	23	4:04	0:11
	5	0	0:00	0:00	5	0	0:00	0:00
Tetra Pond® Pond Sticks	-2	4	0:08	0:02	-2	66	7:58	0:07
	-1	15	1:24	0:06	-1	56	7:22	0:08
	0	189	93:50	0:30	0	168	91:35	0:33
	1	31	4:27	0:09	1	37	4:51	0:08
	2	148	33:53	0:14	2	101	28:05	0:17
	3	144	51:54	0:22	3	114	46:48	0:25
	4	26	4:29	0:10	4	17	3:37	0:13
	5	7	0:56	0:08	5	5	0:45	0:09
Fluker's® Turtle Diet Pellets	-2	5	0:16	0:03	-2	56	4:18	0:05
	-1	3	0:34	0:11	-1	73	11:22	0:09
	0	207	115:02	0:33	0	172	109:54	0:38
	1	43	5:50	0:08	1	55	6:45	0:07
	2	141	25:47	0:11	2	105	20:40	0:12
	3	146	43:18	0:18	3	113	41:12	0:22
	4	46	6:22	0:08	4	22	3:24	0:09
	5	14	2:48	0:12	5	9	2:22	0:16
Oak Leaves	-2	10	0:19	0:02	-2	54	2:50	0:03
	-1	5	0:16	0:03	-1	101	17:20	0:10
	0	182	92:54	0:31	0	197	93:33	0:28
	1	52	4:06	0:05	1	49	6:24	0:08
	2	194	32:50	0:10	2	91	15:27	0:10
	3	186	56:05	0:18	3	148	51:42	0:21
	4	34	2:47	0:05	4	23	2:01	0:05
	5	0	0:00	0:00	5	0	0:00	0:00

Table 3: Frequency, Total duration, and Average Duration *Orconectes rusticus* Spent at Each Intensity Level with Different Resources Present

	Dominant Crayfish				Subordinate Crayfish			
Resource	**Intensity Level**	**Frequency**	**Total Duration at Level (min:sec)**	**Average Duration (min:sec)**	**Intensity Level**	**Frequency**	**Total Duration at Level (min:sec)**	**Average Duration (min:sec)**
Tilapia	-2	2	0:04	0:02	-2	16	0:37	0:02
	-1	6	0:10	0:02	-1	62	4:41	0:05
	0	160	70:34	0:26	0	180	73:40	0:25
	1	86	3:05	0:02	1	48	1:35	0:02
	2	0	0:00	0:00	2	0	0:00	0:00
	3	135	19:01	0:08	3	103	13:29	0:08
	4	56	6:35	0:07	4	49	6:18	0:08
	5	34	3:52	0:07	5	21	3:01	0:09
Meijer® Rabbit Food	-2	4	0:12	0:03	-2	21	0:37	0:02
	-1	13	0:38	0:03	-1	56	2:04	0:02
	0	166	61:38	0:22	0	209	63:56	0:18
	1	78	1:49	0:01	1	34	0:50	0:01
	2	0	0:00	0:00	2	0	0:00	0:00
	3	221	26:04	0:07	3	167	23:05	0:08
	4	90	7:48	0:05	4	81	7:30	0:06
	5	23	1:50	0:05	5	27	1:57	0:04
API® Bottom Feeder Pellets	-2	0	0:00	0:00	-2	11	1:35	0:09
	-1	10	0:16	0:02	-1	56	2:04	0:02
	0	221	64:32	0:18	0	372	73:10	0:12
	1	116	2:32	0:01	1	26	0:30	0:01
	2	0	0:00	0:00	2	0	0:00	0:00
	3	276	29:49	0:06	3	185	21:28	0:07
	4	50	3:24	0:04	4	23	1:48	0:05
	5	7	0:28	0:04	5	7	0:26	0:04
Tetra Pond® Pond Sticks	-2	5	0:07	0:01	-2	7	0:10	0:01
	-1	17	0:41	0:02	-1	35	1:43	0:03
	0	136	45:48	0:20	0	161	47:26	0:18
	1	46	1:24	0:02	1	31	0:42	0:01
	2	0	0:00	0:00	2	0	0:00	0:00
	3	146	17:15	0:07	3	126	15:45	0:07
	4	46	3:43	0:05	4	42	3:34	0:05
	5	14	0:56	0:04	5	8	0:34	0:04
Fluker's® Turtle Diet Pellets	-2	2	0:04	0:02	-2	2	0:02	0:01
	-1	7	0:19	0:03	-1	49	2:14	0:03
	0	174	68:47	0:24	0	225	73:30	0:20
	1	67	2:01	0:02	1	38	0:51	0:01
	2	8	0:08	0:01	2	6	0:06	0:01
	3	178	17:43	0:06	3	135	13:44	0:06
	4	78	8:53	0:07	4	64	7:42	0:07
	5	25	1:54	0:05	5	20	1:40	0:05
Oak Leaves	-2	0	0:00	0:00	-2	7	0:11	0:02
	-1	1	0:02	0:02	-1	71	2:50	0:02
	0	199	68:45	0:21	0	353	81:10	0:14
	1	123	4:02	0:02	1	33	0:37	0:01
	2	0	0:00	0:00	2	0	0:00	0:00
	3	245	22:55	0:06	3	117	11:43	0:06
	4	36	3:25	0:06	4	26	2:44	0:06
	5	13	0:44	0:03	5	10	0:38	0:04

Table 4: Resources Effect on The Average Time Spent at Each Intensity Level of both *Orconectes propinquus* and *Orconectes rusticus*

	Orconectes propinquus		***Orconectes rusticus***	
Intensity Level	**Dominate P-value**	**Subordinate P-value**	**Dominant P-value**	**Subordinate P-value**
-2	0.8810	0.0517	0.4832	0.4732
-1	0.2737	0.6303	0.3840	0.0393*
0	0.0716	0.0025*	0.4255	0.0786
1	0.3009	0.5574	0.2765	0.0386*
2	0.0333*	0.0119*	0.4666	0.4666
3	0.0215*	0.0060*	0.1301	0.3278
4	0.2202	0.3763	0.1942	0.0360*
5	0.0681	0.0434*	0.0368*	0.0116*

This table displays the P-value of the F statistic of the average duration spent at each intensity level when comparing all resources to one another. Statistically significant Comparisons ($P < 0.05$) are indicated by an *. Post Hoc analysis is shown below (Table 5-76). Resources where the confidence interval does not overlap are statistically different.

Table 5: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Control

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.1157	0.03673	133	3.15	0.0020	0.05	0.04301	0.1883
Food_Resource	Bottom feeder pellets	0.1078	0.05194	133	2.08	0.0399	0.05	0.005059	0.2105
Food_Resource	Fluker pellets	0.05100	0.05132	133	0.99	0.3221	0.05	-0.05051	0.1525
Food_Resource	Oak leaves	0.05297	0.05194	133	1.02	0.3096	0.05	-0.04976	0.1557
Food_Resource	Pond Stick	0.1284	0.05194	133	2.47	0.0147	0.05	0.02571	0.2312
Food_Resource	Rabbit Pellets	0.1378	0.05194	133	2.65	0.0090	0.05	0.03505	0.2405
Food_Resource	Tilapia	0.1549	0.05262	133	2.94	0.0038	0.05	0.05085	0.2590
Food_Resource	Control	0	.	.	.	.	.	.	.

Table 6: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.2706	0.03768	133	7.18	<.0001	0.05	0.1960	0.3451
Food_Resource	Bottom feeder pellets	-0.04713	0.05262	133	-0.90	0.3720	0.05	-0.1512	0.05695
Food_Resource	Control	-0.1549	0.05262	133	-2.94	0.0038	0.05	-0.2590	-0.05085
Food_Resource	Fluker pellets	-0.1039	0.05201	133	-2.00	0.0477	0.05	-0.2068	-0.00106
Food_Resource	Oak leaves	-0.1020	0.05262	133	-1.94	0.0548	0.05	-0.2060	0.002127
Food_Resource	Pond Stick	-0.02648	0.05262	133	-0.50	0.6156	0.05	-0.1306	0.07759
Food_Resource	Rabbit Pellets	-0.01714	0.05262	133	-0.33	0.7451	0.05	-0.1212	0.08694
Food_Resource	Tilapia	0	.	.	.	.	.	.	.

Table 7: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Meijer® Rabbit Food

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.2534	0.03673	133	6.90	<.0001	0.05	0.1808	0.3261
Food_Resource	Bottom feeder pellets	-0.02999	0.05194	133	-0.58	0.5646	0.05	-0.1327	0.07275
Food_Resource	Control	-0.1378	0.05194	133	-2.65	0.0090	0.05	-0.2405	-0.03505
Food_Resource	Fluker pellets	-0.08679	0.05132	133	-1.69	0.0932	0.05	-0.1883	0.01472
Food_Resource	Oak leaves	-0.08481	0.05194	133	-1.63	0.1049	0.05	-0.1876	0.01792
Food_Resource	Pond Stick	-0.00935	0.05194	133	-0.18	0.8575	0.05	-0.1121	0.09339
Food_Resource	Tilapia	0.01714	0.05262	133	0.33	0.7451	0.05	-0.08694	0.1212
Food_Resource	Rabbit Pellets	0	.	.	.	.	.	.	.

Table 8: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Tetra Pond® Pond Sticks

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.2441	0.03673	133	6.65	<.0001	0.05	0.1714	0.3167
Food_Resource	Bottom feeder pellets	-0.02065	0.05194	133	-0.40	0.6916	0.05	-0.1234	0.08209
Food_Resource	Control	-0.1284	0.05194	133	-2.47	0.0147	0.05	-0.2312	-0.02571
Food_Resource	Fluker pellets	-0.07744	0.05132	133	-1.51	0.1337	0.05	-0.1789	0.02406
Food_Resource	Oak leaves	-0.07547	0.05194	133	-1.45	0.1486	0.05	-0.1782	0.02727
Food_Resource	Rabbit Pellets	0.009346	0.05194	133	0.18	0.8575	0.05	-0.09339	0.1121
Food_Resource	Tilapia	0.02648	0.05262	133	0.50	0.6156	0.05	-0.07759	0.1306
Food_Resource	Pond Stick	0	.	.	.	.	.	.	.

Table 9: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Oak Leaf Detritus

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.1686	0.03673	133	4.59	<.0001	0.05	0.09598	0.2413
Food_Resource	Bottom feeder pellets	0.05482	0.05194	133	1.06	0.2931	0.05	-0.04791	0.1576
Food_Resource	Control	-0.05297	0.05194	133	-1.02	0.3096	0.05	-0.1557	0.04976
Food_Resource	Fluker pellets	-0.00197	0.05132	133	-0.04	0.9694	0.05	-0.1035	0.09953
Food_Resource	Pond Stick	0.07547	0.05194	133	1.45	0.1486	0.05	-0.02727	0.1782
Food_Resource	Rabbit Pellets	0.08481	0.05194	133	1.63	0.1049	0.05	-0.01792	0.1876
Food_Resource	Tilapia	0.1020	0.05262	133	1.94	0.0548	0.05	-0.00213	0.2060
Food_Resource	Oak leaves	0	.	.	.	.	.	.	.

Table 10: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Fluker's® Turtle Diet

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.1667	0.03584	133	4.65	<.0001	0.05	0.09576	0.2375
Food_Resource	Bottom feeder pellets	0.05680	0.05132	133	1.11	0.2704	0.05	-0.04471	0.1583
Food_Resource	Control	-0.05100	0.05132	133	-0.99	0.3221	0.05	-0.1525	0.05051
Food_Resource	Oak leaves	0.001973	0.05132	133	0.04	0.9694	0.05	-0.09953	0.1035
Food_Resource	Pond Stick	0.07744	0.05132	133	1.51	0.1337	0.05	-0.02406	0.1789
Food_Resource	Rabbit Pellets	0.08679	0.05132	133	1.69	0.0932	0.05	-0.01472	0.1883
Food_Resource	Tilapia	0.1039	0.05201	133	2.00	0.0477	0.05	0.001061	0.2068
Food_Resource	Fluker pellets	0	.	.	.	.	.	.	.

Table 11: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to API® Bottom Feeder Pellets

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.2234	0.03673	133	6.08	<.0001	0.05	0.1508	0.2961
Food_Resource	Control	-0.1078	0.05194	133	-2.08	0.0399	0.05	-0.2105	-0.00506
Food_Resource	Fluker pellets	-0.05680	0.05132	133	-1.11	0.2704	0.05	-0.1583	0.04471
Food_Resource	Oak leaves	-0.05482	0.05194	133	-1.06	0.2931	0.05	-0.1576	0.04791
Food_Resource	Pond Stick	0.02065	0.05194	133	0.40	0.6916	0.05	-0.08209	0.1234
Food_Resource	Rabbit Pellets	0.02999	0.05194	133	0.58	0.5646	0.05	-0.07275	0.1327
Food_Resource	Tilapia	0.04713	0.05262	133	0.90	0.3720	0.05	-0.05695	0.1512
Food_Resource	Bottom feeder pellets	0	.	.	.	.	.	.	.

