A GEOSPATIAL ANALYSIS OF PRE-COLUMBIAN FLORIDA LOG BOATS

A Thesis

by

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ABSTRACT

Log boats or dugout canoes are the earliest known watercraft in the global archaeological record. In pre-Columbian Florida, dugout canoes were used as early as 6,000 years ago. To date, more than 400 log boats have been recorded from archaeological contexts in Florida. Despite their antiquity and clear importance to indigenous populations, variation in their morphology is not well understood. Established typologies of log boat morphology in pre-Columbian Florida are examined here through geo-statistical analyses. Grouping and cluster analyses were implemented within ESRI ArcGIS in order to build a better understanding of variation in log boat size, form, and location of use. Potential relations were created using available characteristics of individual log boat finds and tested using cluster and outlier analyses. Though some correlations were found, characteristic data remains too incomplete for further interpretation.

DEDICATION

Aos meus pais,

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I would like to thank the Florida Division of Historical Resources for allowing me access to their data and to my committee: Filipe Castro, Cecilia Smith, and David Carlson, for their guidance through the process of completing my master's degree. The work could not have been completed without the unending support from the other students in the department, and special thanks to the OG MS cohort and the Riverside crew for suffering with me. Thanks to Joe, for teaching me to fish, paddle, and spending countless hours plying Florida's waterways and shorelines with me; to Scott, whose own accomplishments always inspire me to do more; and to Elanor for her love and patience. Finally, thank you to my family whose immense sacrifices allowed me to do unconventional things.

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All work for the thesis was completed independently by the student and made possible through access to a log boat database as provided by the state of Florida Division of Historical Resources.

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1. INTRODUCTION

Pre-Columbian Watercraft

Transportation technologies employed in the aquatic landscapes of Pre-Columbian Florida are likely to have varied. Ethnographic literature of Indigenous water craft in the Western Hemisphere provides evidence for several variants.[1][2][3][4][5][6][7][8][9][10][11] In the field of nautical archaeology, watercraft can be divided into three categories based on how buoyancy is achieved: floats, rafts, and boats.[12] Floats, for example, are closed hollow vessels that displace water. A series of them can support a platform where passengers and cargo are carried so long as the weight of the water craft is equal or less than the weight of water displaced by the submerged portion of these hollow vessels.[13] Though the use of this technology as a water craft in itself is scant, what does exist is reference to the use of inflated animal skins, sewn shut at all cavities and made watertight. These floats are used in conjunction with other forms of aquatic technologies

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[1] Meide 1995.
[2] Fleetwood 1996.
[3] Haviland 2012.
[4] Haddon and Hornell 1975.
[5] Charles and Dickinson 1942.
[6] Gamble 2002.
[7] Engelbrecth and Seyfert 1994.
[8] Gould 1968.
[9] Roberts and Shackleton 1983.
[10] Neil 1953.
[11] Kandare 2014.
[12] Hocker and Ward 2004.
[13] Ibid.

such as attached to fishing nets, harpoons, or other vessels for added stability.[14] Rafts are made of materials that are less dense than water and so contain their own reserve floatation. These materials, usually reeds and logs, are lashed together creating a platform for carrying people and cargo. An expedition led by Bartolome Ruiz in 1526 sailing south along the Western coast of South America encountered one of these rafts.[15] Chroniclers present during the voyage described this vessel as laden with 20 men and made of two decks of balsa wood logs, fastened together with plant fiber cordage and propelled by sail. As the waves soaked the first deck of this vessel, the top deck kept its reported 35 ton carrying capacity dry.[16] Rafts of this type were said to have successfully navigated the coastal waters partially due to the ability of water from large waves to wash through the deck.[17] They have also been attributed to trade routes of luxury goods and technologies such as metallurgy throughout the tropical regions of present day Central and South America.[18] Finally, boats are open and hollow vessels which also displace water, but whose operational load is supported from inside the hull. On the northeast coast of North America, indigenous boats begun as wooden frames that were then sealed with birch bark.[19] In the Arctic, animal skins replace birch bark, and were stretched tight across these wooden or bone frames creating the umiak and kayak.[20]

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[14] Boas 1964.
[15] Xerez 2013.
[16] Ibid.
[17] Ibid.
[18] Dewan and Hosler 2008.
[19] Adney and Chapelle 1964.
[20] Ibid.

Elsewhere in the hemisphere, and the world, boats were created through the hollowing, often with fire, of a single log. These vessels, coined log boats or dugout canoes are the earliest known watercraft in the global archaeological record.[21][22][23][24][25][26][27][28] The oldest of these vessels span several continents. In 1955, a dugout canoe was found in Pesse, Netherlands dating to 7510 BC. It was carved from a single pine log and was 298 cm long and 44 cm wide, with bone and stone tool marks present in the hollow[29]. A dugout canoe discovered in 1987 near the town of Dufuna in Nigeria has been dated to 6550 BC[30]. Though not a canoe, in Starr Carr, England, an artifact identified as a canoe paddle was dated to 8500 BC[31]. These types of vessels are the only watercraft that have survived in the archaeological record of Pre-Columbian Florida[32]. In 2000, a drought in central Florida dried the waters of Lake Newnan exposing hundreds of dugout canoes, one of which was dated to 6050 BP +/- 60.[33][34][35] The absence of variety in the archaeological record despite ethnographic accounts, as well as possibly the absence of older watercraft is likely due to artifact preservation

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[21] Leshikar 1996.
[22] Kandare 1983.
[23] Arnold et al. 1995.
[24] Rogers 1965.
[25] Hornell 1928.
[26] Hornell 1920.
[27] Hornell 1919.
[28] Meide 1995.
[29] Johnstone 1988.
[30] Garba 1996.
[31] Johnstone 1988.
[3232] Wheeler 1998.
[33] Wheeler et al. 2003.
[34] Ruhl 2001.
[35] Purdy and Ruhl 2005.

issues. Rafts and floats are made of component parts that are easily disassembled and repurposed, possibly into new water craft or other structures, where the varying use life of component parts results in an unidentifiable discard pattern. The very nature of rafts render their existence ephemeral as the portions providing the craft floatation will become water logged and need replacing. Even the dugout canoe, through use and exposure cannot maintain its original function in perpetuity. At this point and perhaps before, it must be repurposed or discarded in environments often unfavorable for preservation. Hartmann, in his 1996 thesis on dugout canoes, comments that many archaeological canoes had been repurposed by farmers both contemporary and in the historical period as feed troughs for their animals.[36] Despite issues of preservation, the amount of Pre-Columbian watercraft in Florida number in the hundreds.

Scope of Work

Jeanne Arnold uses the development of watercraft on the northwestern coast of North America to explore broader topics on the development of sociopolitical complexity.[37] In her analysis she stresses how "analyses must illuminate linkages between elites and producers of the technology, determine the spatial distribution of production, and establish who used the technology and how it was used."[38] For reasons discussed later in this section, this approach lends itself very well to the analysis of

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[36] Hartmann 1996.
[37] Arnold 1995.
[38] Arnold 1995, 734.

Florida's peculiar archaeological record where standard metrics applied to the east coast of North America do not apply. Despite the plethora of data available on archaeological dugout canoes, little work has been done to determine spatial distribution of canoe types. Typologies for Pre-Columbian dugout canoes carried out in Florida have focused on vague characteristics and lack any cultural or geographic affinities to assigned types. This exercise uses Geographic Information Systems (GIS) to analyze various data sets, consisting of location data and observable characteristics for these artifacts, in an attempt to identify statistically relevant similarities and potential groups within the known archaeological examples of Pre-Columbian log boats in Florida.

The remainder of this introductory section provides brief backgrounds on various other topics relevant to the discussion of dugout canoes. This consists of a brief natural history of the study area, discussion on Pre-Columbian subsistence strategies in Florida, current theories on Floridian cultural chronology, examining social complexity on the east coast of North America, and finally, a brief discussion of the present state of research. The second section will discuss the origin and contents of the database, and methodological considerations for the analyses. This section will include the process and justification of subsampling as well as the procedure and work flow used to complete the analyses in GIS. The third section presents the results in the form of attribute tables and maps identifying statistically relevant groupings of artifacts and their geographic and cultural ranges. The final section includes a discussion of the findings, their implication and relevance to future interpretations of Florida's archaeological record, as well as limitations to the conducted study and considerations for continuation of the research.

Natural History of Florida

As this thesis focuses on human interaction with the environment, the discussion of Florida's ecological history will begin with the earliest sign of the areas occupation by humans. A recent publication by a team working at the Page Ladson site, in a deep pocket of the Aucilla River, has identified processed mammoth remains and associated cultural material dating back 14,550 years ago to the late Pleistocene.[39] The discovery shows that since then, and likely earlier, humans in what is now Florida have been exploiting the vast and varied aquatic environments therein. Today Florida is just over 170,000 square km, bound by 2170 km of coast line, and rests on a limestone bed created by the death and accumulation of marine organisms in previous geological epochs. It holds over 30,000 lakes connected by hundreds of rivers, canals, and vast wetland areas. Its humid sub-tropical environment is home to an array of ecosystems. The southern tip is dominated by the tropical flora common to the circum-Caribbean. The north supports the southernmost limit of many of North America's deciduous species. The remainder is covered in temperate forest or low lying scrubland.[40] Florida was a very different place 14,550 years ago. The end of the Pleistocene corresponds to

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[39] Halligan et al. 2016.
[40] Watts and Hansen 1994.

Earth's last period of glaciation and dates to about 12,000 years ago, 2,500 years after the earliest evidence for human occupation in the area. Lowered sea levels pulled the western coastline over 100km further out, near doubling the amount of dry land.[41] The Aucilla River was not a river, and the Page Ladson site was a limestone sinkhole filled by rain and ground water. These sinkholes were one of the few places that collected fresh water and so drew the attention of Pleistocene megafauna such as the mammoth found at Page Ladson.

Pollen analyses of cores taken around the south eastern United States have illuminated our understanding of Florida's paleoecology.[42] The presence and absence of certain species can indicate relative levels of temperature and available water in an environment. In a pollen sample from the Georgia coastal plain representing 13,000 to 11,000 years ago (ka), at the close of the Pleistocene, pollen signatures indicate that the southeast was an open grassland with occasional tree stands.[43] Decreasing amounts of fir and spruce pollen over time coincide with warming temperatures. The inverse relation of oak and pine pollen count is often used to determine moisture levels, the dominance of the former indicating more available water.[44] The pollen record shows a decrease in pine from 39% - 7% and an increase in oak from 12 – 24% over the represented span of time. The increased presence of mosses also indicates increasingly

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[41] Milanich 1994.
[42] LaMoreaux et al. 2009; Watts and Hansen 1994.
[43] LaMoreaux et al. 2009.
[44] Ibid.

wetter climates. Note that increased water availability can be due to factors other than increased precipitation, such as lower rates of water loss to the atmosphere from evaporation, as was the case in Pleistocene Florida's open grassland. The early to mid-Holocene is captured in pollen samples representing 11 to 4.5 ka. By 8 ka, the rising sea level submerged a large coastal area around the Florida peninsula, and the water table began to fill the basins that feed modern day lakes and rivers.[45] Decreases in pine and increases in oak continued, while fir disappeared from the record, further suggesting a continuation in this trend towards a warmer and wetter climate.[46] The pollen samples for this time range were extracted from an area comprised of peat muck and layers of sediment. The appearance of peat requires a higher level of heat and humidity that allows for organic decay, and sedimentation is evidence of occasional periods of flooding often due to increased precipitation. Higher pollen densities in this sample also indicate denser vegetation, though there is a change in pollen dominance from grasses and mosses to mesic tree species such as tupelo, willow, and dogwood.[47] Finally the later portion of the Holocene was assessed in a sample representing 4.5 ka to the present. During this time, conditions approached those of modern day. Florida remains warm and moist, though not to the degree found during the early to mid-Holocene. This is assessed again through the comparison of pine and oak pollen presence. An increase in

[45] Ibid.
[46] Ibid.
[47] Ibid.

charcoal indicates drier conditions, but could also result from increased human activities during this time.[48]

Cultural Chronologies

The first group of humans known to have occupied the area is referred to as Paleo-Indians. It is important to note that archaeological cultures, especially when the time period under study precludes the use of ethnography, are distinct and likely very different from any real cultures that may have lived and identified themselves as such. Archaeological cultures are an organizational convenience based on groupings of material assemblage or "tool kits". Discoveries of Paleo-Indian artifact assemblages in Florida have been most popularly contextualized by the Oases theory, devised by Wilfred T. Neil in the 1960's.[49] The Oases theory stresses the importance of these limited fresh water sources to the survival of animals that Paleo-Indians in turn depended on. Following this rationalization, Paleo-Indian sites would be found in areas in the proximity of rivers and lakes: the now submerged locations of Pleistocene watering holes. Pleistocene animal remains have been found in association with human remains and cultural material in several sink holes in Florida, such as Warm Mineral Springs and the Cutler Fossil Site. The Paleo-Indian tool kit was adapted for killing and processing large Pleistocene game at these watering holes. This is also reflected in the presence of

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[48] Watts and Hansen 1994.
[49] Milanich 1994.

large lanceolate stone bifaces such as the Suwannee, Simpson, and Clovis point.[50] The Clovis point is the most commonly found and widely distributed point type among early occupation sites throughout North America.[51] These large stone points were typically hafted to a short fore shaft made of ivory. The fore shaft was then fit into a slot in a longer wooden shaft. This configuration allows an individual in possession of several hafted points to employ a spear with reloadable stone tips. The tool kit also contains a variety of bone and wood tools including wooden mortars, double sided bone pins, and modified fossil shark teeth.[52] The more extensive distribution of later period Paleo-Indian assemblages indicate an increase in viable hunting areas, likely due to a rising number of water sources. During the end of the Paleo-Indian period, and coinciding with the extinction of Pleistocene Megafauna, large lanceolate points disappear from the Paleo-Indian tool kit and are replaced by smaller stone points, which are intermediary to those used in the ensuing Archaic period.[53]

While there is general agreement regarding the starting and ending points of the Archaic period, scholars disagree on the subdivisions of this broad time period. Often the appearance of a new technology will provide a marker for scholars to differentiate archaeological groups. In this case Purdy divides the Archaic period into Pre-Ceramic and Ceramic periods.[54] Bullen uses four pre-ceramic periods and two post-Ceramic

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[50] Ibid.
[51] Smith 2010.
[52] Milanich 1994.
[53] Ibid.
[54] Purdy 1981.

periods.[55] A more recent classification incorporating multiple lines of data and a focus on adaptation to environmental changes, is Milanich's division of Early, Middle, and Late Archaic periods[56] which reflects Bense's generalized chronology for the south eastern United States.[57] In this schema the early Archaic period begins about 10 ka, when the lanceolate stone points of the Paleo-Indian period disappear from the archaeological record.[58] Early Archaic assemblages overlying late Pleistocene levels show a comparatively wider variety of tool types employed, as well as a preference for stemmed bases in points and knives (Arredondo point, Hamilton point, Kirk point). This coincides with the transition to wetter conditions and less reliability on the Pleistocene megafauna, which were in route to extinction. As water sources increased in size, number, and reliability, Archaic peoples could support larger and occasionally sedentary populations, as demonstrated by a more widespread distribution and a greater number of Archaic sites.[59] The adoption of sedentism allowed for new behaviors, such as burial rituals, to appear more clearly in the archaeological record. For example, at the Windover site (6 to 5 ka) near the central Atlantic coast of Florida, 168 individuals were wrapped in sheets of fabric and staked to the peat bottom of a shallow pond.[60] The location and dating of remains suggest five discrete episodes over a period of about a thousand years.

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[55] Bullen 1975.
[56] Milanich 1994.
[57] Bense 1994.
[58] Milanich 1994; Bense 1994.
[59] Milanich 1994.
[60] Bense 1994.

The Middle Archaic period is relatively brief, lasting from about 7 to 5 ka.[61] By the end of the Middle Archaic period environmental conditions settled nearer to their current arrangement. The assemblage associated with Middle Archaic sites consists of an increase in the fire hardening of stone and the production of stone point types that are significantly wider (Newnan point) than previously seen.[62] Archaeologists working at Harney flats were able to neatly isolate this assemblage above Early Archaic levels.[63] Newnan points associated with burials resembling those at the Windover site are present at the Little Salt Spring and Tick Island sites. The first sites associated with shell middens appear at this time, though it is possible that earlier and older shell midden sites remain buried by newer accumulations, or submerged in the Gulf of Mexico by the post-glacial rising sea levels. Wood working tools considered too large and cumbersome for transport also appear in the record during the Middle Archaic period along with the oldest recorded dugout canoe in Florida.[64]

Finally, the Late Archaic period ranges from 5 to 2.5 ka, and includes the appearance of ceramic technologies in Florida at about 4 ka.[65] Milanich points out that lifeways before and after the appearance of ceramic technology remain generally unchanged. In a shell mound just north of the Windover site, where both pre-ceramic and later Archaic levels are present, no difference is found between the pre-ceramic Mount Taylor culture and the Orange period levels above, except the presence of fiber

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[61] Milanich 1994.
[62] Ibid.
[63] Ibid.
[64] Ibid.
[65] Ibid.

tempered ceramics.[66] These Late Archaic sites are found along the northeastern and southwestern coasts of Florida, as well as in interior wetland areas. For Milanich, the designation of Late Archaic is not based on artifact assemblage but on demographics, or the increased size and density of sites associated with this period.[67] The absence of Late Archaic sites in other parts of the coast is likely due to our inability to see or access inundated sites. In comparison, when Late Archaic ceramics are present in sites located in interior forest areas, they are small scatters, or associated with debris from mixed time periods.[68] By 2.5 ka adaptation to local environments had markedly influenced a regionalization of material culture assemblages. The end of the Archaic period coincides closely with the start of a larger cultural organization scheme called the Woodland stage.[69]

The Woodland stage spans from about 3 to 1 ka and is also subdivided into early, middle, and late periods. At this point the southeast population had divided into several different societies, which passed through facets of the Woodland stage in their own time, and so these subdivisions are another example of organizational convenience.[70] The start of the Early Woodland period coincided with the diffusion of ceramic technology from the Atlantic Coastal Plain to the surrounding regions of southeastern North America. During this time ceramic technologies saw not only a spread in use but also many refinements to the manufacturing process. These refinements include deviance

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[66] Ibid.
[67] Ibid.
[68] Ibid.
[69] Bense 1994.
[70] Ibid.

from traditional fiber based tempers, and the technique of stacking and paddle welding coils. Mortuary patterns in the early period are similar to those found in the Archaic period. The widespread adoption of the Hopewellian ceremonial complex by various groups in the southeast marks the Middle Woodland period. Named after the Hopewell type culture in Ohio, this complex manifests in the construction of highly involved funerary centers, consisting of several mounds surrounded by geometric earthworks.[71] The construction of these centers requires a significantly larger investment of labor compared to burials of earlier periods. The centers housed separate areas for different stages of pre-interment processes, and caches of likely grave goods acquired from across the continent.[72] Throughout the southeast, regional identities preserved though a shared mortuary culture are evident in the pervasiveness of these funerary centers and associated burial goods. The Hopewellian mortuary behaviors disappear from the archaeological record in the south about 1.5 ka, a century or so later than in its Midwestern origins.[73] The abandonment of elaborate mortuary customs marks the beginning of the Late Woodland stage. The loss of a shared ideological framework caused general trade and interaction among the societies of the southeast to diminish during this period. While mounds continued to be built, their style and purpose shifted from conical burial mounds to platform mounds used for sociopolitical purposes.[74] It

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[71] Ibid.
[72] Ibid.
[73] Ibid.
[74] Ibid.

was also during this time that the bow and arrow was introduced to the region, resulting in decreased size of stone points and a change in subsistence strategies.[75][76]

The final Pre-Columbian organizational period in the southeast is called the Mississippian stage, named after the valley where the period's identifying elements were first recognized. Though Woodland characteristics persevered in south Florida, by 1 ka the rest of the southeast had adopted Mississippian traits, such as shell tempered pottery, maize agriculture, and the Southern Ceremonial Complex.[77] Despite shared cultural complexes, maintained regionality continued as it did in the Woodland period. These regional differences are typically divided down two lines, a riverine and a coastal pattern, where the coastal pattern is less dependent on cultivated foods, likely due to poorer soils on the coast, as opposed to riverine flood plains and a larger availability of marine resources.[78] Both patterns emphasize the creation of food surpluses to sustain simple chiefdoms where one kin group held political control over several groups. Notwithstanding regionality, the pervasive characteristic of chiefdoms is institutionalized social inequality, visible in mortuary and settlement hierarchy.[79] The size of these chiefdoms was initially inhibited by the time it took to travel to the ceremonial center, to pay tribute to the elite. Later in the Mississippian period complex chiefdoms would arise, creating subservient chiefdoms and a multi-tier tribute system. These chiefdoms required an even larger surplus of food and so were confined to areas

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[75] Milanich 1994; Bense 1994.
[76] Byrd 1997.
[77] Bense 1994.
[78] Ibid.
[79] Ibid.

that could support that level of production, such as the riverine pattern Mississippians. These complex chiefdoms usually began with a sharp but temporary increase in ceremonialism. This is possibly due to the need for a ruling elite to establish dominance over the lower tier subservient elite, as the ties between these groups were not necessarily familial. The Mississippian period shared a system of ceremony and iconography known as the Southeastern Ceremonial Complex, or Southern Cult, likely developed from earlier Woodland complexes.[80] Rituals and symbols associated with the Southern Cult remained in part throughout the southeast into the period of European contact, but diminished in its sociopolitical role as more secular methods for maintaining social inequality were emphasized.[81] At the close of the Mississippian period it is hypothesized that a tumultuous period of warfare and political instability caused the breakdown of many complex chiefdoms. Some groups were reorganized into simpler chiefdoms, while others seem to have disbanded completely. Others still relocated from spread out individual farmsteads to walled settlements, likely due to the threat of violence from political instability, leaving many previously occupied portions of southeastern North America vacant.[82]

[80] Ibid.
[81] Ibid.
[82] Ibid.

Subsistence Reconstruction

As previously discussed, the Oases theory emphasizes limited water resources in the location of Paleo-Indian sites. The presence of scattered water-bearing sink holes is dependent on the assumption that water tables at the time were significantly lower than today. An opposing theory proposed by Ben Waller suggests a water table closer to present day levels, where natural game trails involved river crossings at shallower locations.[83] Paleo-Indians would then target game at these crossing points where the water, though traversable, would impede speed and restricted movement. Recent paleoecological studies have revealed that both theories are not exclusive, as climate transitions in the Paleo-Indian period were less gradual and more undulating.[84] In contrast is the idea that Paleo-Indians were not involved in the high risk activity of hunting Pleistocene megafauna, and were more reliant on smaller game, like their descendants. Again, it is more likely that both scenarios played a part in Paleo-Indian subsistence, and Dunbar and others have lamented the want of zoological evidence necessary to affirm a position on subsistence predilection.[85]

The Archaic period marks the arrival of log boats in the archaeological record as climactic conditions could more consistently enable wetter inland environments. Pleistocene megafauna was no longer an available resource for the peninsula's inhabitants.[86] The superb preservation conditions at the Windover pond site in northeast

[83] Dunbar 2016.
[84] Ibid.
[85] Ibid.
[86] Russo et al. 1992.

Florida allowed for a combination of analyses to test the presumption that this period saw a rise in aquatic resource use.[87] Faunal, archaeobotanical, and carbon isotope analyses on 32 individuals were combined to provide a holistic interpretation of Archaic subsistence. The isotope data shows a diet not only void of marine resources, but also one with few traces of classic terrestrial fauna such as deer and rabbit. Values support an interpretation of a riverine and marsh oriented diet, where meat is derived from water fowl, turtles, and small fish, supplemented by the harvesting of a wide variety of plant resources.[88] Over 30 species of edible plants were discovered in the Windover deposits, 13 of them found in samples directly associated with human remains. The study provides solid data to illuminate the long held contention that aquatic resources could only be secondary to food means such as agriculture or larger terrestrial game.[89]

Comparative isotopic studies have been performed on various sites along the gulf coast of Florida.[90] In this region there is more reliance on terrestrial fauna by Archaic peoples compared to the riverine based inhabitants of Windover pond as well as the presence of isotopic markers signifying marine food sources. Plant use compared to Windover is very similar and includes many of the same key species, such as prickly pear and saw palmetto. Over time, and especially in the Calusa culture region to the south, traces of terrestrial food resources become negligible as marine resource use increased.[91] This intensification of marine resource use by the Calusa was possibly due

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[87] Tuross et al. 2009.
[88] Ibid.
[89] Ibid.
[90] Hutchinson et al. 2016.
[91] Ibid.

to the coastal geography of their occupation. The Calusa inhabited a region now known as the Ten Thousand Islands, a chain of small islands and submerged mangrove forests. Research elsewhere has shown the importance of small islands to supporting population growth. Though not capable of sustaining a population in or on itself, chains of small islands create a maritime landscape with an ideal distribution of resources for short term extraction periods.[92]

In 1982, an excavation at Fort Center on the west coast of Lake Okeechobee identified maize pollen in deposits dating to 3 ka.[93] Associated with the maize pollen were large circular earth works and mounds hypothesized to be agricultural fields with drainage features. This discovery predated the earliest maize found in northern Florida and fueled speculation of circum-Caribbean routes for the introduction of agriculture to the peninsula.[94] Research in the last five years has proven this initial finding incorrect.[95] The identified maize grains from the initial excavation were either a misidentified grass or a contaminant from a much later historical occupation of the site by the US armed forces, during the Seminole Wars. Local ecological differences played a large part in subsistence preferences and specialization in pre-Columbian Florida, though agriculture was not one of these preferences. Isotopic studies comparing populations across southeastern North America have shown that even by the Mississippian period, when the majority of both coastal and inland occupants in modern Georgia had adopted some form

[92] Keegan et al. 2008.
[93] Thompson et al. 2013.
[94] Ibid.
[95] Ibid.

of maize agriculture, this practice did not become a part of the archaeological record of Florida until after European contact. This same study shows not only the effect of the Spanish mission in steering indigenous groups towards agriculture based subsistence, but also in the spread of an overall homogeneity of subsistence patterns across the peninsula.[96]

Social Complexity

The movements of pre-Columbians towards larger and more hierarchically divided societies are often labeled an increase in social complexity. Whatever the outcome, and despite the resources available, a creation of food surplus to fuel larger populations and tribute systems was necessary for these processes. A long-standing idea that agriculture was absolutely necessary to create this surplus likely influenced the eager misidentification at Fort Center. This preconception would also inhibit interpretations of pre-Columbian Florida, where the absence of agriculture would incorrectly rule out the possibility of more complex modes of cultural organization. As discussed prior, examination of various avenues of evidence has ruled out the presence of agriculture in Florida's pre-Columbian period despite the evidence of classical markers of social complexity.[97] This surplus growth would have been supported instead by the intensification of the exploitation of aquatic resources, as seen in the isotopic data

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[96] Hutchinson et al. 1998.
[97] Hutchinson et al. 1998.

from Gulf Coast. There is a clear connection between the adoption of dugout canoes and the intensification of the exploitation of aquatic resources. Researchers on the west coast of North America studying the transition of coastal hunter-gatherers into maritime peoples have tied innovation in aquatic transportation technologies to developments in social complexity. The Chumash employed plank canoes averaging seven meters in length, called Tomols in both net and deep-sea fishing operations, as well as hunting seals and cetaceans.[98][99][100] The Nootkan made different log boats for whaling expeditions, transporting cargo, and war. Both these peoples operated in environments with abundant marine resources of limited accessibility from shore.[101] These innovations allowed for resources spread across a wide area to be collected and consolidated in one place, creating a surplus that supported larger populations. Unequal access to ownership or use of these watercrafts institutionalized inequality, developing a social hierarchy and creating inherent conflicts. The watercraft is also related to the issue of tribute center distance, fostering the development of complex chiefdoms by lessening travel time to existing tribute centers, and allowing for a wider range of tribute areas.[102][103][104] The development of watercraft opened up new avenues for long distance exchange while creating job specializations, such as those based on boat building and

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[98] Arnold 2007.
[99] Richie and Hager 1973.
[100] Arnold 1995.
[101] Ibid.
[102] Blanchard 1999
[103] Fitzpatrick 2013.
[104] Blanchard 2002

trader skills.[105][106] Unless access to the technology is limited, however, there is no opportunity to create power structures through the manipulation of exchange. In a cultural environment where equal access to watercraft was given to every member of a community there should be no expectation that the innovation would induce the creation of social hierarchy.[107] This west coast comparison is both illuminating and reaffirms the importance in studying Florida's pre-Columbian dugout canoes for the overall interpretation of the peninsula's pre-Columbian history. It also reiterates the importance of identifying zones of production and use for these technologies, in order to more accurately describe the relationships that enabled these social changes. One attempt at this is the creation of typologies to identify sub-categories within the assemblage of pre-Columbian watercraft, and assign them cultural, geographic, or temporal designations.