Table 12: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Control

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.3723	0.08155	133	4.57	<.0001	0.05	0.2110	0.5336
Food_Resource	Bottom feeder pellets	0.2186	0.1153	133	1.90	0.0602	0.05	-0.00952	0.4467
Food_Resource	Fluker pellets	-0.00082	0.1139	133	-0.01	0.9943	0.05	-0.2262	0.2246
Food_Resource	Oak leaves	-0.01587	0.1153	133	-0.14	0.8908	0.05	-0.2440	0.2122
Food_Resource	Pond Stick	0.03759	0.1153	133	0.33	0.7450	0.05	-0.1905	0.2657
Food_Resource	Rabbit Pellets	0.2667	0.1153	133	2.31	0.0223	0.05	0.03856	0.4948
Food_Resource	Tilapia	-0.08959	0.1168	133	-0.77	0.4446	0.05	-0.3207	0.1415
Food_Resource	Control	0	.	.	.	.	.	.	.

Table 13: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.2827	0.08367	133	3.38	0.0010	0.05	0.1172	0.4482
Food_Resource	Bottom feeder pellets	0.3082	0.1168	133	2.64	0.0093	0.05	0.07708	0.5393
Food_Resource	Control	0.08959	0.1168	133	0.77	0.4446	0.05	-0.1415	0.3207
Food_Resource	Fluker pellets	0.08877	0.1155	133	0.77	0.4434	0.05	-0.1396	0.3172
Food_Resource	Oak leaves	0.07372	0.1168	133	0.63	0.5291	0.05	-0.1574	0.3048
Food_Resource	Pond Stick	0.1272	0.1168	133	1.09	0.2783	0.05	-0.1039	0.3583
Food_Resource	Rabbit Pellets	0.3563	0.1168	133	3.05	0.0028	0.05	0.1252	0.5873
Food_Resource	Tilapia	0	.	.	.	.	.	.	.

Table 14: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Meijer® Rabbit Food

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.6390	0.08155	133	7.84	<.0001	0.05	0.4777	0.8003
Food_Resource	Bottom feeder pellets	-0.04808	0.1153	133	-0.42	0.6774	0.05	-0.2762	0.1800
Food_Resource	Control	-0.2667	0.1153	133	-2.31	0.0223	0.05	-0.4948	-0.03856
Food_Resource	Fluker pellets	-0.2675	0.1139	133	-2.35	0.0204	0.05	-0.4929	-0.04211
Food_Resource	Oak leaves	-0.2825	0.1153	133	-2.45	0.0156	0.05	-0.5106	-0.05443
Food_Resource	Pond Stick	-0.2291	0.1153	133	-1.99	0.0491	0.05	-0.4572	-0.00097
Food_Resource	Tilapia	-0.3563	0.1168	133	-3.05	0.0028	0.05	-0.5873	-0.1252
Food_Resource	Rabbit Pellets	0	.	.	.	.	.	.	.

Table 15: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Tetra Pond® Pond Sticks

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.4099	0.08155	133	5.03	<.0001	0.05	0.2486	0.5712
Food_Resource	Bottom feeder pellets	0.1810	0.1153	133	1.57	0.1189	0.05	-0.04711	0.4091
Food_Resource	Control	-0.03759	0.1153	133	-0.33	0.7450	0.05	-0.2657	0.1905
Food_Resource	Fluker pellets	-0.03841	0.1139	133	-0.34	0.7366	0.05	-0.2638	0.1870
Food_Resource	Oak leaves	-0.05346	0.1153	133	-0.46	0.6437	0.05	-0.2816	0.1747
Food_Resource	Rabbit Pellets	0.2291	0.1153	133	1.99	0.0491	0.05	0.000967	0.4572
Food_Resource	Tilapia	-0.1272	0.1168	133	-1.09	0.2783	0.05	-0.3583	0.1039
Food_Resource	Pond Stick	0	.	.	.	.	.	.	.

Table 16: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Oak Leaf Detritus

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.3564	0.08155	133	4.37	<.0001	0.05	0.1951	0.5177
Food_Resource	Bottom feeder pellets	0.2345	0.1153	133	2.03	0.0440	0.05	0.006348	0.4626
Food_Resource	Control	0.01587	0.1153	133	0.14	0.8908	0.05	-0.2122	0.2440
Food_Resource	Fluker pellets	0.01505	0.1139	133	0.13	0.8951	0.05	-0.2103	0.2404
Food_Resource	Pond Stick	0.05346	0.1153	133	0.46	0.6437	0.05	-0.1747	0.2816
Food_Resource	Rabbit Pellets	0.2825	0.1153	133	2.45	0.0156	0.05	0.05443	0.5106
Food_Resource	Tilapia	-0.07372	0.1168	133	-0.63	0.5291	0.05	-0.3048	0.1574
Food_Resource	Oak leaves	0	.	.	.	.	.	.	.

Table 17: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Fluker's® Turtle Diet

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.3715	0.07958	133	4.67	<.0001	0.05	0.2141	0.5289
Food_Resource	Bottom feeder pellets	0.2194	0.1139	133	1.93	0.0563	0.05	-0.00597	0.4448
Food_Resource	Control	0.000817	0.1139	133	0.01	0.9943	0.05	-0.2246	0.2262
Food_Resource	Oak leaves	-0.01505	0.1139	133	-0.13	0.8951	0.05	-0.2404	0.2103
Food_Resource	Pond Stick	0.03841	0.1139	133	0.34	0.7366	0.05	-0.1870	0.2638
Food_Resource	Rabbit Pellets	0.2675	0.1139	133	2.35	0.0204	0.05	0.04211	0.4929
Food_Resource	Tilapia	-0.08877	0.1155	133	-0.77	0.4434	0.05	-0.3172	0.1396
Food_Resource	Fluker pellets	0	.	.	.	.	.	.	.

Table 18: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to API® Bottom Feeder Pellets

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.5909	0.08155	133	7.25	<.0001	0.05	0.4296	0.7522
Food_Resource	Control	-0.2186	0.1153	133	-1.90	0.0602	0.05	-0.4467	0.009521
Food_Resource	Fluker pellets	-0.2194	0.1139	133	-1.93	0.0563	0.05	-0.4448	0.005972
Food_Resource	Oak leaves	-0.2345	0.1153	133	-2.03	0.0440	0.05	-0.4626	-0.00635
Food_Resource	Pond Stick	-0.1810	0.1153	133	-1.57	0.1189	0.05	-0.4091	0.04711
Food_Resource	Rabbit Pellets	0.04808	0.1153	133	0.42	0.6774	0.05	-0.1800	0.2762
Food_Resource	Tilapia	-0.3082	0.1168	133	-2.64	0.0093	0.05	-0.5393	-0.07708
Food_Resource	Bottom feeder pellets	0	.	.	.	.	.	.	.

Table 19: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 0 When Comparing All Resources to Control

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.3440	0.1031	133	3.34	0.0011	0.05	0.1401	0.5479
Food_Resource	Bottom feeder pellets	0.4257	0.1458	133	2.92	0.0041	0.05	0.1374	0.7141
Food_Resource	Fluker pellets	0.3990	0.1440	133	2.77	0.0064	0.05	0.1141	0.6839
Food_Resource	Oak leaves	0.1704	0.1458	133	1.17	0.2447	0.05	-0.1180	0.4587
Food_Resource	Pond Stick	0.2678	0.1458	133	1.84	0.0685	0.05	-0.02061	0.5561
Food_Resource	Rabbit Pellets	0.6089	0.1458	133	4.18	<.0001	0.05	0.3206	0.8973
Food_Resource	Tilapia	0.2948	0.1477	133	2.00	0.0480	0.05	0.002651	0.5869
Food_Resource	Control	0	.	.	.	.	.	.	.

Table 20: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 0 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.6388	0.1058	133	6.04	<.0001	0.05	0.4296	0.8480
Food_Resource	Bottom feeder pellets	0.1309	0.1477	133	0.89	0.3769	0.05	-0.1612	0.4231
Food_Resource	Control	-0.2948	0.1477	133	-2.00	0.0480	0.05	-0.5869	-0.00265
Food_Resource	Fluker pellets	0.1042	0.1460	133	0.71	0.4766	0.05	-0.1845	0.3929
Food_Resource	Oak leaves	-0.1244	0.1477	133	-0.84	0.4010	0.05	-0.4166	0.1677
Food_Resource	Pond Stick	-0.02703	0.1477	133	-0.18	0.8551	0.05	-0.3192	0.2651
Food_Resource	Rabbit Pellets	0.3142	0.1477	133	2.13	0.0353	0.05	0.02201	0.6063
Food_Resource	Tilapia	0	.	.	.	.	.	.	.

Table 21: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 0 When Comparing All Resources to Meijer® Rabbit Food

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.9529	0.1031	133	9.24	<.0001	0.05	0.7490	1.1568
Food_Resource	Bottom feeder pellets	-0.1832	0.1458	133	-1.26	0.2111	0.05	-0.4716	0.1052
Food_Resource	Control	-0.6089	0.1458	133	-4.18	<.0001	0.05	-0.8973	-0.3206
Food_Resource	Fluker pellets	-0.2099	0.1440	133	-1.46	0.1474	0.05	-0.4949	0.07498
Food_Resource	Oak leaves	-0.4386	0.1458	133	-3.01	0.0031	0.05	-0.7270	-0.1502
Food_Resource	Pond Stick	-0.3412	0.1458	133	-2.34	0.0208	0.05	-0.6296	-0.05281
Food_Resource	Tilapia	-0.3142	0.1477	133	-2.13	0.0353	0.05	-0.6063	-0.02201
Food_Resource	Rabbit Pellets	0	.	.	.	.	.	.	.

Table 22: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 0 When Comparing All Resources to Tetra Pond® Pond Sticks

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.6117	0.1031	133	5.93	<.0001	0.05	0.4078	0.8157
Food_Resource	Bottom feeder pellets	0.1580	0.1458	133	1.08	0.2805	0.05	-0.1304	0.4464
Food_Resource	Control	-0.2678	0.1458	133	-1.84	0.0685	0.05	-0.5561	0.02061
Food_Resource	Fluker pellets	0.1312	0.1440	133	0.91	0.3639	0.05	-0.1537	0.4162
Food_Resource	Oak leaves	-0.09741	0.1458	133	-0.67	0.5052	0.05	-0.3858	0.1910
Food_Resource	Rabbit Pellets	0.3412	0.1458	133	2.34	0.0208	0.05	0.05281	0.6296
Food_Resource	Tilapia	0.02703	0.1477	133	0.18	0.8551	0.05	-0.2651	0.3192
Food_Resource	Pond Stick	0	.	.	.	.	.	.	.

Table 23: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 0 When Comparing All Resources to Oak Leaf Detritus

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.5143	0.1031	133	4.99	<.0001	0.05	0.3104	0.7183
Food_Resource	Bottom feeder pellets	0.2554	0.1458	133	1.75	0.0821	0.05	-0.03299	0.5438
Food_Resource	Control	-0.1704	0.1458	133	-1.17	0.2447	0.05	-0.4587	0.1180
Food_Resource	Fluker pellets	0.2286	0.1440	133	1.59	0.1148	0.05	-0.05627	0.5136
Food_Resource	Pond Stick	0.09741	0.1458	133	0.67	0.5052	0.05	-0.1910	0.3858
Food_Resource	Rabbit Pellets	0.4386	0.1458	133	3.01	0.0031	0.05	0.1502	0.7270
Food_Resource	Tilapia	0.1244	0.1477	133	0.84	0.4010	0.05	-0.1677	0.4166
Food_Resource	Oak leaves	0	.	.	.	.	.	.	.

Table 24: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 0 When Comparing All Resources to Fluker's® Turtle Diet

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.7430	0.1006	133	7.38	<.0001	0.05	0.5440	0.9420
Food_Resource	Bottom feeder pellets	0.02673	0.1440	133	0.19	0.8530	0.05	-0.2582	0.3117
Food_Resource	Control	-0.3990	0.1440	133	-2.77	0.0064	0.05	-0.6839	-0.1141
Food_Resource	Oak leaves	-0.2286	0.1440	133	-1.59	0.1148	0.05	-0.5136	0.05627
Food_Resource	Pond Stick	-0.1312	0.1440	133	-0.91	0.3639	0.05	-0.4162	0.1537
Food_Resource	Rabbit Pellets	0.2099	0.1440	133	1.46	0.1474	0.05	-0.07498	0.4949
Food_Resource	Tilapia	-0.1042	0.1460	133	-0.71	0.4766	0.05	-0.3929	0.1845
Food_Resource	Fluker pellets	0	.	.	.	.	.	.	.

Table 25: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 0 When Comparing All Resources to API® Bottom Feeder Pellets

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.7697	0.1031	133	7.47	<.0001	0.05	0.5658	0.9736
Food_Resource	Control	-0.4257	0.1458	133	-2.92	0.0041	0.05	-0.7141	-0.1374
Food_Resource	Fluker pellets	-0.02673	0.1440	133	-0.19	0.8530	0.05	-0.3117	0.2582
Food_Resource	Oak leaves	-0.2554	0.1458	133	-1.75	0.0821	0.05	-0.5438	0.03299
Food_Resource	Pond Stick	-0.1580	0.1458	133	-1.08	0.2805	0.05	-0.4464	0.1304
Food_Resource	Rabbit Pellets	0.1832	0.1458	133	1.26	0.2111	0.05	-0.1052	0.4716
Food_Resource	Tilapia	-0.1309	0.1477	133	-0.89	0.3769	0.05	-0.4231	0.1612
Food_Resource	Bottom feeder pellets	0	.	.	.	.	.	.	.