State of Research

In the 1980s dugout canoes were being found at a rate of one or more reported a month. Newsom and Purdy remark that possibly hundreds more have been lost without ever having been reported. By 1990, over 200 dugout canoes had been recorded by the state of Florida, and in September of that year researchers published an article titled "Florida Canoes: A Maritime Heritage from the Past". In the article Newson and Purdy established a typology for Florida dugout canoes based on several morphological

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[105] Wheeler 1995.
[106] Arnold 1995.
[107] Ibid.

characteristics that replaced older typologies described vaguely and in relative terminology.[108][109][110][111][112] Their typology remains dominant in the region, it is still used in many recording strategies, and is organized as follows:

Type 1. This first type is meant to include the earliest canoes. Its representatives have roughly hewn blunt edges with identical bow and stern areas. The surfaces are unmodified, and in some areas traces of the original bark are still present. The canoes are made through the process of fire hollowing, where charred surfaces are then scraped away using stone and shell adzes. Further in the manufacturing process wet mud was used to prevent further burning of select areas. In some places the charred surface remains visible. Purdy describes them as crude.

Type 2. The second type coexists and later replaces the first type. At the time of the typologies inception, it was the most common type of the dugout canoes recorded. While fire hollowing remains the method for constructing these watercraft, the extent of finishing far surpasses that of Type 1. Not only are outside surfaces and the inner hollow cavity thoroughly finished, but attempts have been made to shape the bow and stern to bevel upward slightly. Both types 1 and 2 are rarely reported in coastal areas, and are more likely found in inland riverine and lake environments.

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[108] Bullen and Brooks 1968.
[109] Dreves 1979.
[110] Pittman and Lipe 1972.
[111] VonBurger 1972.
[112] Newsom and Purdy 1990.

Type 3. The third variation of dugout canoe is also known to coexist with the first two. Type 3 is similar in construction to Type 2 but is fabricated with a prominent extending platform that overhangs the forewordmost point of contact with the water. Below this overhanging platform bow, the hull is often carved in to a V shape. These modifications are hypothesized to have been useful in navigating rougher sections of water.

Type 4. The Type 4 canoes are also very similar in construction to Type 2, the difference being in the adoption of metal tools by the canoe manufacturers. Fire hollowing signs are not always present, though this could indicate that either metal allowed for the complete removal of charred surface or that metal allowed for the de emphases of the burning portion of the manufacturing process, or both. These metal tools left squared gouges and edged surfaces in the wood, as opposed to the circular marks left by stone and shell.

Type 5. Included in this type are composite craft, like the double hulled catamaran reported by early Europeans exploring the peninsula. Archaeological remnants of this type include dugout canoes with drilled holes strategically placed along the gunwales likely for lashing the center platforms as well as a toy model of a catamaran that has been found in Key Marco. Also included are several dugout canoes that appear to be halved and hollowed logs whose sides are then lashed together using a system of cleats. These halved canoes are sometimes expanded with the addition of planks in between the halves. Many of this latter variety of composite craft show signs of metal tool use.

Type 6. The final group in the Purdy and Newsom typology is designated for historic period Seminole canoes. These watercraft are primarily made of cypress, Taxodium distichum, over the more typically utilized pine, Pinus resinosa. They are wider and slightly elevated at the bow and narrow towards the stern. Some of these canoes contain fore and/or aft keels carved out of the single log, and others contain the platforms indicative of Type 3. The construction of the Type 6 Seminole canoe employs an interesting practice to track hull thickness. Gauge holes are drilled along the center line of the log boat during hollowing. After the desired thickness is achieved, the gauge holes are repaired with wooden dowels, which will swell when wet. A number of these canoes also contained extra structural elements such as mast steps or seating thwarts.

In his 1996 dissertation, Mark Hartmann explored the topic of pre-Columbian Florida dugout canoes and critiqued the lack of directive towards placing these artifacts in their proper chronological and cultural context, or acknowledging the non-static nature of both chronological and cultural characteristics in a larger systemic context of use and reuse.[113] The study unfortunately does not go further than pleading the case for this artifact's importance to archaeological interpretations. A 2005 dissertation by Jessica Curci attempted to answer these questions about log boat form. In her work, Curci performs several statistical operations on characteristics of a sample of canoes ranging the entirety of the southeast. She does so primarily in order to test the hypothesis that environment would dictate log boat morphology and be represented in

[113] Hartmann 1996.

the species of wood selected for the log boats construction. Although her work did not return any statistically significant results in this regard, it was a good opening in the discussion of possible ways to approach the problem, especially regarding the application of multi-variate statistics to these data sets.[114]

[114] Curci 2006.

2. DATASET AND METHODOLOGY

Dataset and Management Plan

Access to a log boat database maintained by the Florida Division of Historical Resources was granted to the researcher in 2016. The database consists of over 419 individual entries for log boats recorded in the state of Florida. It is the product of consolidating a large collection of non-standardized reports regarding log boat finds, so there is high variability in the type of information available and how it was presented. Each entry begins with a unique identification number given to every canoe entered in the database. This is then followed by fields for noting details of the find. These include the site ID number and name as well as the environment type for where the water craft was located. The date of discovery, as well as identifying information for the person who reported the craft, the person who recorded the craft, and the agency that is responsible for the stewardship of the log boat follows. Tentative cultural affiliations and associated artifacts are included with some entries. Wood identifications and type of manufacturing marks are also provided as well as radio carbon dates, the latter in an array of formats and calibrations. The percentage of the vessel still intact is estimated as well as a description of which portion of the vessel remains.

Morphometric attributes are specified numerically with measures of maximum length, width, height, inside depth, and side and bottom thickness are provided. Girth measurements for bow and stern are also provided but with no indication of how far along the vessel's length the measurements were taken. Morphological characteristics for the log boats, however, were provided in several fields that made clear the non-standardized nature of the database's constituent reports. A category labelled 'Squared Off' refers to the presence or absence of sharp angles along the edges of the vessel, typically indicative of the presence of metal tools. The database, conversely, often contains information regarding the shape of the bow and stern in this category. Similar data is found in inconsistent specificity associated with a category labelled 'Shape Description'. A category is also present for data relating the shape of the vessels inner hollow at the bow and stern. A true or false designation is given for the presence of overhanging platforms as seen in Newsom and Purdy's Type 3 log boat, as well as sections for providing the lengths of any platforms present. Most informative of the morphological categories are sections for plan and cross section descriptions of the bow and stern. Unfortunately the majority of these categories are populated with blank values, or with descriptions too vague to ascertain intended representation of vessel form. Consolidation of these varied descriptions into a data sample suitable for statistical manipulation was considered but was deemed overly speculative without access to the original reports. Other categories are present such as the presence of thwarts or gauge holes but are likewise also filled with mostly blank values. Though also an available category, disappointingly few entries had been assigned a Newsom Purdy type, though this could be a hesitation of the recorder due to the inherent shortcomings of current log boat typology.

Accompanying the characteristic driven database is a GIS file containing the unique log boat ID numbers and coordinates for the locations of their discovery. Not all vessels represented in the database had location data available for them, as several log boats were reported some time past the date of initial discovery, after they had been potentially moved from their original location of deposition. At the request of the Florida Division of Historical Resources, all specific location data for individual canoes, such as the GIS coordinates have been removed from database representations in this manuscript. All figures such as maps including possible location data for canoes will be presented in such a way as to provide only very general regional information.

Addressing Absent Data

Due to the large quantity of missing values in the database, actions needed to be taken in order to ensure proper samples were used in the analyses. The already fragmentary nature of the archaeological record is partly to blame. Specimens can also be recorded incorrectly or not recorded at all, or as is the case here, data can be missing because data from multiple projects using varying recording methodologies are being combined. There are many ways to address this issue, one is to subsample information, and another is to impute the missing values, or replace them with estimations. Imputation is acceptable to a certain extent but the more imputation is done, the less reliable are any associations made with the data. An arbitrary limit was established to exclude entries that had more than 25% missing values per characteristic. This meant subsampling from the original database was necessary and necessitated creating several subsamples with varying numbers of associated characteristics to include in an analyses.

The first subsample was generated based on the degree to which the log boat was intact. The morphometric characteristics such as length and width, had the most complete set of entries and so were initially targeted as being characteristics of interest for analyses. It was reasoned that only the more complete canoes be included in the analyses, as morphometric measures for fragmentary specimens would highly skew the interpretation. Culling all entries recorded as less than 75% intact brought the sample number from 419 available log boats in the database to 145 considered for the study. The next step in creating subsamples appropriate for this analysis was to identify the entries that did not have associated location data in the GIS file and eliminate them from the study sample. These deletions further reduced the vessel count to 105 log boats. Next, entries were removed that were missing values for both length and width characteristics. Imputing values for both characteristics in a single entry would be far too speculative. After these initial refinements, the dataset used for this analysis included 97 individual entries for log boats over 75% intact, with corresponding GIS data, and with either a length or a width measurement available.

This data set of 97 entries is missing 12 values for width and one value for length. There are two ways of addressing this issue. The first is list wise deletion, where all entries that are missing a value for either length or width are removed from the data set. A data set containing all canoes over 75% intact, with associated GIS data, and with no imputation of missing values was created. This data set contains 84 entries and is the first subsample for analyses. The second option for addressing the missing values is imputation. There are several ways of accomplishing these substitutions. One approach is to replace missing values with a random selection from the pool of already recorded values for the characteristic. Alternately the mean or median of these data pools can be utilized. Another option involves the assumption that there are connections among the data that would allow the researcher to make a more informed decision about value substitutions. Missing values are instead replaced with values from targeted single donors deemed most similar to the entry requiring imputation by any number of assigned characteristics. In practice this means sorting the data by a chosen characteristic to create an ordered list, often called 'hot decking'.[115] Missing values are then assigned the preceding value, a procedure also known as 'last observation carried forward' or LOCF. In this case, the 97 entries were sorted in ascending order by length, and the 12 missing values for width were imputed using LOCF. The same entries were then sorted in ascending order by width, and the one missing length value was replaced in the same manner. This provides a second subsample of 97 entries with complete, but imputed values for length and width, allowing comparison of different effects of imputation and deletion on the analyses. The third subsample adds information regarding the body of water associated with the canoes location to the first sub sample of 84 entries. This is the first instance of categorical data being incorporated into the study sample and includes lakes, ponds, swamps, rivers, creeks, salt water shores, and peat bogs. Only one value was missing for this data and so was imputed using an ascending height hot deck and LOCF procedure like what was done for the second subsample. The fourth

[115] Sullivan and Andride 2015.

subsample includes data for the presence or absence of platforms at the bow and or stern. These platforms are the ones Newson and Purdy use to distinguish their Type 3 log boat. Unfortunately, this characteristic was rarely accounted for, so the subsample for these variables consist of 27 entries. The final dataset used for analyses takes the first sub sample and removes entries that do not include associated radiocarbon dates. In the original database, several columns were available for recording dating information, including conventional ages and various calibration methods. The columns were filled in inconsistently, both in the presence and presentation of values, so the reported conventional ages were used as they were the most consistent and clearly inputted age data. Entries from the first sub sample that also included a recorded conventional age numbered 52.

To review, five different subsamples were created from the original database to be separately analyzed in a GIS. All subsamples are comprised of log boats that were recorded to be over 75% intact, contain associated location data, and have either a length or a width value present. The first consist of 84 log boats have a complete set of length and width data that was achieved through list wise deletion of entries with missing variables. The second subsample imputes missing values for 12 widths and one length to provide a set of data with 97 entries. The third set of data incorporates associated water type with the first sub sample of 84 entries. The fourth subsample adds data regarding the presence or absence of platforms on the canoe to the previous subsample containing water type data, further reducing the amount of entries to 27 log boats. The final sample of 52 log boats introduces the available radiocarbon data to the third subsample. Each subsample was taken through grouping and cluster analyses operations in ArcGIS in an attempt to elucidate relationships between log boat form and their spatial and temporal contexts.

GIS in Archaeology

The use of Geographical Information Systems (GIS), a technology for the multi-variate analysis of spatial data has seen wide spread deployment in the field of archaeology. Research involving the use of GIS dates to at least the 1970's where Mississippi State University researchers published on the use of remote sensing technologies in the identification of archaeological sites.[116] The research was carried out by a professor of forestry and a student of anthropology with the goal of explaining site distribution as an effect of environmental and cultural variables. NASA provided aerial photographs of known sites taken on infrared color film, and visual examinations were performed on the images in an attempt to create a field testable model of identifying areas of high archaeological probability. By 1988, articles about GIS use in archaeology were sure to specify "digital" in their methodologies and at the time of writing, technology has progressed to the point where junior field technicians could employ satellite enabled hand held devices to create and analyze spatial data in the field and in real time.[117]

[116] Miller, Walls, and Blakeman, 1974
[117] Johnson et al. 1988

The continued adoption of GIS in archaeology is undoubtedly due to the increasing accessibility of GIS platforms to non-specialists.[118] Other applications of GIS in archaeology include its use by maritime specialists in pairing targeted magnetic readings with SONAR data to create highly detailed images of shipwrecks on the ocean floor. Archaeologists have also combined ideas about cost-benefit analysis, terrain data, and other factors, such as nutritional availability to propose cost distance models and operational ranges for archaeological populations. Though advanced capabilities such as in depth modeling may be beyond the grasp of beginner users, the ability to visualize data in new ways and observe otherwise obscured correlations can still produce valuable contributions to the archaeological literature.