Table 26: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Control

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.09659	0.04002	133	2.41	0.0172	0.05	0.01743	0.1757
Food_Resource	Bottom feeder pellets	0.1550	0.05660	133	2.74	0.0070	0.05	0.04305	0.2669
Food_Resource	Fluker pellets	0.05106	0.05592	133	0.91	0.3629	0.05	-0.05955	0.1617
Food_Resource	Oak leaves	0.03618	0.05660	133	0.64	0.5238	0.05	-0.07576	0.1481
Food_Resource	Pond Stick	0.1179	0.05660	133	2.08	0.0391	0.05	0.005989	0.2299
Food_Resource	Rabbit Pellets	0.1648	0.05660	133	2.91	0.0042	0.05	0.05284	0.2767
Food_Resource	Tilapia	0.1598	0.05734	133	2.79	0.0061	0.05	0.04636	0.2732
Food_Resource	Control	0	.	.	.	.	.	.	.

Table 27: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.2564	0.04106	133	6.24	<.0001	0.05	0.1751	0.3376
Food_Resource	Bottom feeder pellets	-0.00478	0.05734	133	-0.08	0.9337	0.05	-0.1182	0.1086
Food_Resource	Control	-0.1598	0.05734	133	-2.79	0.0061	0.05	-0.2732	-0.04636
Food_Resource	Fluker pellets	-0.1087	0.05667	133	-1.92	0.0572	0.05	-0.2208	0.003370
Food_Resource	Oak leaves	-0.1236	0.05734	133	-2.16	0.0329	0.05	-0.2370	-0.01019
Food_Resource	Pond Stick	-0.04184	0.05734	133	-0.73	0.4668	0.05	-0.1552	0.07157
Food_Resource	Rabbit Pellets	0.005010	0.05734	133	0.09	0.9305	0.05	-0.1084	0.1184
Food_Resource	Tilapia	0	.	.	.	.	.	.	.

Table 28: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Meijer® Rabbit Food

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.2614	0.04002	133	6.53	<.0001	0.05	0.1822	0.3405
Food_Resource	Bottom feeder pellets	-0.00979	0.05660	133	-0.17	0.8630	0.05	-0.1217	0.1022
Food_Resource	Control	-0.1648	0.05660	133	-2.91	0.0042	0.05	-0.2767	-0.05284
Food_Resource	Fluker pellets	-0.1137	0.05592	133	-2.03	0.0440	0.05	-0.2243	-0.00312
Food_Resource	Oak leaves	-0.1286	0.05660	133	-2.27	0.0247	0.05	-0.2405	-0.01666
Food_Resource	Pond Stick	-0.04685	0.05660	133	-0.83	0.4093	0.05	-0.1588	0.06509
Food_Resource	Tilapia	-0.00501	0.05734	133	-0.09	0.9305	0.05	-0.1184	0.1084
Food_Resource	Rabbit Pellets	0	.	.	.	.	.	.	.

Table 29: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Tetra Pond® Pond Sticks

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.2145	0.04002	133	5.36	<.0001	0.05	0.1354	0.2937
Food_Resource	Bottom feeder pellets	0.03706	0.05660	133	0.65	0.5137	0.05	-0.07488	0.1490
Food_Resource	Control	-0.1179	0.05660	133	-2.08	0.0391	0.05	-0.2299	-0.00599
Food_Resource	Fluker pellets	-0.06687	0.05592	133	-1.20	0.2338	0.05	-0.1775	0.04373
Food_Resource	Oak leaves	-0.08175	0.05660	133	-1.44	0.1509	0.05	-0.1937	0.03019
Food_Resource	Rabbit Pellets	0.04685	0.05660	133	0.83	0.4093	0.05	-0.06509	0.1588
Food_Resource	Tilapia	0.04184	0.05734	133	0.73	0.4668	0.05	-0.07157	0.1552
Food_Resource	Pond Stick	0	.	.	.	.	.	.	.

Table 30: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Oak Leaf Detritus

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.1328	0.04002	133	3.32	0.0012	0.05	0.05361	0.2119
Food_Resource	Bottom feeder pellets	0.1188	0.05660	133	2.10	0.0377	0.05	0.006872	0.2308
Food_Resource	Control	-0.03618	0.05660	133	-0.64	0.5238	0.05	-0.1481	0.07576
Food_Resource	Fluker pellets	0.01488	0.05592	133	0.27	0.7906	0.05	-0.09572	0.1255
Food_Resource	Pond Stick	0.08175	0.05660	133	1.44	0.1509	0.05	-0.03019	0.1937
Food_Resource	Rabbit Pellets	0.1286	0.05660	133	2.27	0.0247	0.05	0.01666	0.2405
Food_Resource	Tilapia	0.1236	0.05734	133	2.16	0.0329	0.05	0.01019	0.2370
Food_Resource	Oak leaves	0	.	.	.	.	.	.	.

Table 31: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to Fluker's® Turtle Diet

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.1476	0.03905	133	3.78	0.0002	0.05	0.07040	0.2249
Food_Resource	Bottom feeder pellets	0.1039	0.05592	133	1.86	0.0653	0.05	-0.00667	0.2145
Food_Resource	Control	-0.05106	0.05592	133	-0.91	0.3629	0.05	-0.1617	0.05955
Food_Resource	Oak leaves	-0.01488	0.05592	133	-0.27	0.7906	0.05	-0.1255	0.09572
Food_Resource	Pond Stick	0.06687	0.05592	133	1.20	0.2338	0.05	-0.04373	0.1775
Food_Resource	Rabbit Pellets	0.1137	0.05592	133	2.03	0.0440	0.05	0.003121	0.2243
Food_Resource	Tilapia	0.1087	0.05667	133	1.92	0.0572	0.05	-0.00337	0.2208
Food_Resource	Fluker pellets	0	.	.	.	.	.	.	.

Table 32: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 2 When Comparing All Resources to API® Bottom Feeder Pellets

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.2516	0.04002	133	6.29	<.0001	0.05	0.1724	0.3307
Food_Resource	Control	-0.1550	0.05660	133	-2.74	0.0070	0.05	-0.2669	-0.04305
Food_Resource	Fluker pellets	-0.1039	0.05592	133	-1.86	0.0653	0.05	-0.2145	0.006667
Food_Resource	Oak leaves	-0.1188	0.05660	133	-2.10	0.0377	0.05	-0.2308	-0.00687
Food_Resource	Pond Stick	-0.03706	0.05660	133	-0.65	0.5137	0.05	-0.1490	0.07488
Food_Resource	Rabbit Pellets	0.009788	0.05660	133	0.17	0.8630	0.05	-0.1022	0.1217
Food_Resource	Tilapia	0.004777	0.05734	133	0.08	0.9337	0.05	-0.1086	0.1182
Food_Resource	Bottom feeder pellets	0	.	.	.	.	.	.	.

Table 33: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Control

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.3768	0.07163	133	5.26	<.0001	0.05	0.2352	0.5185
Food_Resource	Bottom feeder pellets	0.2279	0.1013	133	2.25	0.0261	0.05	0.02751	0.4282
Food_Resource	Fluker pellets	0.007402	0.1001	133	0.07	0.9412	0.05	-0.1906	0.2054
Food_Resource	Oak leaves	-0.00218	0.1013	133	-0.02	0.9829	0.05	-0.2025	0.1982
Food_Resource	Pond Stick	0.04927	0.1013	133	0.49	0.6275	0.05	-0.1511	0.2496
Food_Resource	Rabbit Pellets	0.2724	0.1013	133	2.69	0.0081	0.05	0.07204	0.4728
Food_Resource	Tilapia	-0.06549	0.1026	133	-0.64	0.5245	0.05	-0.2685	0.1375
Food_Resource	Control	0	.	.	.	.	.	.	.

Table 34: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.3114	0.07349	133	4.24	<.0001	0.05	0.1660	0.4567
Food_Resource	Bottom feeder pellets	0.2933	0.1026	133	2.86	0.0049	0.05	0.09037	0.4963
Food_Resource	Control	0.06549	0.1026	133	0.64	0.5245	0.05	-0.1375	0.2685
Food_Resource	Fluker pellets	0.07289	0.1014	133	0.72	0.4736	0.05	-0.1277	0.2735
Food_Resource	Oak leaves	0.06331	0.1026	133	0.62	0.5383	0.05	-0.1397	0.2663
Food_Resource	Pond Stick	0.1148	0.1026	133	1.12	0.2655	0.05	-0.08822	0.3177
Food_Resource	Rabbit Pellets	0.3379	0.1026	133	3.29	0.0013	0.05	0.1349	0.5409
Food_Resource	Tilapia	0	.	.	.	.	.	.	.

Table 35: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Meijer® Rabbit Food

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.6492	0.07163	133	9.06	<.0001	0.05	0.5076	0.7909
Food_Resource	Bottom feeder pellets	-0.04453	0.1013	133	-0.44	0.6609	0.05	-0.2449	0.1558
Food_Resource	Control	-0.2724	0.1013	133	-2.69	0.0081	0.05	-0.4728	-0.07204
Food_Resource	Fluker pellets	-0.2650	0.1001	133	-2.65	0.0091	0.05	-0.4629	-0.06704
Food_Resource	Oak leaves	-0.2746	0.1013	133	-2.71	0.0076	0.05	-0.4749	-0.07422
Food_Resource	Pond Stick	-0.2231	0.1013	133	-2.20	0.0293	0.05	-0.4235	-0.02277
Food_Resource	Tilapia	-0.3379	0.1026	133	-3.29	0.0013	0.05	-0.5409	-0.1349
Food_Resource	Rabbit Pellets	0	.	.	.	.	.	.	.

Table 36: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Tetra Pond® Pond Sticks

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.4261	0.07163	133	5.95	<.0001	0.05	0.2844	0.5678
Food_Resource	Bottom feeder pellets	0.1786	0.1013	133	1.76	0.0802	0.05	-0.02176	0.3789
Food_Resource	Control	-0.04927	0.1013	133	-0.49	0.6275	0.05	-0.2496	0.1511
Food_Resource	Fluker pellets	-0.04187	0.1001	133	-0.42	0.6764	0.05	-0.2398	0.1561
Food_Resource	Oak leaves	-0.05145	0.1013	133	-0.51	0.6124	0.05	-0.2518	0.1489
Food_Resource	Rabbit Pellets	0.2231	0.1013	133	2.20	0.0293	0.05	0.02277	0.4235
Food_Resource	Tilapia	-0.1148	0.1026	133	-1.12	0.2655	0.05	-0.3177	0.08822
Food_Resource	Pond Stick	0	.	.	.	.	.	.	.

Table 37: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Oak Leaf Detritus

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.3747	0.07163	133	5.23	<.0001	0.05	0.2330	0.5163
Food_Resource	Bottom feeder pellets	0.2300	0.1013	133	2.27	0.0248	0.05	0.02968	0.4304
Food_Resource	Control	0.002178	0.1013	133	0.02	0.9829	0.05	-0.1982	0.2025
Food_Resource	Fluker pellets	0.009580	0.1001	133	0.10	0.9239	0.05	-0.1884	0.2075
Food_Resource	Pond Stick	0.05145	0.1013	133	0.51	0.6124	0.05	-0.1489	0.2518
Food_Resource	Rabbit Pellets	0.2746	0.1013	133	2.71	0.0076	0.05	0.07422	0.4749
Food_Resource	Tilapia	-0.06331	0.1026	133	-0.62	0.5383	0.05	-0.2663	0.1397
Food_Resource	Oak leaves	0	.	.	.	.	.	.	.

Table 38: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to Fluker's® Turtle Diet

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.3842	0.06990	133	5.50	<.0001	0.05	0.2460	0.5225
Food_Resource	Bottom feeder pellets	0.2205	0.1001	133	2.20	0.0293	0.05	0.02250	0.4184
Food_Resource	Control	-0.00740	0.1001	133	-0.07	0.9412	0.05	-0.2054	0.1906
Food_Resource	Oak leaves	-0.00958	0.1001	133	-0.10	0.9239	0.05	-0.2075	0.1884
Food_Resource	Pond Stick	0.04187	0.1001	133	0.42	0.6764	0.05	-0.1561	0.2398
Food_Resource	Rabbit Pellets	0.2650	0.1001	133	2.65	0.0091	0.05	0.06704	0.4629
Food_Resource	Tilapia	-0.07289	0.1014	133	-0.72	0.4736	0.05	-0.2735	0.1277
Food_Resource	Fluker pellets	0	.	.	.	.	.	.	.

Table 39: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 3 When Comparing All Resources to API® Bottom Feeder Pellets

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.6047	0.07163	133	8.44	<.0001	0.05	0.4630	0.7464
Food_Resource	Control	-0.2279	0.1013	133	-2.25	0.0261	0.05	-0.4282	-0.02751
Food_Resource	Fluker pellets	-0.2205	0.1001	133	-2.20	0.0293	0.05	-0.4184	-0.02250
Food_Resource	Oak leaves	-0.2300	0.1013	133	-2.27	0.0248	0.05	-0.4304	-0.02968
Food_Resource	Pond Stick	-0.1786	0.1013	133	-1.76	0.0802	0.05	-0.3789	0.02176
Food_Resource	Rabbit Pellets	0.04453	0.1013	133	0.44	0.6609	0.05	-0.1558	0.2449
Food_Resource	Tilapia	-0.2933	0.1026	133	-2.86	0.0049	0.05	-0.4963	-0.09037
Food_Resource	Bottom feeder pellets	0	.	.	.	.	.	.	.

Table 40: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 5 When Comparing All Resources to Control

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.01472	0.01123	133	1.31	0.1920	0.05	-0.00749	0.03693
Food_Resource	Bottom feeder pellets	-0.01472	0.01588	133	-0.93	0.3555	0.05	-0.04613	0.01669
Food_Resource	Fluker pellets	0.03012	0.01569	133	1.92	0.0570	0.05	-0.00091	0.06115
Food_Resource	Oak leaves	-0.01472	0.01588	133	-0.93	0.3555	0.05	-0.04613	0.01669
Food_Resource	Pond Stick	-0.00347	0.01588	133	-0.22	0.8272	0.05	-0.03488	0.02794
Food_Resource	Rabbit Pellets	-0.01472	0.01588	133	-0.93	0.3555	0.05	-0.04613	0.01669
Food_Resource	Tilapia	-0.01472	0.01609	133	-0.92	0.3617	0.05	-0.04654	0.01710
Food_Resource	Control	0	.	.	.	.	.	.	.

Table 41: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 5 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		5.89E-18	0.01152	133	0.00	1.0000	0.05	-0.02279	0.02279
Food_Resource	Bottom feeder pellets	-589E-20	0.01609	133	-0.00	1.0000	0.05	-0.03182	0.03182
Food_Resource	Control	0.01472	0.01609	133	0.92	0.3617	0.05	-0.01710	0.04654
Food_Resource	Fluker pellets	0.04484	0.01590	133	2.82	0.0055	0.05	0.01339	0.07629
Food_Resource	Oak leaves	-565E-20	0.01609	133	-0.00	1.0000	0.05	-0.03182	0.03182
Food_Resource	Pond Stick	0.01125	0.01609	133	0.70	0.4856	0.05	-0.02057	0.04307
Food_Resource	Rabbit Pellets	-618E-20	0.01609	133	-0.00	1.0000	0.05	-0.03182	0.03182
Food_Resource	Tilapia	0	.	.	.	.	.	.	.

Table 42: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 5 When Comparing All Resources to Meijer® Rabbit Food

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		6.74E-18	0.01123	133	0.00	1.0000	0.05	-0.02221	0.02221
Food_Resource	Bottom feeder pellets	-674E-20	0.01588	133	-0.00	1.0000	0.05	-0.03141	0.03141
Food_Resource	Control	0.01472	0.01588	133	0.93	0.3555	0.05	-0.01669	0.04613
Food_Resource	Fluker pellets	0.04484	0.01569	133	2.86	0.0049	0.05	0.01381	0.07587
Food_Resource	Oak leaves	-649E-20	0.01588	133	-0.00	1.0000	0.05	-0.03141	0.03141
Food_Resource	Pond Stick	0.01125	0.01588	133	0.71	0.4799	0.05	-0.02016	0.04266
Food_Resource	Tilapia	-825E-20	0.01609	133	-0.00	1.0000	0.05	-0.03182	0.03182
Food_Resource	Rabbit Pellets	0	.	.	.	.	.	.	.

Table 43: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 5 When Comparing All Resources to Tetra Pond® Pond Sticks

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.01125	0.01123	133	1.00	0.3182	0.05	-0.01096	0.03346
Food_Resource	Bottom feeder pellets	-0.01125	0.01588	133	-0.71	0.4799	0.05	-0.04266	0.02016
Food_Resource	Control	0.003472	0.01588	133	0.22	0.8272	0.05	-0.02794	0.03488
Food_Resource	Fluker pellets	0.03359	0.01569	133	2.14	0.0341	0.05	0.002560	0.06462
Food_Resource	Oak leaves	-0.01125	0.01588	133	-0.71	0.4799	0.05	-0.04266	0.02016
Food_Resource	Rabbit Pellets	-0.01125	0.01588	133	-0.71	0.4799	0.05	-0.04266	0.02016
Food_Resource	Tilapia	-0.01125	0.01609	133	-0.70	0.4856	0.05	-0.04307	0.02057
Food_Resource	Pond Stick	0	.	.	.	.	.	.	.

Table 44: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 5 When Comparing All Resources to Oak Leaf Detritus

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		7.11E-18	0.01123	133	0.00	1.0000	0.05	-0.02221	0.02221
Food_Resource	Bottom feeder pellets	-711E-20	0.01588	133	-0.00	1.0000	0.05	-0.03141	0.03141
Food_Resource	Control	0.01472	0.01588	133	0.93	0.3555	0.05	-0.01669	0.04613
Food_Resource	Fluker pellets	0.04484	0.01569	133	2.86	0.0049	0.05	0.01381	0.07587
Food_Resource	Pond Stick	0.01125	0.01588	133	0.71	0.4799	0.05	-0.02016	0.04266
Food_Resource	Rabbit Pellets	-702E-20	0.01588	133	-0.00	1.0000	0.05	-0.03141	0.03141
Food_Resource	Tilapia	-848E-20	0.01609	133	-0.00	1.0000	0.05	-0.03182	0.03182
Food_Resource	Oak leaves	0	.	.	.	.	.	.	.

Table 45: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 5 When Comparing All Resources to Fluker's® Turtle Diet

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.04484	0.01096	133	4.09	<.0001	0.05	0.02317	0.06651
Food_Resource	Bottom feeder pellets	-0.04484	0.01569	133	-2.86	0.0049	0.05	-0.07587	-0.01381
Food_Resource	Control	-0.03012	0.01569	133	-1.92	0.0570	0.05	-0.06115	0.000912
Food_Resource	Oak leaves	-0.04484	0.01569	133	-2.86	0.0049	0.05	-0.07587	-0.01381
Food_Resource	Pond Stick	-0.03359	0.01569	133	-2.14	0.0341	0.05	-0.06462	-0.00256
Food_Resource	Rabbit Pellets	-0.04484	0.01569	133	-2.86	0.0049	0.05	-0.07587	-0.01381
Food_Resource	Tilapia	-0.04484	0.01590	133	-2.82	0.0055	0.05	-0.07629	-0.01339
Food_Resource	Fluker pellets	0	.	.	.	.	.	.	.

Table 46: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration at Intensity Level 5 When Comparing All Resources to API® Bottom Feeder Pellets

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		5.27E-18	0.01123	133	0.00	1.0000	0.05	-0.02221	0.02221
Food_Resource	Control	0.01472	0.01588	133	0.93	0.3555	0.05	-0.01669	0.04613
Food_Resource	Fluker pellets	0.04484	0.01569	133	2.86	0.0049	0.05	0.01381	0.07587
Food_Resource	Oak leaves	-546E-20	0.01588	133	-0.00	1.0000	0.05	-0.03141	0.03141
Food_Resource	Pond Stick	0.01125	0.01588	133	0.71	0.4799	0.05	-0.02016	0.04266
Food_Resource	Rabbit Pellets	-534E-20	0.01588	133	-0.00	1.0000	0.05	-0.03141	0.03141
Food_Resource	Tilapia	-591E-20	0.01609	133	-0.00	1.0000	0.05	-0.03182	0.03182
Food_Resource	Bottom feeder pellets	0	.	.	.	.	.	.	.

Table 47: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.09077	0.01575	51	5.76	<.0001	0.05	0.05915	0.1224
Food_Resource	Bottom feeder pellets	-0.06577	0.02227	51	-2.95	0.0047	0.05	-0.1105	-0.02106
Food_Resource	Fluker pellets	-0.02699	0.02227	51	-1.21	0.2311	0.05	-0.07170	0.01772
Food_Resource	Oak leaves	-0.05535	0.02227	51	-2.49	0.0163	0.05	-0.1001	-0.01064
Food_Resource	Pond Stick	-0.06775	0.02454	51	-2.76	0.0080	0.05	-0.1170	-0.01848
Food_Resource	Rabbit pellets	-0.04528	0.02227	51	-2.03	0.0473	0.05	-0.08999	-0.00057
Food_Resource	Tilapia	0	.	.	.	.	.	.	.

Table 48: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Meijer® Rabbit Food

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.04549	0.01575	51	2.89	0.0057	0.05	0.01387	0.07710
Food_Resource	Bottom feeder pellets	-0.02049	0.02227	51	-0.92	0.3619	0.05	-0.06520	0.02422
Food_Resource	Fluker pellets	0.01829	0.02227	51	0.82	0.4153	0.05	-0.02642	0.06300
Food_Resource	Oak leaves	-0.01007	0.02227	51	-0.45	0.6530	0.05	-0.05478	0.03464
Food_Resource	Pond Stick	-0.02247	0.02454	51	-0.92	0.3641	0.05	-0.07174	0.02680
Food_Resource	Tilapia	0.04528	0.02227	51	2.03	0.0473	0.05	0.000569	0.08999
Food_Resource	Rabbit pellets	0	.	.	.	.	.	.	.

Table 49: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Tetra Pond® Pond Sticks

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.02302	0.01882	51	1.22	0.2270	0.05	-0.01477	0.06080
Food_Resource	Bottom feeder pellets	0.001984	0.02454	51	0.08	0.9359	0.05	-0.04729	0.05125
Food_Resource	Fluker pellets	0.04076	0.02454	51	1.66	0.1029	0.05	-0.00851	0.09003
Food_Resource	Oak leaves	0.01240	0.02454	51	0.51	0.6155	0.05	-0.03687	0.06167
Food_Resource	Rabbit pellets	0.02247	0.02454	51	0.92	0.3641	0.05	-0.02680	0.07174
Food_Resource	Tilapia	0.06775	0.02454	51	2.76	0.0080	0.05	0.01848	0.1170
Food_Resource	Pond Stick	0	.	.	.	.	.	.	.

Table 50: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Oak Leaf Detritus

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.03542	0.01575	51	2.25	0.0289	0.05	0.003801	0.06703
Food_Resource	Bottom feeder pellets	-0.01042	0.02227	51	-0.47	0.6420	0.05	-0.05513	0.03429
Food_Resource	Fluker pellets	0.02836	0.02227	51	1.27	0.2086	0.05	-0.01635	0.07307
Food_Resource	Pond Stick	-0.01240	0.02454	51	-0.51	0.6155	0.05	-0.06167	0.03687
Food_Resource	Rabbit pellets	0.01007	0.02227	51	0.45	0.6530	0.05	-0.03464	0.05478
Food_Resource	Tilapia	0.05535	0.02227	51	2.49	0.0163	0.05	0.01064	0.1001
Food_Resource	Oak leaves	0	.	.	.	.	.	.	.

Table 51: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Fluker's® Turtle Diet

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.06378	0.01575	51	4.05	0.0002	0.05	0.03216	0.09539
Food_Resource	Bottom feeder pellets	-0.03878	0.02227	51	-1.74	0.0877	0.05	-0.08349	0.005933
Food_Resource	Oak leaves	-0.02836	0.02227	51	-1.27	0.2086	0.05	-0.07307	0.01635
Food_Resource	Pond Stick	-0.04076	0.02454	51	-1.66	0.1029	0.05	-0.09003	0.008507
Food_Resource	Rabbit pellets	-0.01829	0.02227	51	-0.82	0.4153	0.05	-0.06300	0.02642
Food_Resource	Tilapia	0.02699	0.02227	51	1.21	0.2311	0.05	-0.01772	0.07170
Food_Resource	Fluker pellets	0	.	.	.	.	.	.	.

Table 52: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to API® Bottom Feeder Pellets

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.02500	0.01575	51	1.59	0.1186	0.05	-0.00662	0.05662
Food_Resource	Fluker pellets	0.03878	0.02227	51	1.74	0.0877	0.05	-0.00593	0.08349
Food_Resource	Oak leaves	0.01042	0.02227	51	0.47	0.6420	0.05	-0.03429	0.05513
Food_Resource	Pond Stick	-0.00198	0.02454	51	-0.08	0.9359	0.05	-0.05125	0.04729
Food_Resource	Rabbit pellets	0.02049	0.02227	51	0.92	0.3619	0.05	-0.02422	0.06520
Food_Resource	Tilapia	0.06577	0.02227	51	2.95	0.0047	0.05	0.02106	0.1105
Food_Resource	Bottom feeder pellets	0	.	.	.	.	.	.	.

Table 53: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level -1 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.06623	0.009104	51	7.27	<.0001	0.05	0.04795	0.08451
Food_Resource	Bottom feeder pellets	-0.04048	0.01288	51	-3.14	0.0028	0.05	-0.06633	-0.01463
Food_Resource	Fluker pellets	-0.02853	0.01288	51	-2.22	0.0312	0.05	-0.05438	-0.00268
Food_Resource	Oak leaves	-0.03220	0.01288	51	-2.50	0.0156	0.05	-0.05805	-0.00635
Food_Resource	Pond Stick	-0.01546	0.01419	51	-1.09	0.2811	0.05	-0.04394	0.01303
Food_Resource	Rabbit pellets	-0.03297	0.01288	51	-2.56	0.0134	0.05	-0.05882	-0.00712
Food_Resource	Tilapia	0	.	.	.	.	.	.	.

Table 54: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level -1 When Comparing All Resources to Meijer® Rabbit Food

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.03326	0.009104	51	3.65	0.0006	0.05	0.01498	0.05154
Food_Resource	Bottom feeder pellets	-0.00751	0.01288	51	-0.58	0.5623	0.05	-0.03336	0.01834
Food_Resource	Fluker pellets	0.004440	0.01288	51	0.34	0.7316	0.05	-0.02141	0.03029
Food_Resource	Oak leaves	0.000768	0.01288	51	0.06	0.9527	0.05	-0.02508	0.02662
Food_Resource	Pond Stick	0.01751	0.01419	51	1.23	0.2227	0.05	-0.01097	0.04600
Food_Resource	Tilapia	0.03297	0.01288	51	2.56	0.0134	0.05	0.007122	0.05882
Food_Resource	Rabbit pellets	0	.	.	.	.	.	.	.