Mapping Clusters

Cluster analysis refers to the process of organizing data into useful groups by their associated characteristics. In creating groups, the process ideally maximizes both the similarities between data points in a shared group and the differences between data points in separate groups. This evaluation utilizes both the ArcGIS software Grouping Analysis tool, and the Cluster and Outlier Analysis tool from the Mapping Clusters tool set. The combination of tools allows for the creation of an optimal number of groups per subsample that can then be analyzed for the presence of significant clusters and outliers. This tool set is found within the Spatial Statistics toolbox in ArcGIS for Desktop 10.4

[118] Conolly and Lake, 2006

produced by ESRI. Spatial statistics share many of the same concepts as traditional statistics but incorporate relationships of space directly into the calculations. The first portion of the GIS analysis involves preparing the subsamples to bring into the ArcGIS software. A processing limitation of the ArcGIS Spatial Statistics Toolbox is that analyzed characteristics need to be presented in a numerical format. Dummy variables need to be created for categorical data such as water type. A dummy variable uses binary codes to denote the presence or absence of a variable expected to change the outcome of analysis. The water type category is divided into several categories, one for each available option of water type. An entry would then denote a one under the water type it is associated with, and a zero below all others. The single category representing overhanging platforms is split in two, one for presence and one for absence, with the number one marking positive association as with water type.

The Grouping Analysis tool processes all of the log boat entries and creates an optimal number of groups for the characteristics included in the analysis. A sample of the dialog box for the Grouping Analysis tool is shown in figure 1. The first set of inputs specifies the group of entries being analyzed, a unique ID field to identify each entry, and a name and destination for the data generated denoting the group that each log boat has been assigned to. The next input is group number. When the number of groups most appropriate for the study is not known, as is the case here, the grouping analysis tool has a function to evaluate the optimal number of groups. This function computes f-statistics, used for comparing significance between groups similar to what a t-test does for individual variables, for outcomes containing two to fifteen groups. A higher f-statistic indicates a grouping solution that maximizes intergroup similarity and outer group difference, as was previously stated to be the ideal situation for the procedure. Grouping analysis was executed again with the optimal number of groups used in place of the default. The subsequent required input is to select which characteristics, such as length, width, age, and the absence/ presence categories, should be used for the grouping analysis. The final required input is to specify a spatial constraint and refers to the way spatial relationships constrain the parameters of group creation. Though an option for no spatial constraint can be chosen, this selection introduces a random component to the algorithm and produces inconsistent f-statistics when attempting to select an optimal group number. This study employs the K Nearest Neighbor option for spatial constraints. The K Nearest Neighbor option ensures the proximity of group members, that all entries have a neighbor, and that all spatial and data relationships are included, preventing noted failures by the Grouping Analysis tool.[119] The neighbor relationships and groups are constructed so that each entry is evaluated by consulting a set number of candidates/neighbors defined as an integer (K) by the user. An input for a K value is prompted once K nearest neighbor is selected as the spatial constraint. This constraint requires that entries be a K nearest neighbor with at least one other entry to be considered in the group. The exact value for K varies by data set. Large values for K can lessen statistical distance between groups, but compensate for irrelevant data skewing group composition. ESRI, the distributor of the ArcGIS software recommends

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[119] ESRI 2016.

a minimum of eight neighbors for an accurate analysis. A common method, and the one used in this procedure is to take the square root of the number of entries in the data set (n) where $K = \sqrt{n}$.[120] When the value for K was less than ESRI's recommended minimum, grouping analysis was conducted with both the recommended minimum of eight neighbors and the value for K where $K = \sqrt{n}$ for comparison.

Once grouping analysis using the identified optimal group number is accomplished, the resulting data is put into the cluster and outlier analysis tool. A sample dialog box for the Cluster and Analysis tool is shown in figure 2. This tool begins with the same first input specifying which dataset to analyze and contains a field for a destination of output data. The cluster and outlier tool however only evaluates one characteristic of data set (Input Field), necessitating the creation of groups and the output of a single evaluable category. The final required input is called Conceptualization of Spatial Relationships and is very similar to the grouping analysis Spatial Constraint input. An inverse distance conceptualization was chosen that assumes that as distance between the discovery location of two log boats increases, the probability of their developmental influence on each other decreases. The output for the cluster and outlier analysis tool includes the identification of cluster and outliers as well as p-values, z-scores, and Local Moran's I index, for each entry. The Local Moran's I index (I) point to where entry characteristic values occur outside of random distribution in space or if a spatial distribution is random or clustered. The I value specifies that an entry is part of a

[120] Hassanat et al. 2014.

cluster with a positive value, or is an outlier with a negative one. The combined p and z values allows for the acceptance or rejection of the null hypothesis of Complete Spatial Randomness (CSR), that entries and or the values associated with those entries are populated randomly.

3. RESULTS

A table summary of statistically significant findings (fig. 3) as well as the complete outputs generated for each grouping analysis are listed in the Appendix. The grouping outputs include Overall Variable Statistics, Group-Wise summaries, Variable-Wise summaries, a graph of f-statistics, and a box plot illustrating how each group was constructed. Maps displaying the identified clusters and outliers for each analysis are also included in the Appendix (fig 4 - 8). An entry that has neighboring entries with correspondingly high or low characteristic values is considered to be part of a high (HH) or low (LL) cluster respectively. These neighboring entries may contribute to the clustering status of other entries while not being highlighted as part of a cluster themselves. Outliers can be either surrounded by higher values (HL) or lower values (LH) and are so noted. Individual log boat locations were not shown on the maps as per the request of the Florida Division of Historical Resources.

Subsample 1

Parameters: Log boats over 75% intact, associated location data, complete length and width data with no imputations, 84 entries, optimal group number = 12, K = 9.

Findings: Groups 10 and 12 were associated with HH clustering, and groups five, one, and four were associated with LL clustering.

Subsample 2

Parameters: Log boats over 75% intact, associated location data, 12 imputed widths, one imputed length, 97 entries, optimal group number = 15, K = 10.

Findings: Group four was considered an LH outlier, while groups five and three were associated with LL clustering.

Subsample 3

Parameters: Log boats over 75% intact, associated location data, complete length and width data with no imputations, body of water associated with find, 84 entries, optimal group number = 15, K =10.

Findings: Groups 3, 10, and 2 are considered LH outliers, and group 4 is associated with LL clustering.

Subsample 4

Parameters: Log boats over 75% intact, associated location data, complete length and width data with no imputations, body of water associated with find, presence or absence of overhanging platform, 27 entries, optimal group number = 15, K = 5.

Findings: This test yielded no statistically relevant clusters or outliers and so no map is included.

Subsample 4a

Parameters: Log boats over 75% intact, associated location data, complete length and width data with no imputations, body of water associated with find, presence or absence of overhanging platform, 27 entries, optimal group number = 15, K = 8 (ESRI recommended minimum).

Findings: Group 2 was considered an LH outlier.

Subsample 5

Parameters: Log boats over 75% intact, associated location data, complete length and width data with no imputations, age in years BP, optimal group number = 7, K = 2. This analysis resulted in an error message reporting two unconnected groups based on my conceptualization of spatial relationships. The result is that no optimal group number can be calculated from the selected parameters, and the software suggests changing parameters to increase the K value until there are no unconnected groups.

Findings: Analysis failure

Subsample 5a

Parameters: Log boats over 75% intact, associated location data, complete length and width data with no imputations, age in years BP, optimal group number = 8 (ESRI recommended minimum), K = 14.

Findings: Groups 3 and 2 were considered LH outliers and group 4 was associated with LL clustering.

4. CONCLUSIONS

Interpretation of Clusters and Outliers

The interpretation of results towards the goal of identifying regional affinities to log boat form is greatly dependent on how close to a representation of truth the optimal group numbers are believed to be. As has been discussed previously, despite testing for f-statistics, the optimal group number is in part based on subjective decisions made by the researcher, such as assigning a value for K. Archaeological groupings are, in the end, organizational conventions that researchers hypothesize to try to make sense of a past world for which they have incomplete data. Watercraft were not essentially built with a specific type in mind and the characteristics deemed important and relevant by the researcher to analyze a set of data are also not necessarily the same characteristics that boat builders envisioned in the conceptualization of their vessel types. In order to continue with a discussion, however, we can assume that statistically significant clusters of these created groups suggest increased confidence in at least that subset of the grouping schema.

The first subsample returned 16 entries composed of 5 groups likely to be part of a statistical cluster. Imputing missing lengths and widths, though increasing sample size, reduces the statistically significant output of identified clusters to seven entries of three groups and three outliers. The outliers were not the log boats with imputed values. Of note is that one grouping of identical composition was present in both initial samples. Two other groups of identical composition are shared between subsamples but not identified as clusters in the analysis of subsample 2. Another interesting observation is that for the dataset with imputed measurements, clusters were identified in the southern portion of the peninsula, and outliers were identified in the central portion of the peninsula [ref to image]. In the subsample with non-imputed measurements, clusters were identified in the central and northern portion of the peninsula and no outliers were identified. Imputed values are perhaps allowing for the visualization of patterns in different geographic regions that are possibly subject to worse conservation conditions and therefore contain more missing values. On the other hand imputing data depends on an underlying relationship between length and width, or any combination of variables that is likely to be of the researcher's artifice, introducing bias and skewing identification of statistically relevant patterns and their interpretation.

The incorporation of associated water type data in subsample three identifies two clusters in the northwestern part of the state, one for creek and one for salt water shore environments. This subsample also identified more outliers in the central portion of the state, with some overlap with the outliers from subsample two. The fourth subsample introduces the presence and absence of overhanging platforms as described in Newsom and Purdy's Type 3 log boat. The first set of analyses using a K Nearest Neighbor spatial constraint where $K = \sqrt{n}$ yielded no clusters or outliers. The second set of analyses for subsample four where K was set to the ESRI recommended minimum of eight produced two outliers on opposite sides of the peninsula. Though outliers may not be useful in direct grouping of log boats, they can be valuable in describing what not to expect given a set of parameters. The final set of analysis incorporates conventional radiocarbon dates in years before present. As grouping analysis using the K Nearest Neighbor spatial constraint where $K = \sqrt{n}$ failed, cluster and outlier analysis was performed using grouping analysis outputs from the trial employing the ESRI recommended minimum K value of eight. The final cluster and outlier analysis identified one significantly clustered type with an associated date of 800 years ago, and two outliers dating to 1.8 and 1.4 ka. Though the grouping analysis on its own yielded interesting results, declarations of type affinity seem unsubstantiated without the statistically significant clustering of identified groups seen in figure 3.

Current Limitations of Research

Despite the large quantity of individual log boats discovered in the state of Florida, little is known about their actual role in the formation of the peninsulas pre-Columbian communities. This brief examination of the log boat database is an attempt to bridge that gap though is beset by some limitations. My choice to first perform a grouping analysis and then a cluster and outlier analysis meant certain log boats that would usually have been identified as outliers were grouped in with closer more standard entries and overlooked. Three examples are entries for log boats that measure over 12 meters long and average less than half a meter wide. These vessels would have required several well balanced people to operate, and be very limited in terms of maneuverability. Large log boats such as these would essentially be restricted to straight runs up and down a shore line which is exactly where they were located albeit on different coasts.

When grouping and cluster analysis was done on the length variable alone, the peculiarity of these entries becomes glaringly apparent.

The database provided by the state of Florida contains only log boats found within the state. The current northern boundaries of Florida were only established in 1854, several thousand years after the appearance of the first log boat in the peninsulas archaeological record. Examination of both Woodland and Mississippian patterns in the south east of North American indicates widespread exchange of ideas and material culture long before the bounding of contemporary state lines. The jurisdiction of states creates an artificial distance threshold for associating commonalities in North American log boats by disregarding possible entries past state lines. Further limitations involve the number of missing variables. An analysis of all reports and a reanalysis of the database seem paramount for any meaningful study at this stage. It is unfortunate that for some of the more functionally interesting and structurally apparent characteristics, such as overhanging platforms, the number of missing values was so large that sample size decreased by more than half. For log boats over 75% intact this feature does not seem like one that would be missing from what remained of the artifact, and the absence of a value is likely due to the value not being included in the original report. It is possible that the absence of a value indicates the absence of an overhanging platform and therefore the rationalization to skip any related fields in the process of recording these artifacts. Making this assumption however would violate the earlier decision to not impute more than 25% of values for any one characteristic in a sub sample.

Potential for Future Research

Initial suggestions for future research aim to ameliorate the discussed limitations of current research and somewhat mirror the conclusions of the Curci thesis briefly mentioned in the introduction. Efforts should begin with improving the standardization of content and widening the geographic breadth of the log boat database. The former is difficult for canoes already in the database without the ability to reexamine either the artifact or the original records reporting on the find. For new finds, it is a question of introducing a standardized methodology for archaeologists not familiar with log boats to nonetheless be able to accurately describe the vessels. Ideally the methodology would require the least amount of deliberation for assigning values to the prescribed fields, would discourage the temptation to leave fields blank, and allows for easy input of the data into an evaluable database. Length, width, and water type seem to be easy enough characteristics to be recorded consistently, though are very few characteristics to realistically assign log boat types. If a descriptive vocabulary for shape could become standardized, the description of the plan and cross section view of the bow and stern, would provide a simple but detailed set of categorical data to include in grouping analysis. Platform presence though not identified as creating any statistically significant clusters in this analyses, is the most evident structural difference between log boat variations. A more complete data set for this characteristic and concurrently more radio carbon dates, and consistency in their standardizations would certainly illuminate new spatial relationships in log boat distribution.

It is also important to remember that not only does a canoe usually float away from the cultural context of its use before it is deposited into the archaeological record but constantly changing climates over the past thousand years mean that environments can change very drastically. The associated water type characteristic represents the type of water environment in which the log boat was discovered, and is not necessarily an accurate representation of the environment the log boat operated in during its use life. An environmental reconstruction of the peninsula, indicating wetter and drier areas and periods would be of tremendous help in not only identifying the actual environments that canoes operated in but also in possibly tracking their pre depositional voyage from their point of use origin.

While these analyses did not produce clusters that can be definitively tied to cultural groups or geographic affinities for log boat form, they are a valuable exploration of the possibilities for producing clusters that may be tied to cultural groups. The use of GIS and database manipulation are worthwhile tools in the examination of the role log boats played in the development of south eastern indigenous cultures. With refinement of the dataset through more consistent recording methods and further research into the paleoecology of the peninsula, more robust conclusions can be developed.

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APPENDIX A

FIGURES

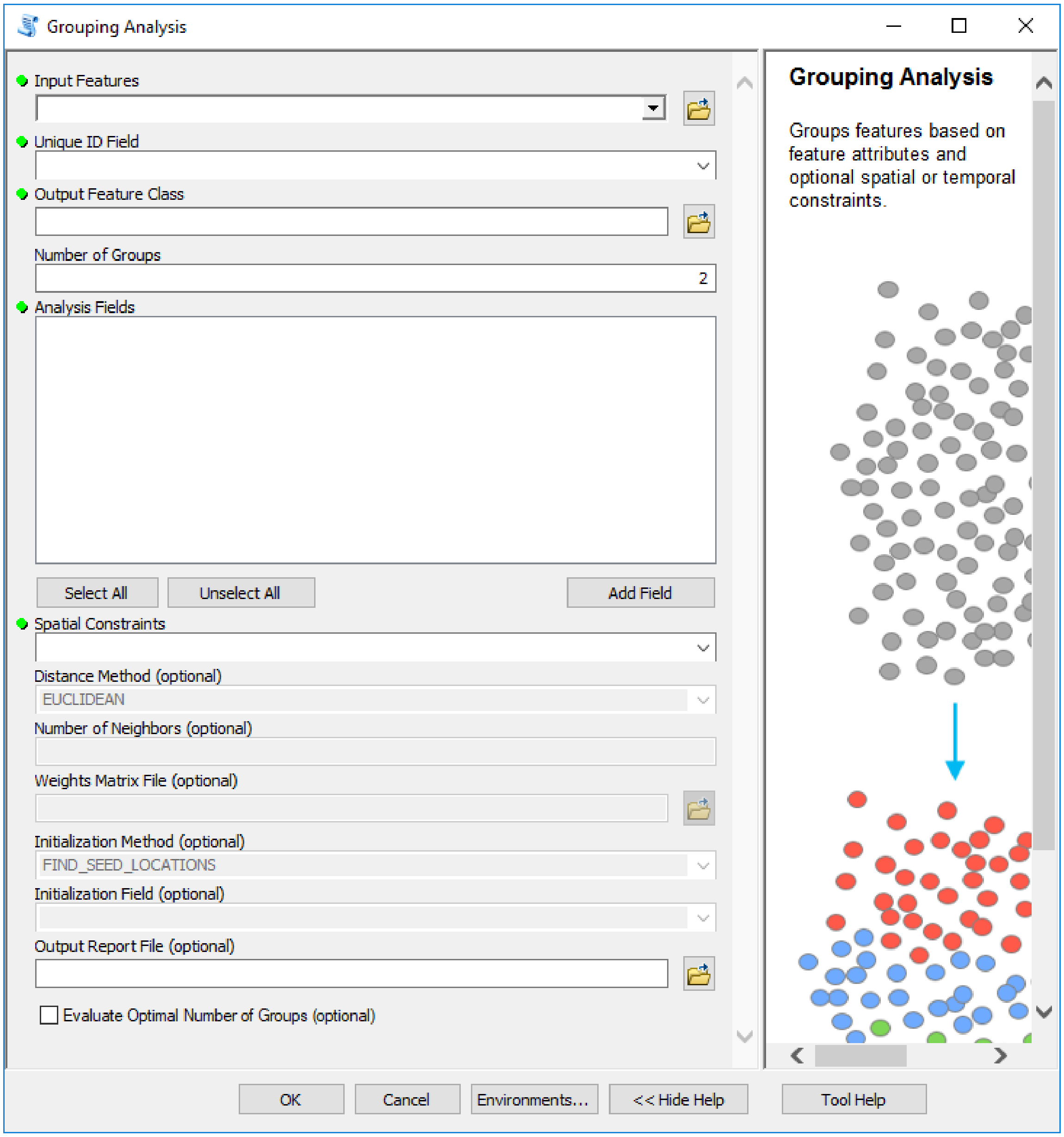


Figure 1. Grouping Analysis Dialogue Box. ESRI ArcGIS 10.4 (May 2016)

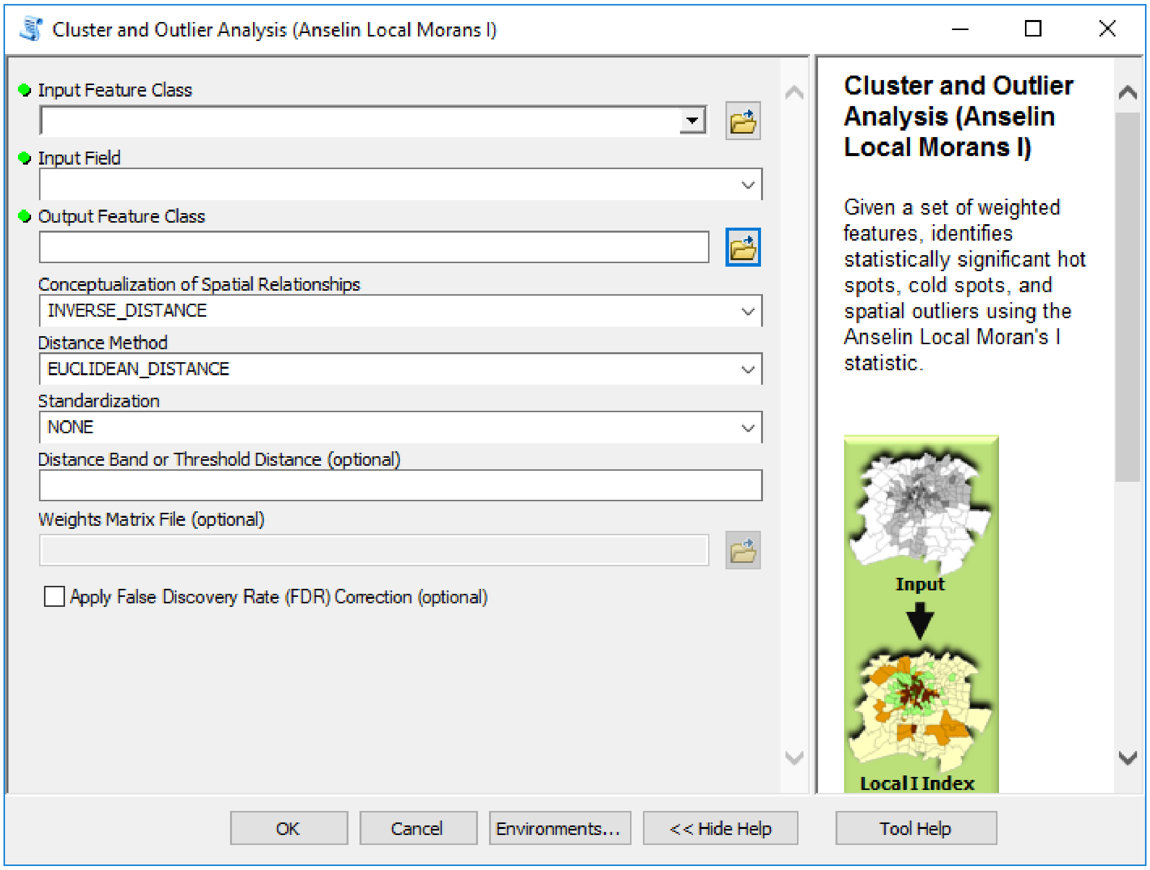


Figure 2. Cluster and Outlier Analysis Dialogue Box. ESRI ArcGIS 10.4 (May 2016)

Statistically Significant Clusters and Outliers by Subsample

Sample#	Group	Cluster/Outlier Type	Mean Length	Mean Width	Water Type	Platform	Age (YrsBP)
S1	12	HH	6.36	0.48			
	10	HH	4.68	0.4			
	5	LL	7.098	0.638			
	1	LL	15	0.58			
	4	LL	7.74	0.54			
S2	4	LH	7.2617	0.4117			
	5	LL	5.0325	0.6765			
	3	LL	13.8	0.3			
S3	3	LH	4.1725	0.446	RIVER		
	10	LH	3.52	0.49	POND		
	2	LH	4.8	0.55	PEAT BOG		
	4	LL	8.25	1.2	CREEK		
	8	LL	6.13	0.54	SALT WATER SHORE		
S4a	2	LH	5.405	0.735	LAKE	NO	
S5a	3	LH	7.06	0.686			1420
	2	LH	8.25	1.2			1870
	4	LL	5.9467	0.4667			806.7