Table 55: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level -1 When Comparing All Resources to Tetra Pond® Pond Sticks

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.05077	0.01088	51	4.67	<.0001	0.05	0.02893	0.07262
Food_Resource	Bottom feeder pellets	-0.02503	0.01419	51	-1.76	0.0838	0.05	-0.05351	0.003459
Food_Resource	Fluker pellets	-0.01307	0.01419	51	-0.92	0.3611	0.05	-0.04156	0.01541
Food_Resource	Oak leaves	-0.01675	0.01419	51	-1.18	0.2434	0.05	-0.04523	0.01174
Food_Resource	Rabbit pellets	-0.01751	0.01419	51	-1.23	0.2227	0.05	-0.04600	0.01097
Food_Resource	Tilapia	0.01546	0.01419	51	1.09	0.2811	0.05	-0.01303	0.04394
Food_Resource	Pond Stick	0	.	.	.	.	.	.	.

Table 56: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level -1 When Comparing All Resources to Oak Leaf Detritus

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.03403	0.009104	51	3.74	0.0005	0.05	0.01575	0.05231
Food_Resource	Bottom feeder pellets	-0.00828	0.01288	51	-0.64	0.5231	0.05	-0.03413	0.01757
Food_Resource	Fluker pellets	0.003672	0.01288	51	0.29	0.7767	0.05	-0.02218	0.02952
Food_Resource	Pond Stick	0.01675	0.01419	51	1.18	0.2434	0.05	-0.01174	0.04523
Food_Resource	Rabbit pellets	-0.00077	0.01288	51	-0.06	0.9527	0.05	-0.02662	0.02508
Food_Resource	Tilapia	0.03220	0.01288	51	2.50	0.0156	0.05	0.006354	0.05805
Food_Resource	Oak leaves	0	.	.	.	.	.	.	.

Table 57: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level -1 When Comparing All Resources to Fluker's® Turtle Diet

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.03770	0.009104	51	4.14	0.0001	0.05	0.01942	0.05598
Food_Resource	Bottom feeder pellets	-0.01195	0.01288	51	-0.93	0.3577	0.05	-0.03780	0.01390
Food_Resource	Oak leaves	-0.00367	0.01288	51	-0.29	0.7767	0.05	-0.02952	0.02218
Food_Resource	Pond Stick	0.01307	0.01419	51	0.92	0.3611	0.05	-0.01541	0.04156
Food_Resource	Rabbit pellets	-0.00444	0.01288	51	-0.34	0.7316	0.05	-0.03029	0.02141
Food_Resource	Tilapia	0.02853	0.01288	51	2.22	0.0312	0.05	0.002682	0.05438
Food_Resource	Fluker pellets	0	.	.	.	.	.	.	.

Table 58: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level -1 When Comparing All Resources to API® Bottom Feeder Pellets

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.02575	0.009104	51	2.83	0.0067	0.05	0.007471	0.04403
Food_Resource	Fluker pellets	0.01195	0.01288	51	0.93	0.3577	0.05	-0.01390	0.03780
Food_Resource	Oak leaves	0.008279	0.01288	51	0.64	0.5231	0.05	-0.01757	0.03413
Food_Resource	Pond Stick	0.02503	0.01419	51	1.76	0.0838	0.05	-0.00346	0.05351
Food_Resource	Rabbit pellets	0.007511	0.01288	51	0.58	0.5623	0.05	-0.01834	0.03336
Food_Resource	Tilapia	0.04048	0.01288	51	3.14	0.0028	0.05	0.01463	0.06633
Food_Resource	Bottom feeder pellets	0	.	.	.	.	.	.	.

Table 59: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 1 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.03571	0.004551	51	7.85	<.0001	0.05	0.02658	0.04485
Food_Resource	Bottom feeder pellets	-0.02048	0.006436	51	-3.18	0.0025	0.05	-0.03340	-0.00756
Food_Resource	Fluker pellets	-0.01849	0.006436	51	-2.87	0.0059	0.05	-0.03141	-0.00557
Food_Resource	Oak leaves	-0.01548	0.006436	51	-2.40	0.0199	0.05	-0.02840	-0.00256
Food_Resource	Pond Stick	-0.01618	0.007092	51	-2.28	0.0268	0.05	-0.03041	-0.00194
Food_Resource	Rabbit pellets	-0.01520	0.006436	51	-2.36	0.0220	0.05	-0.02812	-0.00228
Food_Resource	Tilapia	0	.	.	.	.	.	.	.

Table 60: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 1 When Comparing All Resources to Meijer® Rabbit Food

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.02051	0.004551	51	4.51	<.0001	0.05	0.01137	0.02965
Food_Resource	Bottom feeder pellets	-0.00527	0.006436	51	-0.82	0.4164	0.05	-0.01819	0.007648
Food_Resource	Fluker pellets	-0.00329	0.006436	51	-0.51	0.6115	0.05	-0.01621	0.009632
Food_Resource	Oak leaves	-0.00027	0.006436	51	-0.04	0.9663	0.05	-0.01319	0.01265
Food_Resource	Pond Stick	-0.00097	0.007092	51	-0.14	0.8915	0.05	-0.01521	0.01327
Food_Resource	Tilapia	0.01520	0.006436	51	2.36	0.0220	0.05	0.002282	0.02812
Food_Resource	Rabbit pellets	0	.	.	.	.	.	.	.

Table 61: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 1 When Comparing All Resources to Tetra Pond® Pond Sticks

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.01954	0.005439	51	3.59	0.0007	0.05	0.008619	0.03046
Food_Resource	Bottom feeder pellets	-0.00430	0.007092	51	-0.61	0.5469	0.05	-0.01854	0.009937
Food_Resource	Fluker pellets	-0.00232	0.007092	51	-0.33	0.7453	0.05	-0.01655	0.01192
Food_Resource	Oak leaves	0.000699	0.007092	51	0.10	0.9219	0.05	-0.01354	0.01494
Food_Resource	Rabbit pellets	0.000972	0.007092	51	0.14	0.8915	0.05	-0.01327	0.01521
Food_Resource	Tilapia	0.01618	0.007092	51	2.28	0.0268	0.05	0.001937	0.03041
Food_Resource	Pond Stick	0	.	.	.	.	.	.	.

Table 62: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 1 When Comparing All Resources to Oak Leaf Detritus

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.02024	0.004551	51	4.45	<.0001	0.05	0.01110	0.02937
Food_Resource	Bottom feeder pellets	-0.00500	0.006436	51	-0.78	0.4408	0.05	-0.01792	0.007921
Food_Resource	Fluker pellets	-0.00302	0.006436	51	-0.47	0.6414	0.05	-0.01594	0.009905
Food_Resource	Pond Stick	-0.00070	0.007092	51	-0.10	0.9219	0.05	-0.01494	0.01354
Food_Resource	Rabbit pellets	0.000273	0.006436	51	0.04	0.9663	0.05	-0.01265	0.01319
Food_Resource	Tilapia	0.01548	0.006436	51	2.40	0.0199	0.05	0.002555	0.02840
Food_Resource	Oak leaves	0	.	.	.	.	.	.	.

Table 63: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 1 When Comparing All Resources to Fluker's® Turtle Diet

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.01722	0.004551	51	3.78	0.0004	0.05	0.008086	0.02636
Food_Resource	Bottom feeder pellets	-0.00198	0.006436	51	-0.31	0.7591	0.05	-0.01491	0.01094
Food_Resource	Oak leaves	0.003016	0.006436	51	0.47	0.6414	0.05	-0.00991	0.01594
Food_Resource	Pond Stick	0.002317	0.007092	51	0.33	0.7453	0.05	-0.01192	0.01655
Food_Resource	Rabbit pellets	0.003289	0.006436	51	0.51	0.6115	0.05	-0.00963	0.01621
Food_Resource	Tilapia	0.01849	0.006436	51	2.87	0.0059	0.05	0.005571	0.03141
Food_Resource	Fluker pellets	0	.	.	.	.	.	.	.

Table 64: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 1 When Comparing All Resources to API® Bottom Feeder Pellets

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.01524	0.004551	51	3.35	0.0015	0.05	0.006102	0.02437
Food_Resource	Fluker pellets	0.001984	0.006436	51	0.31	0.7591	0.05	-0.01094	0.01491
Food_Resource	Oak leaves	0.005000	0.006436	51	0.78	0.4408	0.05	-0.00792	0.01792
Food_Resource	Pond Stick	0.004301	0.007092	51	0.61	0.5469	0.05	-0.00994	0.01854
Food_Resource	Rabbit pellets	0.005273	0.006436	51	0.82	0.4164	0.05	-0.00765	0.01819
Food_Resource	Tilapia	0.02048	0.006436	51	3.18	0.0025	0.05	0.007555	0.03340
Food_Resource	Bottom feeder pellets	0	.	.	.	.	.	.	.

Table 65: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 4 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.1284	0.01892	51	6.78	<.0001	0.05	0.09036	0.1663
Food_Resource	Bottom feeder pellets	-0.07622	0.02676	51	-2.85	0.0063	0.05	-0.1299	-0.02249
Food_Resource	Fluker pellets	0.000278	0.02676	51	0.01	0.9918	0.05	-0.05344	0.05400
Food_Resource	Oak leaves	-0.05192	0.02676	51	-1.94	0.0579	0.05	-0.1056	0.001806
Food_Resource	Pond Stick	-0.04301	0.02949	51	-1.46	0.1509	0.05	-0.1022	0.01619
Food_Resource	Rabbit pellets	-0.01945	0.02676	51	-0.73	0.4706	0.05	-0.07317	0.03427
Food_Resource	Tilapia	0	.	.	.	.	.	.	.

Table 66: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 4 When Comparing All Resources to Meijer® Rabbit Food

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.1089	0.01892	51	5.76	<.0001	0.05	0.07091	0.1469
Food_Resource	Bottom feeder pellets	-0.05677	0.02676	51	-2.12	0.0388	0.05	-0.1105	-0.00304
Food_Resource	Fluker pellets	0.01973	0.02676	51	0.74	0.4643	0.05	-0.03399	0.07345
Food_Resource	Oak leaves	-0.03247	0.02676	51	-1.21	0.2306	0.05	-0.08619	0.02126
Food_Resource	Pond Stick	-0.02355	0.02949	51	-0.80	0.4281	0.05	-0.08275	0.03564
Food_Resource	Tilapia	0.01945	0.02676	51	0.73	0.4706	0.05	-0.03427	0.07317
Food_Resource	Rabbit pellets	0	.	.	.	.	.	.	.

Table 67: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 4 When Comparing All Resources to Tetra Pond® Pond Sticks

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.08535	0.02262	51	3.77	0.0004	0.05	0.03994	0.1307
Food_Resource	Bottom feeder pellets	-0.03321	0.02949	51	-1.13	0.2653	0.05	-0.09241	0.02599
Food_Resource	Fluker pellets	0.04328	0.02949	51	1.47	0.1483	0.05	-0.01592	0.1025
Food_Resource	Oak leaves	-0.00891	0.02949	51	-0.30	0.7637	0.05	-0.06811	0.05029
Food_Resource	Rabbit pellets	0.02355	0.02949	51	0.80	0.4281	0.05	-0.03564	0.08275
Food_Resource	Tilapia	0.04301	0.02949	51	1.46	0.1509	0.05	-0.01619	0.1022
Food_Resource	Pond Stick	0	.	.	.	.	.	.	.

Table 68: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 4 When Comparing All Resources to Oak Leaf Detritus

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.07644	0.01892	51	4.04	0.0002	0.05	0.03845	0.1144
Food_Resource	Bottom feeder pellets	-0.02430	0.02676	51	-0.91	0.3681	0.05	-0.07802	0.02942
Food_Resource	Fluker pellets	0.05219	0.02676	51	1.95	0.0566	0.05	-0.00153	0.1059
Food_Resource	Pond Stick	0.008911	0.02949	51	0.30	0.7637	0.05	-0.05029	0.06811
Food_Resource	Rabbit pellets	0.03247	0.02676	51	1.21	0.2306	0.05	-0.02126	0.08619
Food_Resource	Tilapia	0.05192	0.02676	51	1.94	0.0579	0.05	-0.00181	0.1056
Food_Resource	Oak leaves	0	.	.	.	.	.	.	.

Table 69: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 4 When Comparing All Resources to Fluker's® Turtle Diet

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.1286	0.01892	51	6.80	<.0001	0.05	0.09064	0.1666
Food_Resource	Bottom feeder pellets	-0.07649	0.02676	51	-2.86	0.0061	0.05	-0.1302	-0.02277
Food_Resource	Oak leaves	-0.05219	0.02676	51	-1.95	0.0566	0.05	-0.1059	0.001528
Food_Resource	Pond Stick	-0.04328	0.02949	51	-1.47	0.1483	0.05	-0.1025	0.01592
Food_Resource	Rabbit pellets	-0.01973	0.02676	51	-0.74	0.4643	0.05	-0.07345	0.03399
Food_Resource	Tilapia	-0.00028	0.02676	51	-0.01	0.9918	0.05	-0.05400	0.05344
Food_Resource	Fluker pellets	0	.	.	.	.	.	.	.