Figure 3. Statistically Significant Findings

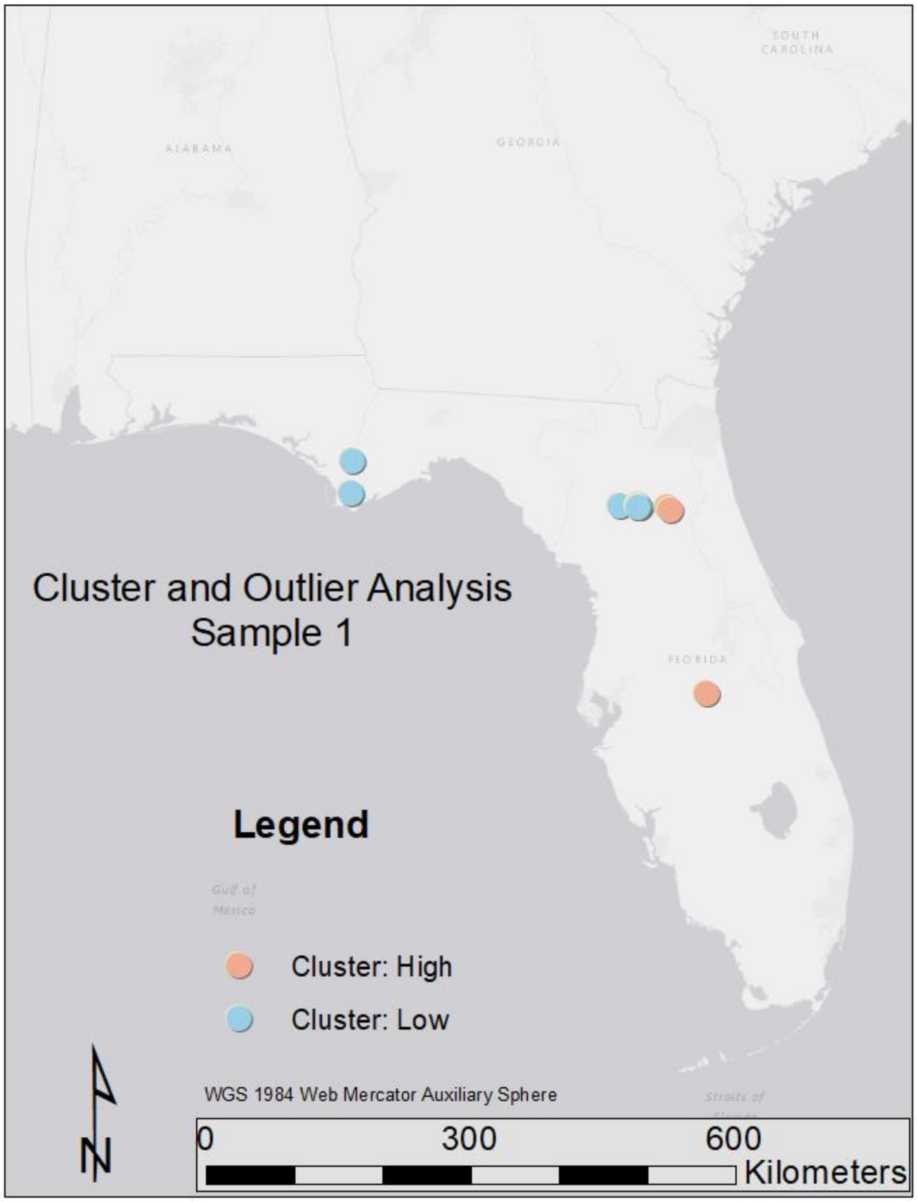


Figure 4. Cluster and Outlier Analysis of Subsample 1

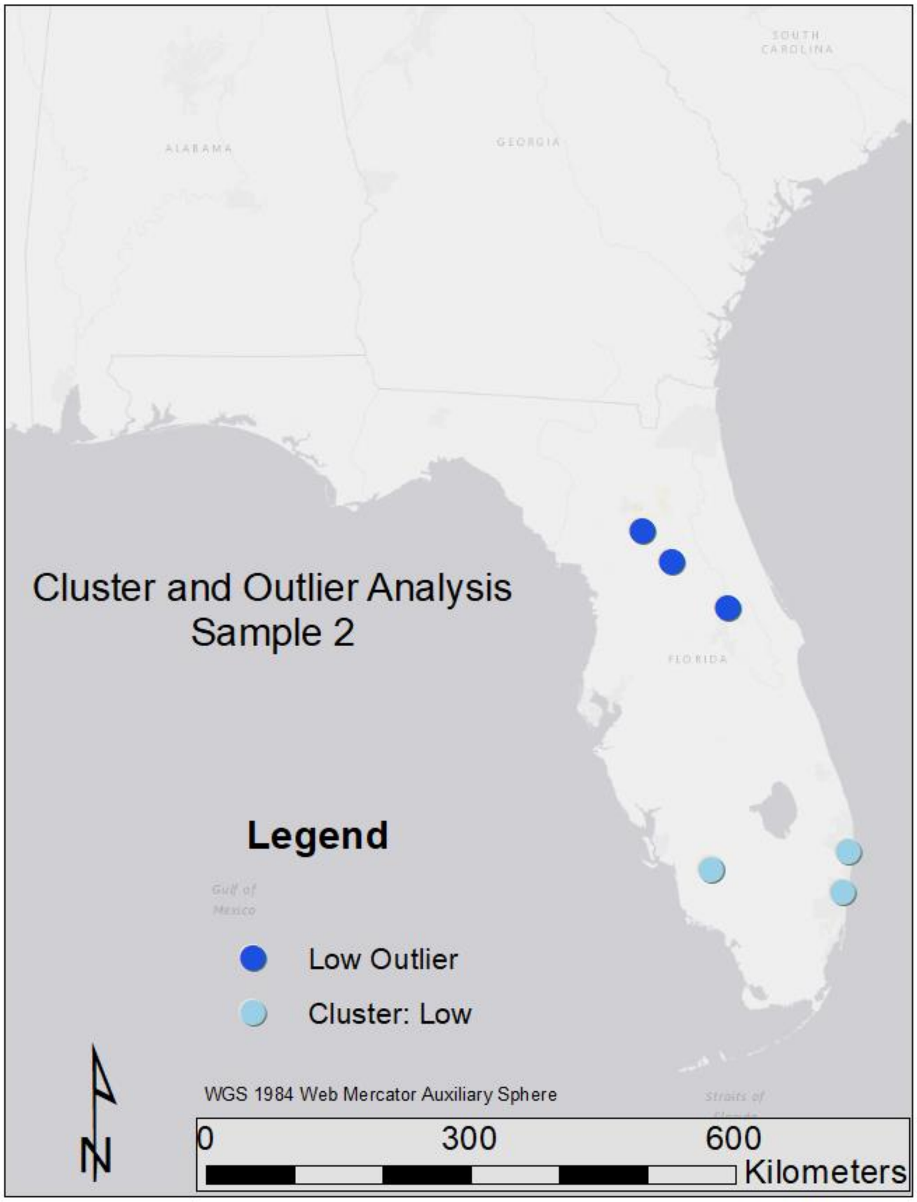


Figure 5. Cluster and Outlier Analysis of Subsample 2

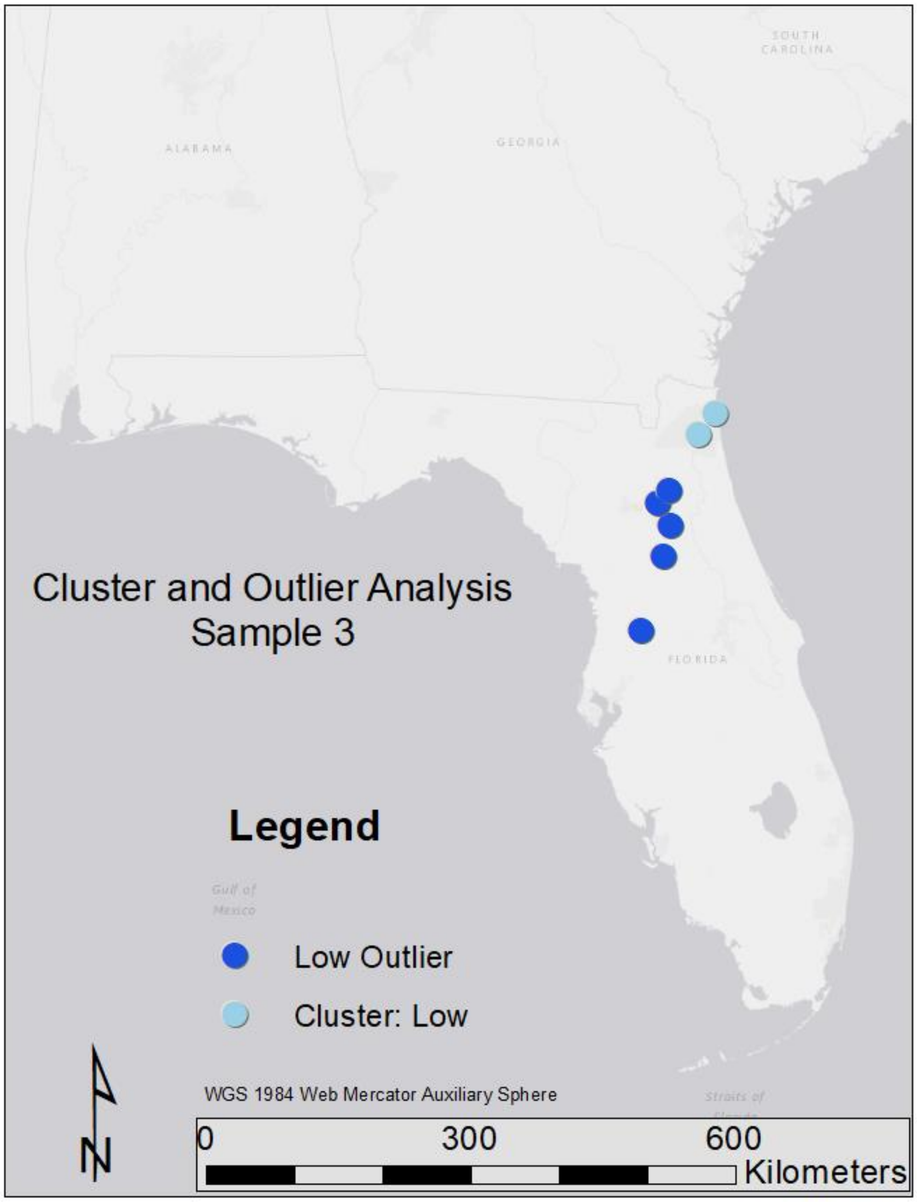


Figure 6. Cluster and Outlier Analysis of Subsample 3

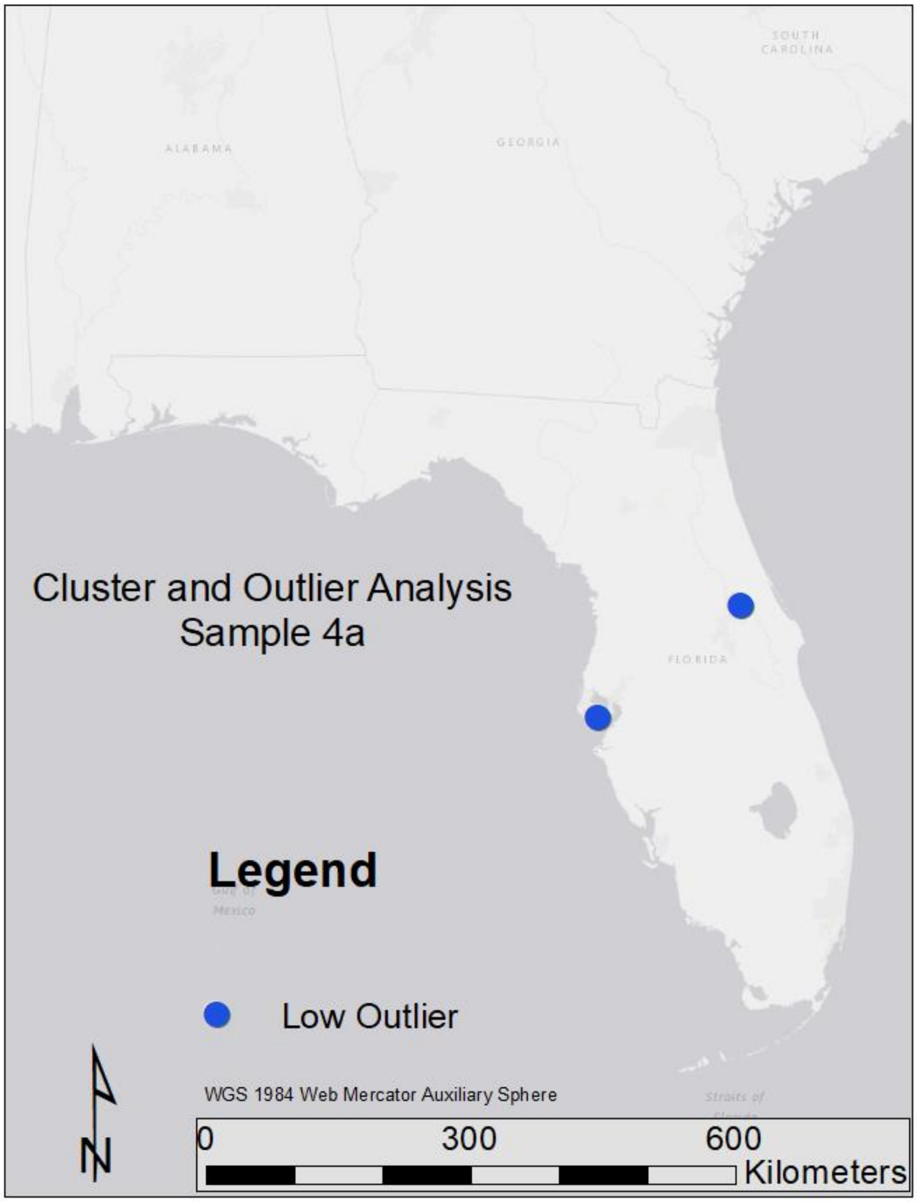


Figure 7. Cluster and Outlier Analysis of Subsample 4a

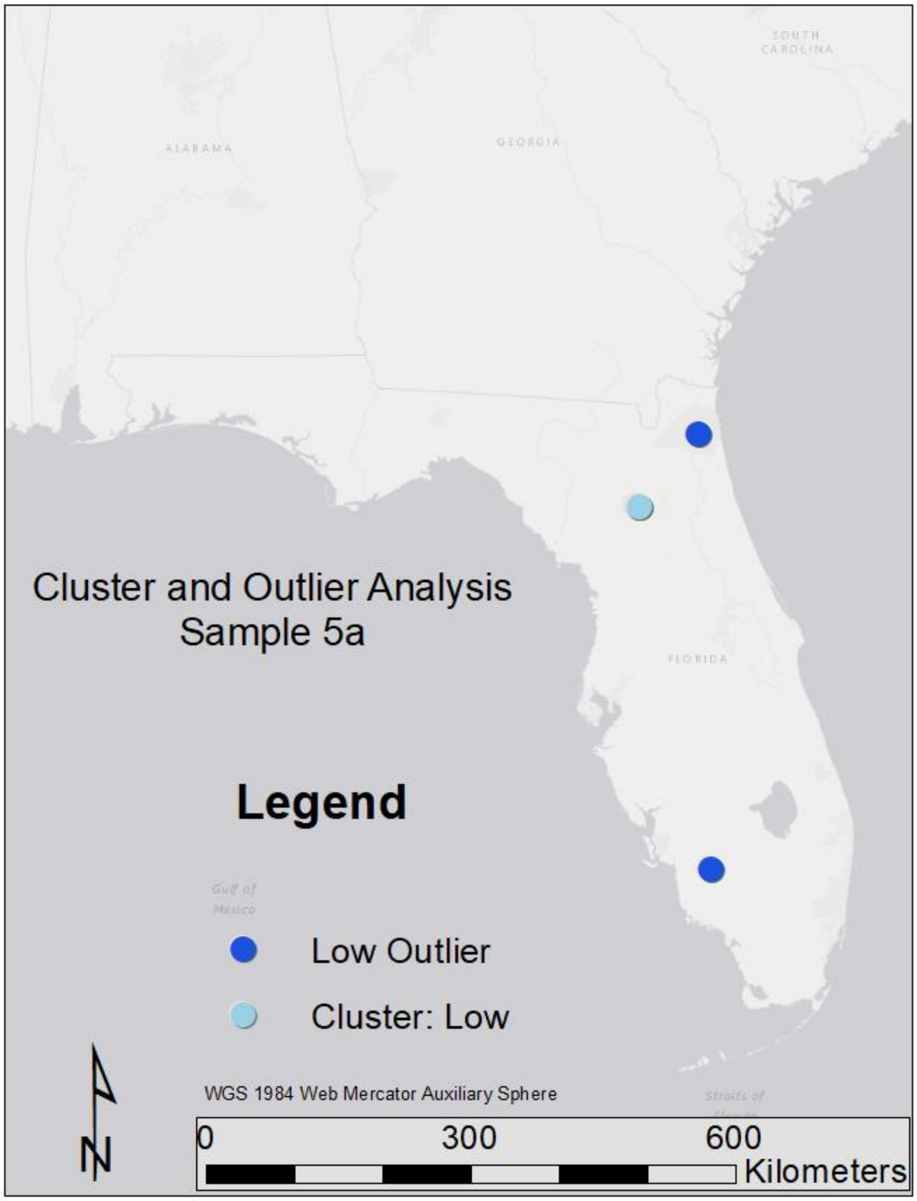
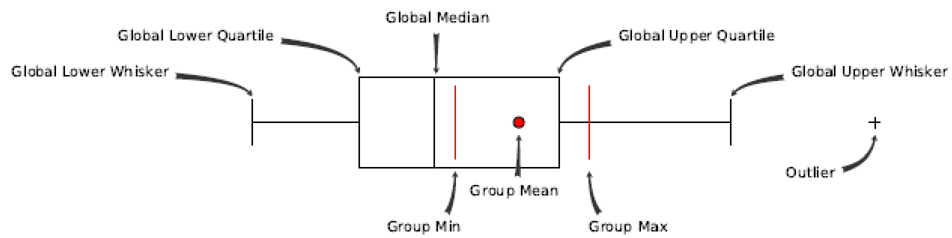


Figure 8. Cluster and Outlier Analysis of Subsample 5

APPENDIX B

GROUPING OUTPUTS

Group-Wise Summary



Overall Variable Statistics: Count = 84, Std. Distance = 2.0459, SSD = 29.2120

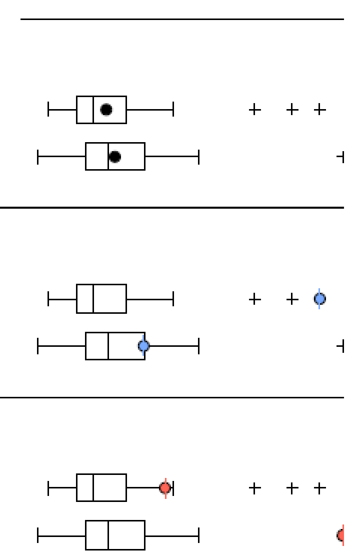
Variable	Mean	Std. Dev.	Min	Max	R2
MAX_LENGTH	5.7049	2.0410	3.1500	15.0000	0.8323
MAX_WIDTH	0.4915	0.1413	0.2500	1.2000	0.8199

Group 1: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	15.0000	0.0000	15.0000	15.0000	0.0000
MAX_WIDTH	0.5800	0.0000	0.5800	0.5800	0.0000

Group 2: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	8.2500	0.0000	8.2500	8.2500	0.0000
MAX_WIDTH	1.2000	0.0000	1.2000	1.2000	0.0000

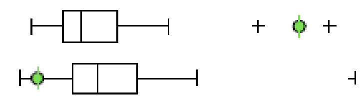


Subsample 1

Group-Wise Summary (cont.)

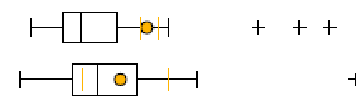
Group 3: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	13.8000	0.0000	13.8000	13.8000	0.0000
MAX_WIDTH	0.3000	0.0000	0.3000	0.3000	0.0000



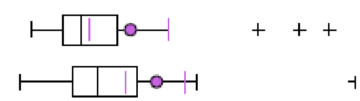
Group 4: Count = 5, Std. Distance = 0.2568, SSD = 2.0500

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	7.7440	0.2409	7.4800	8.1900	0.0599
MAX_WIDTH	0.5360	0.0889	0.4300	0.6700	0.2526



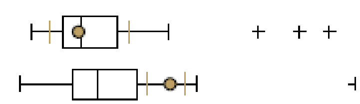
Group 5: Count = 10, Std. Distance = 0.8664, SSD = 3.1965

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	7.0980	0.8648	5.4900	8.6000	0.2624
MAX_WIDTH	0.6380	0.0529	0.5500	0.7200	0.1789



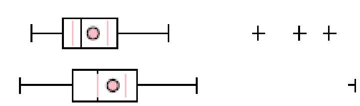
Group 6: Count = 4, Std. Distance = 1.2256, SSD = 1.7710

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	5.0325	1.2250	3.8600	7.0600	0.2700
MAX_WIDTH	0.6765	0.0406	0.6100	0.7200	0.1158



Group 7: Count = 5, Std. Distance = 0.5921, SSD = 0.6263

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	5.6120	0.5915	4.8000	6.2000	0.1181
MAX_WIDTH	0.5140	0.0287	0.4700	0.5500	0.0842



Group-Wise Summary (cont.)

Group 8: Count = 8, Std. Distance = 0.7522, SSD = 4.6917

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	5.6725	0.7462	4.5700	6.6500	0.1755
MAX_WIDTH	0.4413	0.0951	0.3000	0.5900	0.3053

Group 9: Count = 10, Std. Distance = 0.7545, SSD = 3.8267

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	4.7090	0.7512	3.5000	5.9300	0.2051
MAX_WIDTH	0.5832	0.0702	0.4900	0.7500	0.2737

Group 10: Count = 37, Std. Distance = 0.9466, SSD = 13.0498

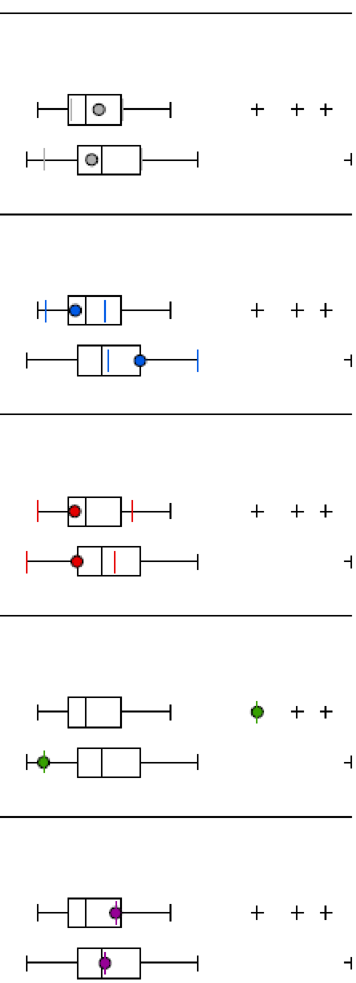
Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	4.6831	0.9451	3.1500	7.0300	0.3274
MAX_WIDTH	0.3981	0.0525	0.2500	0.5080	0.2716

Group 11: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	12.1700	0.0000	12.1700	12.1700	0.0000
MAX_WIDTH	0.3000	0.0000	0.3000	0.3000	0.0000

Group 12: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

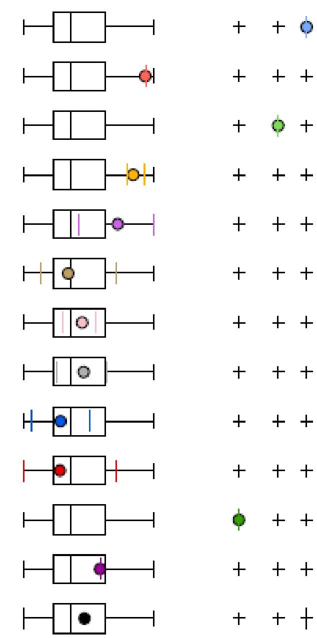
Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	6.3600	0.0000	6.3600	6.3600	0.0000
MAX_WIDTH	0.4800	0.0000	0.4800	0.4800	0.0000



Variable-Wise Summary

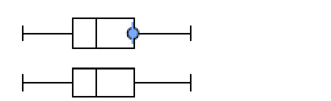
MAX_LENGTH: R2 = 0.83

Group	Mean	Std. Dev.	Min	Max	Share
1	15.0000	0.0000	15.0000	15.0000	0.0000
2	8.2500	0.0000	8.2500	8.2500	0.0000
3	13.8000	0.0000	13.8000	13.8000	0.0000
4	7.7440	0.2409	7.4800	8.1900	0.0599
5	7.0980	0.8648	5.4900	8.6000	0.2624
6	5.0325	1.2250	3.8600	7.0600	0.2700
7	5.6120	0.5915	4.8000	6.2000	0.1181
8	5.6725	0.7462	4.5700	6.6500	0.1755
9	4.7090	0.7512	3.5000	5.9300	0.2051
10	4.6831	0.9451	3.1500	7.0300	0.3274
11	12.1700	0.0000	12.1700	12.1700	0.0000
12	6.3600	0.0000	6.3600	6.3600	0.0000
Total	5.7049	2.0410	3.1500	15.0000	1.0000



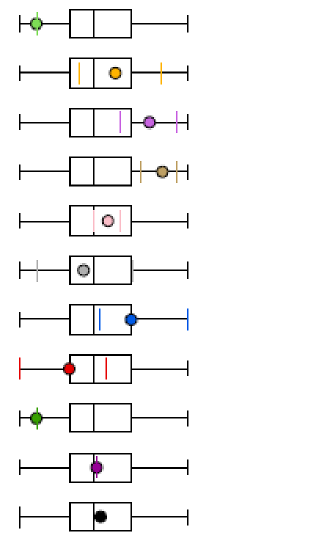
MAX_WIDTH: R2 = 0.82

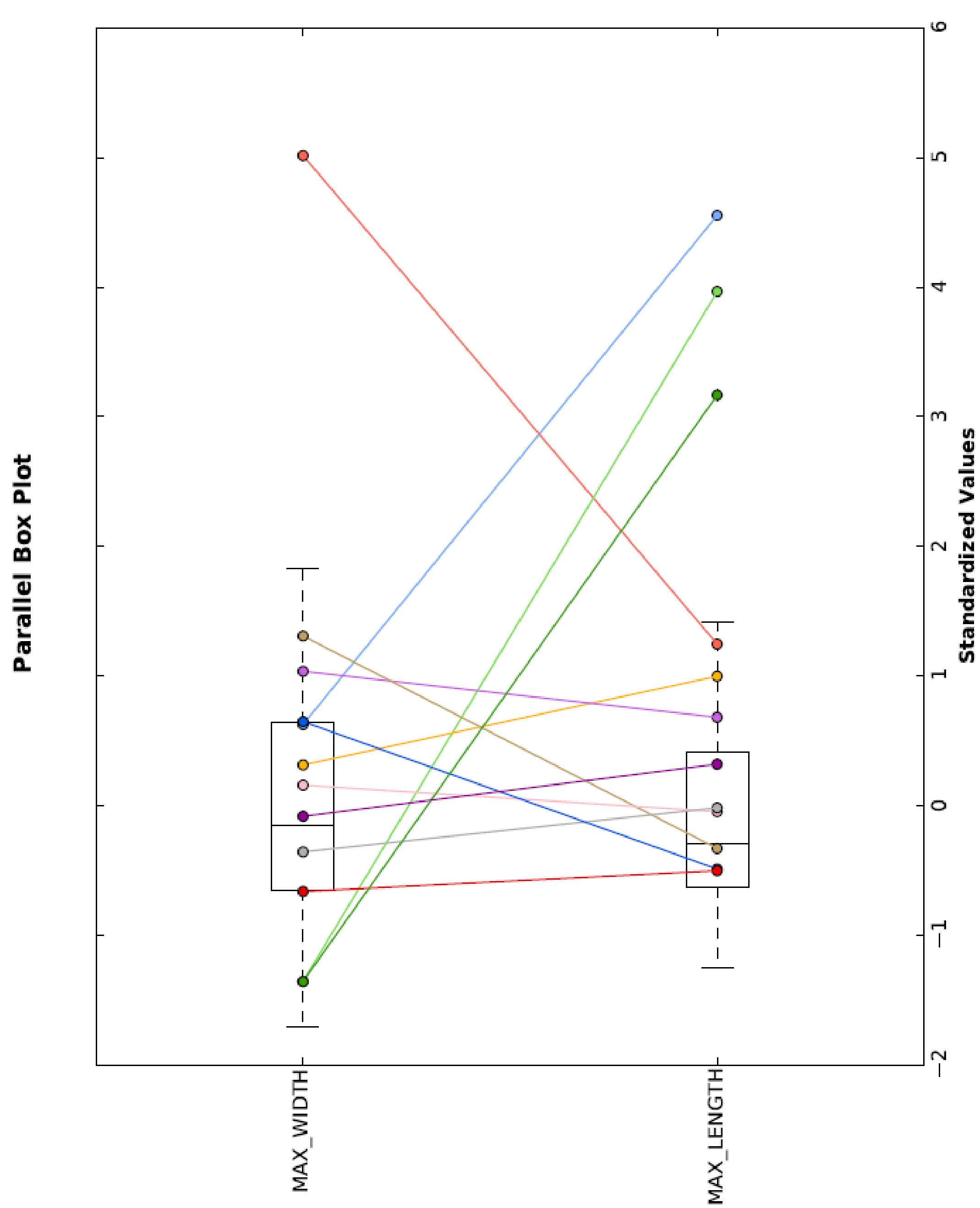
Group	Mean	Std. Dev.	Min	Max	Share
1	0.5800	0.0000	0.5800	0.5800	0.0000
2	1.2000	0.0000	1.2000	1.2000	0.0000



Variable-Wise Summary (cont.)

Group	Mean	Std. Dev.	Min	Max	Share
3	0.3000	0.0000	0.3000	0.3000	0.0000
4	0.5360	0.0889	0.4300	0.6700	0.2526
5	0.6380	0.0529	0.5500	0.7200	0.1789
6	0.6765	0.0406	0.6100	0.7200	0.1158
7	0.5140	0.0287	0.4700	0.5500	0.0842
8	0.4413	0.0951	0.3000	0.5900	0.3053
9	0.5832	0.0702	0.4900	0.7500	0.2737
10	0.3981	0.0525	0.2500	0.5080	0.2716
11	0.3000	0.0000	0.3000	0.3000	0.0000
12	0.4800	0.0000	0.4800	0.4800	0.0000
Total	0.4915	0.1413	0.2500	1.2000	1.0000

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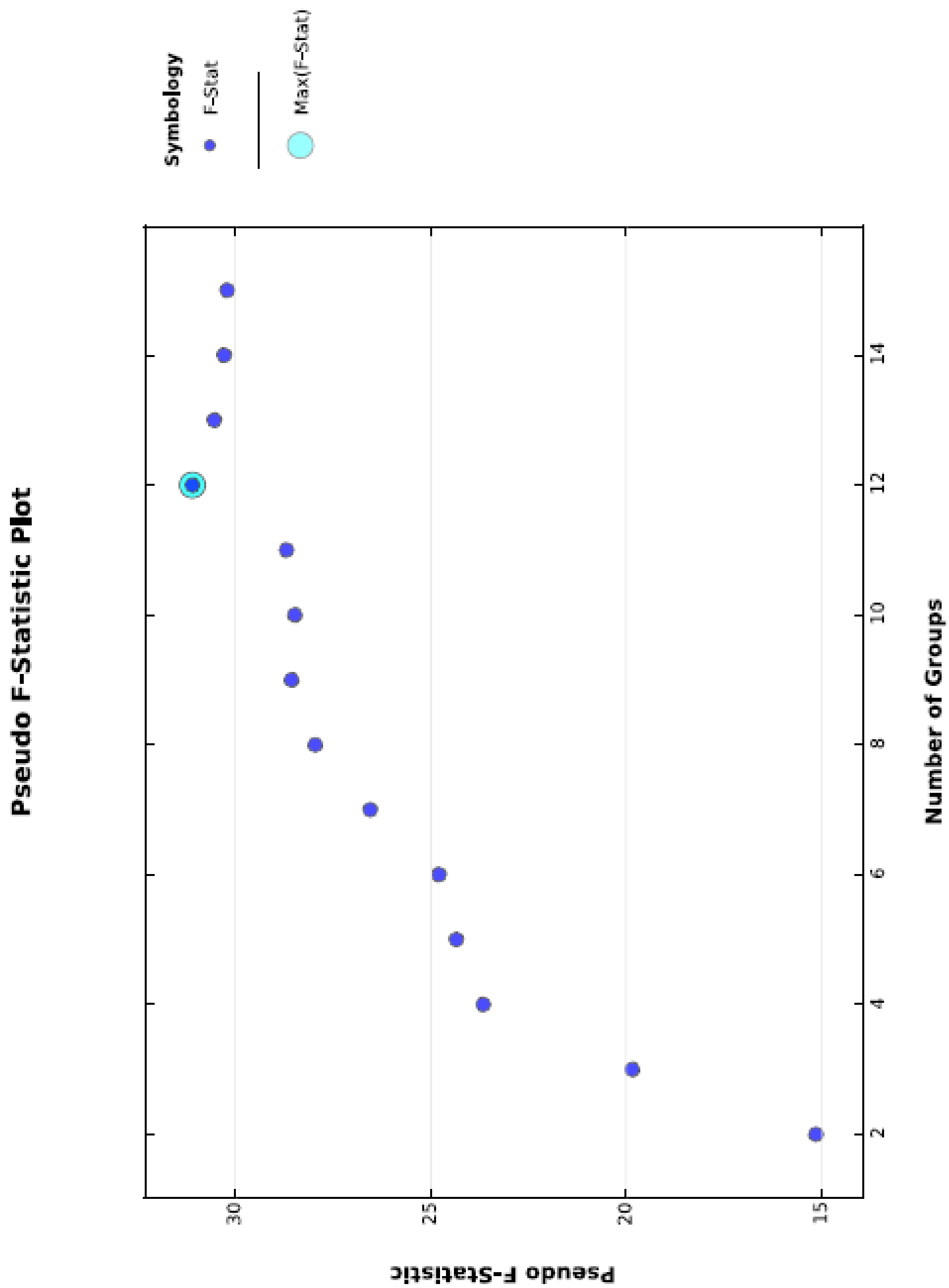
6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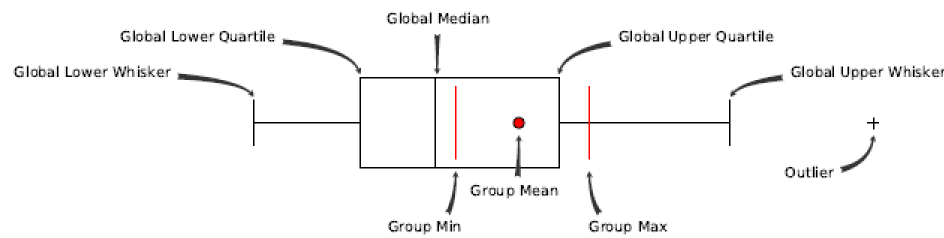
14