Table 70: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 4 When Comparing All Resources to API® Bottom Feeder Pellets

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.05213	0.01892	51	2.76	0.0081	0.05	0.01415	0.09012
Food_Resource	Fluker pellets	0.07649	0.02676	51	2.86	0.0061	0.05	0.02277	0.1302
Food_Resource	Oak leaves	0.02430	0.02676	51	0.91	0.3681	0.05	-0.02942	0.07802
Food_Resource	Pond Stick	0.03321	0.02949	51	1.13	0.2653	0.05	-0.02599	0.09241
Food_Resource	Rabbit pellets	0.05677	0.02676	51	2.12	0.0388	0.05	0.003043	0.1105
Food_Resource	Tilapia	0.07622	0.02676	51	2.85	0.0063	0.05	0.02249	0.1299
Food_Resource	Bottom feeder pellets	0	.	.	.	.	.	.	.

Table 71: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.1003	0.01695	51	5.92	<.0001	0.05	0.06625	0.1343
Food_Resource	Bottom feeder pellets	-0.08472	0.02397	51	-3.53	0.0009	0.05	-0.1328	-0.03660
Food_Resource	Fluker pellets	-0.03433	0.02397	51	-1.43	0.1581	0.05	-0.08245	0.01378
Food_Resource	Oak leaves	-0.06417	0.02397	51	-2.68	0.0100	0.05	-0.1123	-0.01605
Food_Resource	Pond Stick	-0.07869	0.02641	51	-2.98	0.0044	0.05	-0.1317	-0.02567
Food_Resource	Rabbit pellets	-0.05635	0.02397	51	-2.35	0.0226	0.05	-0.1045	-0.00823
Food_Resource	Tilapia	0	.	.	.	.	.	.	.

Table 72: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Meijer® Rabbit Food

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.04393	0.01695	51	2.59	0.0124	0.05	0.009904	0.07795
Food_Resource	Bottom feeder pellets	-0.02837	0.02397	51	-1.18	0.2420	0.05	-0.07649	0.01974
Food_Resource	Fluker pellets	0.02202	0.02397	51	0.92	0.3626	0.05	-0.02610	0.07013
Food_Resource	Oak leaves	-0.00782	0.02397	51	-0.33	0.7456	0.05	-0.05593	0.04030
Food_Resource	Pond Stick	-0.02234	0.02641	51	-0.85	0.4016	0.05	-0.07536	0.03068
Food_Resource	Tilapia	0.05635	0.02397	51	2.35	0.0226	0.05	0.008232	0.1045
Food_Resource	Rabbit pellets	0	.	.	.	.	.	.	.

Table 73: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Tetra Pond® Pond Sticks

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.02159	0.02026	51	1.07	0.2916	0.05	-0.01908	0.06225
Food_Resource	Bottom feeder pellets	-0.00603	0.02641	51	-0.23	0.8203	0.05	-0.05905	0.04699
Food_Resource	Fluker pellets	0.04436	0.02641	51	1.68	0.0992	0.05	-0.00867	0.09738
Food_Resource	Oak leaves	0.01452	0.02641	51	0.55	0.5848	0.05	-0.03850	0.06755
Food_Resource	Rabbit pellets	0.02234	0.02641	51	0.85	0.4016	0.05	-0.03068	0.07536
Food_Resource	Tilapia	0.07869	0.02641	51	2.98	0.0044	0.05	0.02567	0.1317
Food_Resource	Pond Stick	0	.	.	.	.	.	.	.

Table 74: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Oak Leaf Detritus

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.03611	0.01695	51	2.13	0.0380	0.05	0.002087	0.07014
Food_Resource	Bottom feeder pellets	-0.02056	0.02397	51	-0.86	0.3951	0.05	-0.06867	0.02756
Food_Resource	Fluker pellets	0.02983	0.02397	51	1.24	0.2189	0.05	-0.01828	0.07795
Food_Resource	Pond Stick	-0.01452	0.02641	51	-0.55	0.5848	0.05	-0.06755	0.03850
Food_Resource	Rabbit pellets	0.007817	0.02397	51	0.33	0.7456	0.05	-0.04030	0.05593
Food_Resource	Tilapia	0.06417	0.02397	51	2.68	0.0100	0.05	0.01605	0.1123
Food_Resource	Oak leaves	0	.	.	.	.	.	.	.

Table 75: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to Fluker's® Turtle Diet

Solution for Fixed Effects									
Effect	**Food Resource**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.06594	0.01695	51	3.89	0.0003	0.05	0.03192	0.09997
Food_Resource	Bottom feeder pellets	-0.05039	0.02397	51	-2.10	0.0405	0.05	-0.09851	-0.00227
Food_Resource	Oak leaves	-0.02983	0.02397	51	-1.24	0.2189	0.05	-0.07795	0.01828
Food_Resource	Pond Stick	-0.04436	0.02641	51	-1.68	0.0992	0.05	-0.09738	0.008666
Food_Resource	Rabbit pellets	-0.02202	0.02397	51	-0.92	0.3626	0.05	-0.07013	0.02610
Food_Resource	Tilapia	0.03433	0.02397	51	1.43	0.1581	0.05	-0.01378	0.08245
Food_Resource	Fluker pellets	0	.	.	.	.	.	.	.

Table 76: Post Hoc Analysis of Subordinate *Orconectes rusticus* Average Duration at Intensity Level 5 When Comparing All Resources to API® Bottom Feeder Pellets

Solution for Fixed Effects									
Effect	Food Resource	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.01556	0.01695	51	0.92	0.3630	0.05	-0.01847	0.04958
Food_Resource	Fluker pellets	0.05039	0.02397	51	2.10	0.0405	0.05	0.002271	0.09851
Food_Resource	Oak leaves	0.02056	0.02397	51	0.86	0.3951	0.05	-0.02756	0.06867
Food_Resource	Pond Stick	0.006032	0.02641	51	0.23	0.8203	0.05	-0.04699	0.05905
Food_Resource	Rabbit pellets	0.02837	0.02397	51	1.18	0.2420	0.05	-0.01974	0.07649
Food_Resource	Tilapia	0.08472	0.02397	51	3.53	0.0009	0.05	0.03660	0.1328
Food_Resource	Bottom feeder pellets	0	.	.	.	.	.	.	.

Table 77: Total and Average Duration *Orconectes propinquus* Crayfish Made Contact With the Food Bag Containing Each Resource

	Dominant Crayfish		**Subordinate Crayfish**	
Resource	**Total Duration**	**Average Duration**	**Total Duration**	**Average Duration**
Control	13:46	0:27	10:25	0:19
Tilapia	90:14	1:45	40:21	0:44
Meijer® Rabbit Food	56:34	1:14	43:46	0:52
API® Bottom Feeder Pellets	82:42	1:43	75:02	1:40
Tetra Pond® Pond Sticks	85:50	1:28	57:16	1:10
Fluker's® Turtle Diet Pellets	111:21	2:15	54:27	1:01
Oak Leaves	40:49	0:38	24:25	0:32

Table 78: Total and Average Duration *Orconectes rusticus* Crayfish Made Contact With the Food Bag Containing Each Resource

	Dominant Crayfish		Subordinate Crayfish	
Resource	**Total Duration**	**Average Duration**	**Total Duration**	**Average Duration**
Tilapia	15:41	1:46	12:43	3:51
Meijer® Rabbit Food	31:54	1:43	12:47	0:48
API® Bottom Feeder Pellets	16:45	0:53	11:18	0:56
Tetra Pond® Pond Sticks	20:11	2:29	6:11	0:35
Fluker's® Turtle Diet Pellets	9:58	0:46	3:58	0:23
Oak Leaves	3:11	0:15	0:47	0:05

Table 79: Resources Effect on The Average Bag Contact Time of both *Orconectes propinquus* and *Orconectes rusticus*

Orconectes propinquus		***Orconectes rusticus***	
Dominate P-value	**Subordinate P-value**	**Dominant P-value**	**Subordinate P-value**
<.0001*	<.0001*	0.0302*	0.1898

This table displays the P-value of the F statistic of the average duration contacting the food bag when comparing all resources to one another. Statistically significant Comparisons ($P < 0.05$) are indicated by an *. Post Hoc analysis is shown below (Table 80-99). Resources where the confidence interval does not overlap are statistically different.

Table 80: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration Contacting the Food Bag When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets

Solution for Fixed Effects									
Effect	**Food**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.9892	0.6194	50	1.60	0.1166	0.05	-0.2550	2.2333
Food	Bottom feeder pellets	-0.5747	0.8595	50	-0.67	0.5068	0.05	-2.3011	1.1517
Food	Fluker pellets	-0.7079	0.8228	50	-0.86	0.3936	0.05	-2.3605	0.9446
Food	Oak leaves	-1.5226	0.8274	50	-1.84	0.0717	0.05	-3.1845	0.1394
Food	Pond Stick	1.0668	0.9096	50	1.17	0.2464	0.05	-0.7602	2.8938
Food	Rabbit pellets	0.9403	0.8595	50	1.09	0.2792	0.05	-0.7861	2.6667
Food	Tilapia	0	.	.	.	.	.	.	.
DomTotalTouches		0.3407	0.1269	50	2.68	0.0098	0.05	0.08582	0.5956

Table 81: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration Contacting the Food Bag When Comparing All Resources to Meijer® Rabbit Food

Solution for Fixed Effects									
Effect	**Food**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		1.9295	0.7467	50	2.58	0.0127	0.05	0.4296	3.4293
Food	Bottom feeder pellets	-1.5150	0.8212	50	-1.84	0.0710	0.05	-3.1644	0.1344
Food	Fluker pellets	-1.6482	0.8459	50	-1.95	0.0570	0.05	-3.3473	0.05084
Food	Oak leaves	-2.4628	0.8352	50	-2.95	0.0048	0.05	-4.1404	-0.7853
Food	Pond Stick	0.1265	0.9192	50	0.14	0.8911	0.05	-1.7197	1.9727
Food	Tilapia	-0.9403	0.8595	50	-1.09	0.2792	0.05	-2.6667	0.7861
Food	Rabbit pellets	0	.	.	.	.	.	.	.
DomTotalTouches		0.3407	0.1269	50	2.68	0.0098	0.05	0.08582	0.5956

Table 82: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration Contacting the Food Bag When Comparing All Resources to Tetra Pond® Pond Sticks

Solution for Fixed Effects									
Effect	**Food**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		2.0559	0.7594	50	2.71	0.0093	0.05	0.5307	3.5812
Food	Bottom feeder pellets	-1.6415	0.9192	50	-1.79	0.0802	0.05	-3.4877	0.2047
Food	Fluker pellets	-1.7747	0.9059	50	-1.96	0.0557	0.05	-3.5942	0.04476
Food	Oak leaves	-2.5893	0.9050	50	-2.86	0.0061	0.05	-4.4070	-0.7717
Food	Rabbit pellets	-0.1265	0.9192	50	-0.14	0.8911	0.05	-1.9727	1.7197
Food	Tilapia	-1.0668	0.9096	50	-1.17	0.2464	0.05	-2.8938	0.7602
Food	Pond Stick	0	.	.	.	.	.	.	.
DomTotalTouches		0.3407	0.1269	50	2.68	0.0098	0.05	0.08582	0.5956

Table 83: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration Contacting the Food Bag When Comparing All Resources to Oak Leaf Detritus

Solution for Fixed Effects									
Effect	**Food**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		-0.5334	0.6617	50	-0.81	0.4240	0.05	-1.8624	0.7956
Food	Bottom feeder pellets	0.9478	0.8352	50	1.13	0.2618	0.05	-0.7297	2.6254
Food	Fluker pellets	0.8146	0.8228	50	0.99	0.3269	0.05	-0.8379	2.4672
Food	Pond Stick	2.5893	0.9050	50	2.86	0.0061	0.05	0.7717	4.4070
Food	Rabbit pellets	2.4628	0.8352	50	2.95	0.0048	0.05	0.7853	4.1404
Food	Tilapia	1.5226	0.8274	50	1.84	0.0717	0.05	-0.1394	3.1845
Food	Oak leaves	0	.	.	.	.	.	.	.
DomTotalTouches		0.3407	0.1269	50	2.68	0.0098	0.05	0.08582	0.5956

Table 84: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration Contacting the Food Bag When Comparing All Resources to Fluker's® Turtle Diet

Solution for Fixed Effects									
Effect	**Food**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.2812	0.6389	50	0.44	0.6617	0.05	-1.0020	1.5645
Food	Bottom feeder pellets	0.1332	0.8459	50	0.16	0.8755	0.05	-1.5658	1.8323
Food	Oak leaves	-0.8146	0.8228	50	-0.99	0.3269	0.05	-2.4672	0.8379
Food	Pond Stick	1.7747	0.9059	50	1.96	0.0557	0.05	-0.04476	3.5942
Food	Rabbit pellets	1.6482	0.8459	50	1.95	0.0570	0.05	-0.05084	3.3473
Food	Tilapia	0.7079	0.8228	50	0.86	0.3936	0.05	-0.9446	2.3605
Food	Fluker pellets	0	.	.	.	.	.	.	.
DomTotalTouches		0.3407	0.1269	50	2.68	0.0098	0.05	0.08582	0.5956

Table 85: Post Hoc Analysis of Dominate *Orconectes rusticus* Average Duration Contacting the Food Bag When Comparing All Resources to API® Bottom Feeder Pellets

Solution for Fixed Effects									
Effect	**Food**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.4145	0.7467	50	0.56	0.5814	0.05	-1.0854	1.9143
Food	Fluker pellets	-0.1332	0.8459	50	-0.16	0.8755	0.05	-1.8323	1.5658
Food	Oak leaves	-0.9478	0.8352	50	-1.13	0.2618	0.05	-2.6254	0.7297
Food	Pond Stick	1.6415	0.9192	50	1.79	0.0802	0.05	-0.2047	3.4877
Food	Rabbit pellets	1.5150	0.8212	50	1.84	0.0710	0.05	-0.1344	3.1644
Food	Tilapia	0.5747	0.8595	50	0.67	0.5068	0.05	-1.1517	2.3011
Food	Bottom feeder pellets	0	.	.	.	.	.	.	.
DomTotalTouches		0.3407	0.1269	50	2.68	0.0098	0.05	0.08582	0.5956

Table 86: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Control

Solution for Fixed Effects									
Effect	Food	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		0.5520	0.4481	83	1.23	0.2214	0.05	-0.3392	1.4433
Food	Bottom feeder pellets	4.8231	0.7288	83	6.62	<.0001	0.05	3.3735	6.2728
Food	Fluker pellets	3.2768	0.6707	83	4.89	<.0001	0.05	1.9428	4.6109
Food	Oak leaves	1.3027	0.6088	83	2.14	0.0353	0.05	0.09184	2.5136
Food	Pond Stick	4.3228	0.7510	83	5.76	<.0001	0.05	2.8291	5.8166
Food	Rabbit Pellets	2.4788	0.6133	83	4.04	0.0001	0.05	1.2589	3.6986
Food	Tilapia	5.2333	0.6735	83	7.77	<.0001	0.05	3.8938	6.5727
Food	Control	0	.	.	.	.	.	.	.
DomTotalTouches		0.04326	0.07299	83	0.59	0.5549	0.05	-0.1019	0.1884

Table 87: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets

Solution for Fixed Effects									
Effect	**Food**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		5.7853	0.6354	83	9.10	<.0001	0.05	4.5215	7.0491
Food	Bottom feeder pellets	-0.4101	0.7941	83	-0.52	0.6069	0.05	-1.9896	1.1693
Food	Control	-5.2333	0.6735	83	-7.77	<.0001	0.05	-6.5727	-3.8938
Food	Fluker pellets	-1.9564	0.7562	83	-2.59	0.0114	0.05	-3.4604	-0.4525
Food	Oak leaves	-3.9305	0.7000	83	-5.62	<.0001	0.05	-5.3228	-2.5383
Food	Pond Stick	-0.9104	0.8083	83	-1.13	0.2633	0.05	-2.5181	0.6973
Food	Rabbit Pellets	-2.7545	0.7129	83	-3.86	0.0002	0.05	-4.1724	-1.3366
Food	Tilapia	0	.	.	.	.	.	.	.
DomTotalTouches		0.04326	0.07299	83	0.59	0.5549	0.05	-0.1019	0.1884

Table 88: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Meijer® Rabbit Food

Solution for Fixed Effects									
Effect	**Food**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		3.0308	0.5837	83	5.19	<.0001	0.05	1.8698	4.1918
Food	Bottom feeder pellets	2.3443	0.7313	83	3.21	0.0019	0.05	0.8899	3.7988
Food	Control	-2.4788	0.6133	83	-4.04	0.0001	0.05	-3.6986	-1.2589
Food	Fluker pellets	0.7981	0.6950	83	1.15	0.2541	0.05	-0.5843	2.1804
Food	Oak leaves	-1.1760	0.6328	83	-1.86	0.0667	0.05	-2.4347	0.08259
Food	Pond Stick	1.8441	0.7445	83	2.48	0.0153	0.05	0.3633	3.3248
Food	Tilapia	2.7545	0.7129	83	3.86	0.0002	0.05	1.3366	4.1724
Food	Rabbit Pellets	0	.	.	.	.	.	.	.
DomTotalTouches		0.04326	0.07299	83	0.59	0.5549	0.05	-0.1019	0.1884

Table 89: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Tetra Pond® Pond Sticks

Solution for Fixed Effects									
Effect	Food	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		4.8749	0.7927	83	6.15	<.0001	0.05	3.2983	6.4515
Food	Bottom feeder pellets	0.5003	0.7710	83	0.65	0.5182	0.05	-1.0331	2.0337
Food	Control	-4.3228	0.7510	83	-5.76	<.0001	0.05	-5.8166	-2.8291
Food	Fluker pellets	-1.0460	0.7695	83	-1.36	0.1777	0.05	-2.5766	0.4846
Food	Oak leaves	-3.0201	0.7100	83	-4.25	<.0001	0.05	-4.4322	-1.6080
Food	Rabbit Pellets	-1.8441	0.7445	83	-2.48	0.0153	0.05	-3.3248	-0.3633
Food	Tilapia	0.9104	0.8083	83	1.13	0.2633	0.05	-0.6973	2.5181
Food	Pond Stick	0	.	.	.	.	.	.	.
DomTotalTouches		0.04326	0.07299	83	0.59	0.5549	0.05	-0.1019	0.1884

Table 90: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Oak Leaf Detritus

Solution for Fixed Effects									
Effect	Food	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		1.8548	0.6041	83	3.07	0.0029	0.05	0.6533	3.0563
Food	Bottom feeder pellets	3.5204	0.7008	83	5.02	<.0001	0.05	2.1266	4.9142
Food	Control	-1.3027	0.6088	83	-2.14	0.0353	0.05	-2.5136	-0.09184
Food	Fluker pellets	1.9741	0.6739	83	2.93	0.0044	0.05	0.6338	3.3144
Food	Pond Stick	3.0201	0.7100	83	4.25	<.0001	0.05	1.6080	4.4322
Food	Rabbit Pellets	1.1760	0.6328	83	1.86	0.0667	0.05	-0.08259	2.4347
Food	Tilapia	3.9305	0.7000	83	5.62	<.0001	0.05	2.5383	5.3228
Food	Oak leaves	0	.	.	.	.	.	.	.
DomTotalTouches		0.04326	0.07299	83	0.59	0.5549	0.05	-0.1019	0.1884

Table 91: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Fluker's® Turtle Diet

Solution for Fixed Effects									
Effect	Food	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		3.8289	0.6620	83	5.78	<.0001	0.05	2.5122	5.1455
Food	Bottom feeder pellets	1.5463	0.7602	83	2.03	0.0451	0.05	0.03427	3.0583
Food	Control	-3.2768	0.6707	83	-4.89	<.0001	0.05	-4.6109	-1.9428
Food	Oak leaves	-1.9741	0.6739	83	-2.93	0.0044	0.05	-3.3144	-0.6338
Food	Pond Stick	1.0460	0.7695	83	1.36	0.1777	0.05	-0.4846	2.5766
Food	Rabbit Pellets	-0.7981	0.6950	83	-1.15	0.2541	0.05	-2.1804	0.5843
Food	Tilapia	1.9564	0.7562	83	2.59	0.0114	0.05	0.4525	3.4604
Food	Fluker pellets	0	.	.	.	.	.	.	.
DomTotalTouches		0.04326	0.07299	83	0.59	0.5549	0.05	-0.1019	0.1884

Table 92: Post Hoc Analysis of Dominate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to API® Bottom Feeder Pellets

Solution for Fixed Effects									
Effect	Food	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		5.3752	0.7563	83	7.11	<.0001	0.05	3.8708	6.8795
Food	Control	-4.8231	0.7288	83	-6.62	<.0001	0.05	-6.2728	-3.3735
Food	Fluker pellets	-1.5463	0.7602	83	-2.03	0.0451	0.05	-3.0583	-0.03427
Food	Oak leaves	-3.5204	0.7008	83	-5.02	<.0001	0.05	-4.9142	-2.1266
Food	Pond Stick	-0.5003	0.7710	83	-0.65	0.5182	0.05	-2.0337	1.0331
Food	Rabbit Pellets	-2.3443	0.7313	83	-3.21	0.0019	0.05	-3.7988	-0.8899
Food	Tilapia	0.4101	0.7941	83	0.52	0.6069	0.05	-1.1693	1.9896
Food	Bottom feeder pellets	0	.	.	.	.	.	.	.
DomTotalTouches		0.04326	0.07299	83	0.59	0.5549	0.05	-0.1019	0.1884

Table 93: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Control

Solution for Fixed Effects									
Effect	Food	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		-0.1357	0.3905	83	-0.35	0.7291	0.05	-0.9124	0.6410
Food	Bottom feeder pellets	4.2953	0.5924	83	7.25	<.0001	0.05	3.1171	5.4735
Food	Fluker pellets	1.9147	0.5747	83	3.33	0.0013	0.05	0.7717	3.0577
Food	Oak leaves	0.6083	0.5065	83	1.20	0.2332	0.05	-0.3992	1.6158
Food	Pond Stick	2.1741	0.6158	83	3.53	0.0007	0.05	0.9492	3.3990
Food	Rabbit Pellets	1.5187	0.5320	83	2.85	0.0054	0.05	0.4605	2.5769
Food	Tilapia	1.9492	0.5889	83	3.31	0.0014	0.05	0.7779	3.1204
Food	Control	0	.	.	.	.	.	.	.
SubTotalTouches		0.2020	0.06183	83	3.27	0.0016	0.05	0.07904	0.3250

Table 94: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Meijer® Farm Raised Tilapia Fillets

Solution for Fixed Effects									
Effect	**Food**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		1.8135	0.5622	83	3.23	0.0018	0.05	0.6954	2.9316
Food	Bottom feeder pellets	2.3461	0.6699	83	3.50	0.0007	0.05	1.0136	3.6786
Food	Control	-1.9492	0.5889	83	-3.31	0.0014	0.05	-3.1204	-0.7779
Food	Fluker pellets	-0.03450	0.6545	83	-0.05	0.9581	0.05	-1.3363	1.2673
Food	Oak leaves	-1.3409	0.6047	83	-2.22	0.0293	0.05	-2.5437	-0.1381
Food	Pond Stick	0.2249	0.6779	83	0.33	0.7409	0.05	-1.1234	1.5732
Food	Rabbit Pellets	-0.4305	0.6200	83	-0.69	0.4894	0.05	-1.6637	0.8027
Food	Tilapia	0	.	.	.	.	.	.	.
SubTotalTouches		0.2020	0.06183	83	3.27	0.0016	0.05	0.07904	0.3250

Table 95: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Meijer® Rabbit Food

Solution for Fixed Effects									
Effect	Food	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		1.3830	0.5030	83	2.75	0.0073	0.05	0.3825	2.3834
Food	Bottom feeder pellets	2.7766	0.6202	83	4.48	<.0001	0.05	1.5430	4.0102
Food	Control	-1.5187	0.5320	83	-2.85	0.0054	0.05	-2.5769	-0.4605
Food	Fluker pellets	0.3960	0.6036	83	0.66	0.5135	0.05	-0.8044	1.5965
Food	Oak leaves	-0.9104	0.5493	83	-1.66	0.1013	0.05	-2.0030	0.1822
Food	Pond Stick	0.6555	0.6286	83	1.04	0.3001	0.05	-0.5947	1.9057
Food	Tilapia	0.4305	0.6200	83	0.69	0.4894	0.05	-0.8027	1.6637
Food	Rabbit Pellets	0	.	.	.	.	.	.	.
SubTotalTouches		0.2020	0.06183	83	3.27	0.0016	0.05	0.07904	0.3250

Table 96: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Tetra Pond® Pond Sticks

Solution for Fixed Effects									
Effect	**Food**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		2.0384	0.6251	83	3.26	0.0016	0.05	0.7951	3.2817
Food	Bottom feeder pellets	2.1211	0.6753	83	3.14	0.0023	0.05	0.7781	3.4642
Food	Control	-2.1741	0.6158	83	-3.53	0.0007	0.05	-3.3990	-0.9492
Food	Fluker pellets	-0.2594	0.6601	83	-0.39	0.6953	0.05	-1.5724	1.0536
Food	Oak leaves	-1.5658	0.6200	83	-2.53	0.0135	0.05	-2.7990	-0.3327
Food	Rabbit Pellets	-0.6555	0.6286	83	-1.04	0.3001	0.05	-1.9057	0.5947
Food	Tilapia	-0.2249	0.6779	83	-0.33	0.7409	0.05	-1.5732	1.1234
Food	Pond Stick	0	.	.	.	.	.	.	.
SubTotalTouches		0.2020	0.06183	83	3.27	0.0016	0.05	0.07904	0.3250

Table 97: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Oak Leaf Detritus

Solution for Fixed Effects									
Effect	**Food**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		0.4726	0.4596	83	1.03	0.3068	0.05	-0.4415	1.3867
Food	Bottom feeder pellets	3.6870	0.6061	83	6.08	<.0001	0.05	2.4814	4.8926
Food	Control	-0.6083	0.5065	83	-1.20	0.2332	0.05	-1.6158	0.3992
Food	Fluker pellets	1.3064	0.5890	83	2.22	0.0293	0.05	0.1349	2.4779
Food	Pond Stick	1.5658	0.6200	83	2.53	0.0135	0.05	0.3327	2.7990
Food	Rabbit Pellets	0.9104	0.5493	83	1.66	0.1013	0.05	-0.1822	2.0030
Food	Tilapia	1.3409	0.6047	83	2.22	0.0293	0.05	0.1381	2.5437
Food	Oak leaves	0	.	.	.	.	.	.	.
SubTotalTouches		0.2020	0.06183	83	3.27	0.0016	0.05	0.07904	0.3250

Table 98: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to Fluker's® Turtle Diet

Solution for Fixed Effects									
Effect	**Food**	**Estimate**	**Standard Error**	**DF**	**t Value**	**Pr > |t|**	**Alpha**	**Lower**	**Upper**
Intercept		1.7790	0.5536	83	3.21	0.0019	0.05	0.6779	2.8801
Food	Bottom feeder pellets	2.3806	0.6543	83	3.64	0.0005	0.05	1.0792	3.6819
Food	Control	-1.9147	0.5747	83	-3.33	0.0013	0.05	-3.0577	-0.7717
Food	Oak leaves	-1.3064	0.5890	83	-2.22	0.0293	0.05	-2.4779	-0.1349
Food	Pond Stick	0.2594	0.6601	83	0.39	0.6953	0.05	-1.0536	1.5724
Food	Rabbit Pellets	-0.3960	0.6036	83	-0.66	0.5135	0.05	-1.5965	0.8044
Food	Tilapia	0.03450	0.6545	83	0.05	0.9581	0.05	-1.2673	1.3363
Food	Fluker pellets	0	.	.	.	.	.	.	.
SubTotalTouches		0.2020	0.06183	83	3.27	0.0016	0.05	0.07904	0.3250

Table 99: Post Hoc Analysis of Subordinate *Orconectes propinquus* Average Duration Contacting the Food Bag When Comparing All Resources to API® Bottom Feeder Pellets

Solution for Fixed Effects									
Effect	Food	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
Intercept		4.1596	0.5724	83	7.27	<.0001	0.05	3.0212	5.2980
Food	Control	-4.2953	0.5924	83	-7.25	<.0001	0.05	-5.4735	-3.1171
Food	Fluker pellets	-2.3806	0.6543	83	-3.64	0.0005	0.05	-3.6819	-1.0792
Food	Oak leaves	-3.6870	0.6061	83	-6.08	<.0001	0.05	-4.8926	-2.4814
Food	Pond Stick	-2.1211	0.6753	83	-3.14	0.0023	0.05	-3.4642	-0.7781
Food	Rabbit Pellets	-2.7766	0.6202	83	-4.48	<.0001	0.05	-4.0102	-1.5430
Food	Tilapia	-2.3461	0.6699	83	-3.50	0.0007	0.05	-3.6786	-1.0136
Food	Bottom feeder pellets	0	.	.	.	.	.	.	.
SubTotalTouches		0.2020	0.06183	83	3.27	0.0016	0.05	0.07904	0.3250

Literature Cited

Ahvenharju, T., & Ruohonen, K. (2006). Unequal division of food resources suggests feeding hierarchy of signal crayfish (Pacifastacus leniusculus) juveniles. *Aquaculture*, *259*(1–4), 181–189. http://doi.org/10.1016/j.aquaculture.2006.05.006

Baird, H. P., Patullo, B. W., & Macmillan, D. L. (2006). Reducing aggression between freshwater crayfish (Cherax destructor Clark: Decapoda, Parastacidae) by increasing habitat complexity. *Aquaculture Research*, *37*(14), 1419–1428. http://doi.org/10.1111/j.1365-2109.2006.01575.x

Bergman, D. A., Kozlowski, C. P., McIntyre, J. C., Huber, R., Daws, A. G., & Moore, P. A. (2003). Temporal Dynamics and Communication of Winner-Effects in the Crayfish, Orconectes rusticus. *Behaviour*, *140*(6), 805–825.

Bergman, D. A., Martin, A. L., & Moore, P. A. (2005). Control of information flow through the influence of mechanical and chemical signals during agonistic encounters by the crayfish, Orconectes rusticus. *Animal Behaviour*, *70*(3), 485–496. http://doi.org/10.1016/j.anbehav.2004.11.021

Bergman, D. A., & Moore, P. A. (2003). Field observations of intraspecific agonistic behavior of two crayfish species, Orconectes rusticus and Orconectes virilis, in different habitats. *The Biological Bulletin*, *205*(1), 26–35.

Bergman, D. A., & Moore, P. A. (2005). Prolonged exposure to social odours alters subsequent social interactions in crayfish (Orconectes rusticus). *Animal Behaviour*, *70*(2), 311–318. http://doi.org/10.1016/j.anbehav.2004.10.026

Bovbjerg, R. V. (1956). Some Factors Affecting Aggressive Behavior in Crayfish. *Physiological Zoology*, *29*(2), 127–136.

Breithaupt, T. (2001). Fan Organs of Crayfish Enhance Chemical Information Flow. *The Biological Bulletin*, *200*(2), 150.

Brown, P. (1995). A Review of Nutritional Research with Crayfish. *Journal of Shellfish Research*, *14*(2), 561–568.

Bruski, C. A., & Dunham, D. W. (1987). The Importance of Vision in Agonistic Communication of the Crayfish Orconectes rusticus. I: An Analysis of Bout Dynamics. *Behaviour*, *103*(1/3), 83–107.

Capelli, G. M., & Hamilton, P. A. (1984). Effects of Food and Shelter on Aggressive Activity in the Crayfish Orconectes rusticus (Girard). *Journal of Crustacean Biology*, *4*(2), 252–260. http://doi.org/10.2307/1548022

Chucholl, C. (2013). Feeding ecology and ecological impact of an alien "warm-water" omnivore in cold lakes. *Limnologica - Ecology and Management of Inland Waters*, *43*(4), 219–229. http://doi.org/10.1016/j.limno.2012.10.001

Corkum, L. D., & Cronin, D. J. (2004). Habitat complexity reduces aggression and enhances consumption in crayfish. *Journal of Ethology*, *22*(1), 23–27. http://doi.org/10.1007/s10164-003-0095-x

Davies, N. B., Krebs, J. R., & West, S. A. (2012). *Introduction to Behavioural Ecology* (4th ed.). Hoboken: Wiley.

Davis, K. M., & Huber, R. (2007). Activity Patterns, Behavioural Repertoires, and Agonistic Interactions of Crayfish: A Non-Manipulative Field Study. *Behaviour*, *144*(2), 229–247.

Daws, A. G., Grills, J., Konzen, K., & Moore, P. A. (2002). Previous Experiences Alter the Outcome of Aggressive Interactions Between Males in the Crayfish, Procambarus

Clarkii. *Marine and Freshwater Behaviour and Physiology*, *35*(3), 139–148. http://doi.org/10.1080/1023624021000014725

Edwards, D. H., & Kravitz, E. A. (1997). Serotonin, social status and aggression. *Current Opinion in Neurobiology*, *7*(6), 812–819. http://doi.org/10.1016/S0959-4388(97)80140-7

Ellrott, B. J., Ellen Marsden, J., Fitzsimons, J. D., Jonas, J. L., & Claramunt, R. M. (2007). Effects of Temperature and Density on Consumption of Trout Eggs by Orconectes propinquus and O. rusticus. *Journal of Great Lakes Research*, *33*(1), 7–14. http://doi.org/10.3394/0380-1330(2007)33[7:EOTADO]2.0.CO;2

FAO: FAQs. (n.d.). Retrieved December 5, 2014, from http://www.fao.org/fishery/affris/species-profiles/nile-tilapia/faqs/en/

Fero, K., Simon, J. L., Jourdie, V., & Moore, P. A. (2007). Consequences of Social Dominance on Crayfish Resource Use. *Behaviour*, *144*(1), 61–82.

Figter, M. H., Finkelstein, J. E., Twum, M., & Peeke, H. V. S. (1995). Intruding Male Red Swamp Crayfish, Procambarus clarkii, Immediately Dominate Members of Established Communities of Smaller, Mixed-Sex Conspecifics. *Aggressive Behavior*, *21*(3), 225–236.

Fujimoto, S., Hirata, B., & Nagayama, T. (2011). Dominance hierarchy-dependent behavioural plasticity of crayfish avoidance reactions. *The Journal of Experimental Biology*, *214*(16), 2718–2723. http://doi.org/10.1242/jeb.057752

Gabor, C. R., & Jaeger, R. G. (1995). Resource quality affects the agonistic behaviour of territorial salamanders. *Animal Behaviour*, *49*(1), 71–79. http://doi.org/10.1016/0003-3472(95)80155-3

Gherardi, F. (2006). Fighting behavior in hermit crabs: the combined effect of resource-holding potential and resource value in Pagurus longicarpus. *Behavioral Ecology and*

Sociobiology, *59*(4), 500–510. http://doi.org/http://dx.doi.org.ezproxy.gvsu.edu/10.1007/s00265-005-0074-z

Gherardi, F., & Daniels, W. H. (2003). Dominance hierarchies and status recognition in the crayfish Procambarus acutus acutus. *Canadian Journal of Zoology*, *81*(7), 1269.

Hazlett, B., Rubenstein, D., & Rittschof, D. (1975). Starvation, Energy Reserves, and Aggression in the Crayfish Orconectes virilis (Hagen, 1870) (Decapoda, Cambaridae). *Crustaceana*, *28*(1), 11–16.

Herberholz, J., McCurdy, C., & Edwards, D. H. (2007). Direct Benefits of Social Dominance in Juvenile Crayfish. *The Biological Bulletin*, *213*(1), 21–7.

Hsu, Y., & Wolf, L. L. (1999). The winner and loser effect: integrating multiple experiences. *Animal Behaviour*, *57*(4), 903–910. http://doi.org/10.1006/anbe.1998.1049

Huber, R., Smith, K., Delago, A., Isaksson, K., & Kravitz, E. A. (1997). Serotonin and aggressive motivation in crustaceans: Altering the decision to retreat. *Proceedings of the National Academy of Sciences of the United States of America*, *94*(11), 5939–5942.

Johnston, K., Robson, B. J., & Fairweather, P. G. (2011). Trophic positions of omnivores are not always flexible: Evidence from four species of freshwater crayfish. *Austral Ecology*, *36*(3), 269–279. http://doi.org/10.1111/j.1442-9993.2010.02147.x

Lisa Schroeder, & Huber, R. (2001). Fight Strategies Differ with Size and Allometric Growth of Claws in Crayfish, Orconectes rusticus. *Behaviour*, *138*(11/12), 1437–1449.

Martin, A. L., & Moore, P. A. (2007). Field Observations of Agonism in the Crayfish, Orconectes rusticus: Shelter Use in a Natural Environment. *Ethology*, *113*(12), 1192–1201. http://doi.org/10.1111/j.1439-0310.2007.01429.x

Parker, G. A. (1974). Assessment strategy and the evolution of fighting behaviour. *Journal of Theoretical Biology*, *47*(1), 223–243. http://doi.org/10.1016/0022-5193(74)90111-8

Patullo, B. W., Baird, H. P., & Macmillan, D. L. (2009). Altered aggression in different sized groups of crayfish supports a dynamic social behaviour model. *Applied Animal Behaviour Science*, *120*(3–4), 231–237. http://doi.org/10.1016/j.applanim.2009.07.007

Pavey, C. R., & Fielder, D. R. (1996). The influence of size differntial on agonistic behaviour in the freshwater crayfish, Cherax cuspidatus (Decapoda: Parastacidae). *Journal of Zoology*, *238*(3), 445–457. http://doi.org/10.1111/j.1469-7998.1996.tb05405.x

Pecor, K. W., & Hazlett, B. A. (2008). The tradeoff between reproductive and food resources in the crayfish Orconectes virilis. *Marine & Freshwater Behaviour & Physiology*, *41*(4), 273–280. http://doi.org/10.1080/10236240802518834

Peeke, H. V. S., Sippel, J., & Figler, M. H. (1995). Prior Residence Effects in Shelter Defense in Adult Signal Crayfish (Pacifastacus leniusculus (Dana)): Results in Same- and Mixed-Sex Dyads. *Crustaceana*, *68*(7), 873–881.

Rutherford, P. L., Dunham, D. W., & Allison, V. (1995). Winning Agonistic Encounters by Male Crayfish Orconectes rusticus (Girard) (Decapoda, Cambaridae): Chela Size Matters but Chela Symmetry Does Not. *Crustaceana*, *68*(4), 526–529.

Schneider, R. A. Z., Huber, R., & Moore, P. A. (2001). Individual and Status Recognition in the Crayfish, Orconectes rusticus: The Effects of Urine Release on Fight Dynamics. *Behaviour*, *138*(2), 137–153.

Schneider, R. A., Zulandt, Schneider, R. W., S, & Moore, P. A. (1999). Recognition of Dominance Status By Chemoreception in the Red Swamp Crayfish, Procambarus clarkii.

Journal of Chemical Ecology, *25*(4), 781–794. http://doi.org/http://dx.doi.org.ezproxy.gvsu.edu/10.1023/A:1020888532513

Tierney, A. J., Godleski, M. S., & Massanari, J. R. (2000). Comparative Analysis of Agonistic Behavior in Four Crayfish Species. *Journal of Crustacean Biology*, *20*(1), 54–66.

Tierney, A. J., Thompson, C. S., & Dunham, D. W. (1984). Site of Pheromone Reception in the Crayfish Orconectes propinquus (Decapoda, Cambaridae). *Journal of Crustacean Biology*, *4*(4), 554–559. http://doi.org/10.2307/1548069

Yeh, S.-R., Fricke, R. A., & Edwards, D. H. (1996). The effect of social experience on serotonergic modulation of the escape circuit of crayfish. *Science*, *271*(5247), 366+.

Yeh, S.-R., Musolf, B. E., & Edwards, D. H. (1997). Neuronal Adaptations to Changes in the Social Dominance Status of Crayfish. *The Journal of Neuroscience*, *17*(2), 697–708.

Zulandt, T., Zulandt-Schneider, R. A., & Moore, P. A. (2008). Observing agonistic interactions alters subsequent fighting dynamics in the crayfish, Orconectes rusticus. *Animal Behaviour*, *75*(1), 13–20. http://doi.org/10.1016/j.anbehav.2007.04.017