Group-Wise Summary



Overall Variable Statistics: Count = 97, Std. Distance = 1.9754, SSD = 27.0862

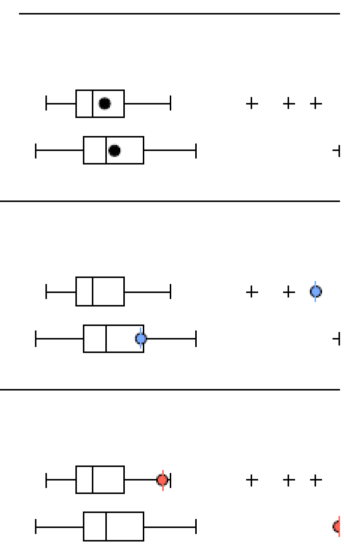
Variable	Mean	Std. Dev.	Min	Max	R2
MAX_LENGTH	5.7294	1.9694	3.1500	15.0000	0.8605
MAX_WIDTH	0.4970	0.1547	0.2500	1.2000	0.8603

Group 1: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	15.0000	0.0000	15.0000	15.0000	0.0000
MAX_WIDTH	0.5800	0.0000	0.5800	0.5800	0.0000

Group 2: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	8.2500	0.0000	8.2500	8.2500	0.0000
MAX_WIDTH	1.2000	0.0000	1.2000	1.2000	0.0000



Subsample 2

Group-Wise Summary (cont.)

Group 3: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	13.8000	0.0000	13.8000	13.8000	0.0000
MAX_WIDTH	0.3000	0.0000	0.3000	0.3000	0.0000

Group 4: Count = 6, Std. Distance = 0.6542, SSD = 1.9924

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	7.2617	0.6501	6.4100	8.1900	0.1502
MAX_WIDTH	0.4117	0.0731	0.3302	0.5400	0.2208

Group 5: Count = 4, Std. Distance = 1.2256, SSD = 1.8230

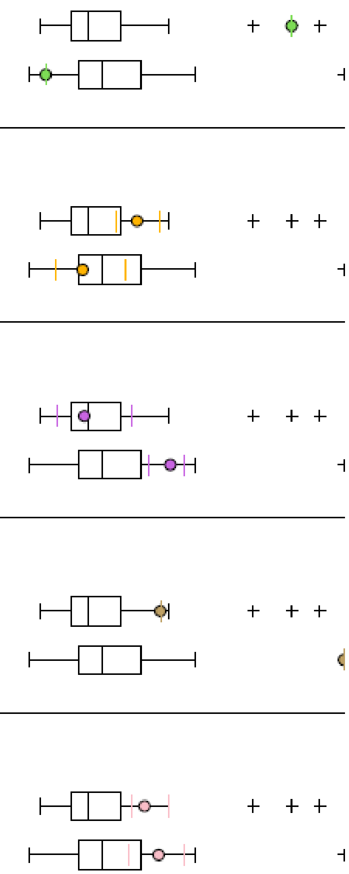
Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	5.0325	1.2250	3.8600	7.0600	0.2700
MAX_WIDTH	0.6765	0.0406	0.6100	0.7200	0.1158

Group 6: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	8.2500	0.0000	8.2500	8.2500	0.0000
MAX_WIDTH	1.2000	0.0000	1.2000	1.2000	0.0000

Group 7: Count = 8, Std. Distance = 0.5316, SSD = 1.8080

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	7.5812	0.5281	7.0200	8.6000	0.1333
MAX_WIDTH	0.6412	0.0607	0.5500	0.7200	0.1789



Group-Wise Summary (cont.)

Group 8: Count = 2, Std. Distance = 0.5296, SSD = 0.5518

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	5.5850	0.5250	5.0600	6.1100	0.0886
MAX_WIDTH	0.3700	0.0700	0.3000	0.4400	0.1474

Group 9: Count = 6, Std. Distance = 0.3214, SSD = 0.7532

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	6.0150	0.3176	5.4000	6.4300	0.0869
MAX_WIDTH	0.4717	0.0488	0.4000	0.5400	0.1474

Group 10: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

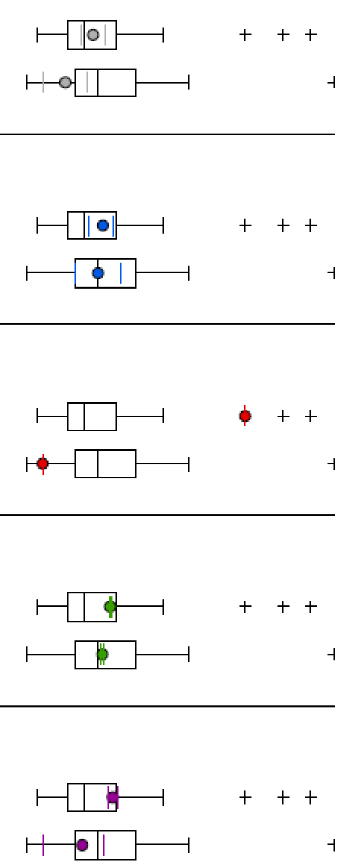
Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	12.1700	0.0000	12.1700	12.1700	0.0000
MAX_WIDTH	0.3000	0.0000	0.3000	0.3000	0.0000

Group 11: Count = 2, Std. Distance = 0.0354, SSD = 0.0027

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	6.3250	0.0350	6.2900	6.3600	0.0059
MAX_WIDTH	0.4850	0.0050	0.4800	0.4900	0.0105

Group 12: Count = 4, Std. Distance = 0.1816, SSD = 1.0426

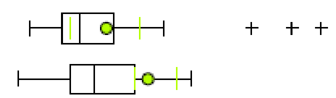
Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	6.4325	0.1641	6.2500	6.6500	0.0338
MAX_WIDTH	0.4225	0.0779	0.3000	0.4900	0.2000



Group-Wise Summary (cont.)

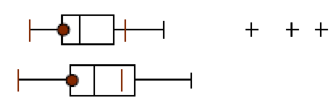
Group 13: Count = 8, Std. Distance = 0.9886, SSD = 2.5721

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	6.2812	0.9877	4.8000	7.6000	0.2363
MAX_WIDTH	0.6262	0.0409	0.5900	0.7100	0.1263



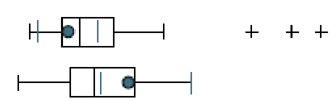
Group 14: Count = 40, Std. Distance = 0.8217, SSD = 12.5052

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	4.5329	0.8196	3.1500	7.0300	0.3274
MAX_WIDTH	0.4063	0.0577	0.2500	0.5500	0.3158



Group 15: Count = 12, Std. Distance = 0.6978, SSD = 4.0353

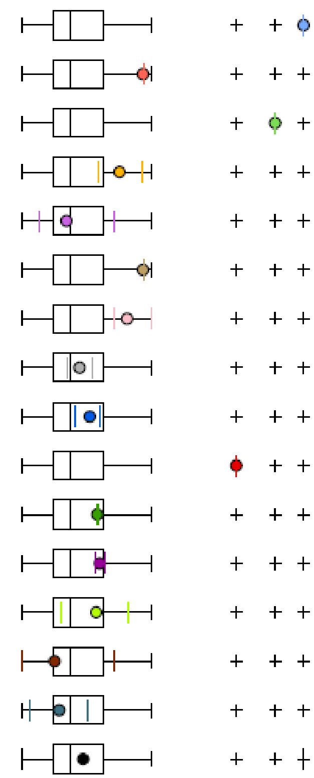
Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	4.7267	0.6941	3.5000	5.9300	0.2051
MAX_WIDTH	0.5693	0.0712	0.4900	0.7500	0.2737



Variable-Wise Summary

MAX_LENGTH: R2 = 0.86

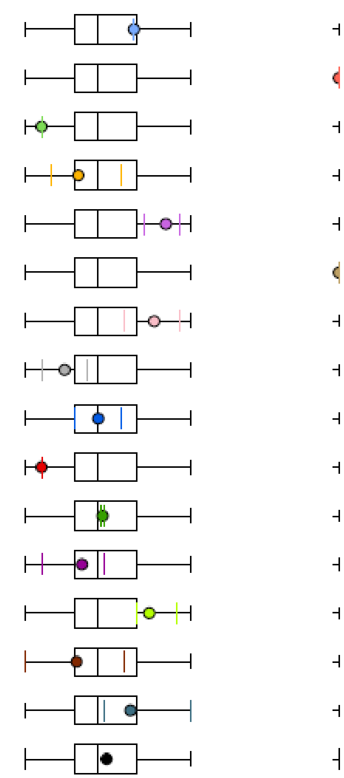
Group	Mean	Std. Dev.	Min	Max	Share
1	15.0000	0.0000	15.0000	15.0000	0.0000
2	8.2500	0.0000	8.2500	8.2500	0.0000
3	13.8000	0.0000	13.8000	13.8000	0.0000
4	7.2617	0.6501	6.4100	8.1900	0.1502
5	5.0325	1.2250	3.8600	7.0600	0.2700
6	8.2500	0.0000	8.2500	8.2500	0.0000
7	7.5812	0.5281	7.0200	8.6000	0.1333
8	5.5850	0.5250	5.0600	6.1100	0.0886
9	6.0150	0.3176	5.4000	6.4300	0.0869
10	12.1700	0.0000	12.1700	12.1700	0.0000
11	6.3250	0.0350	6.2900	6.3600	0.0059
12	6.4325	0.1641	6.2500	6.6500	0.0338
13	6.2812	0.9877	4.8000	7.6000	0.2363
14	4.5329	0.8196	3.1500	7.0300	0.3274
15	4.7267	0.6941	3.5000	5.9300	0.2051
Total	5.7294	1.9694	3.1500	15.0000	1.0000

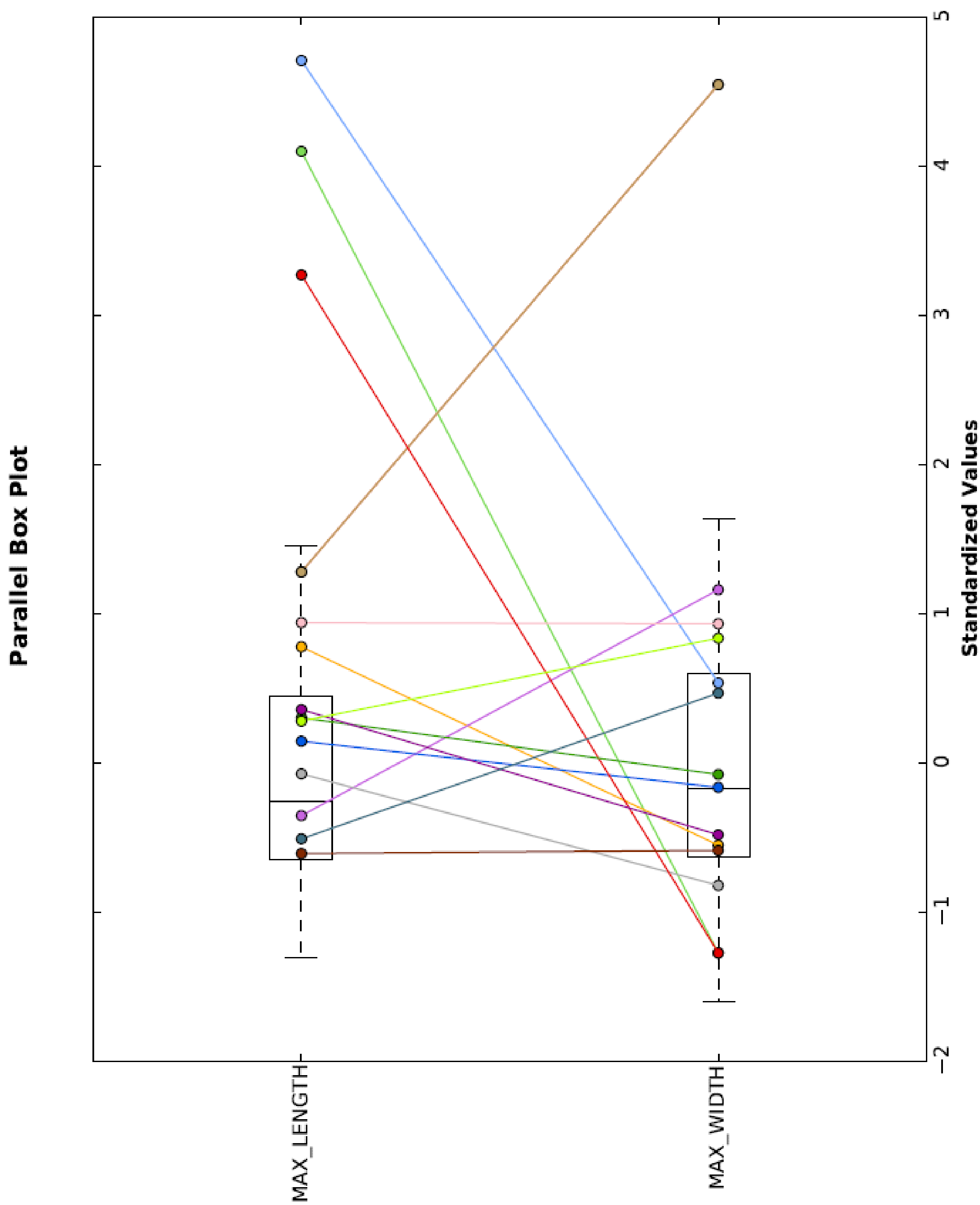


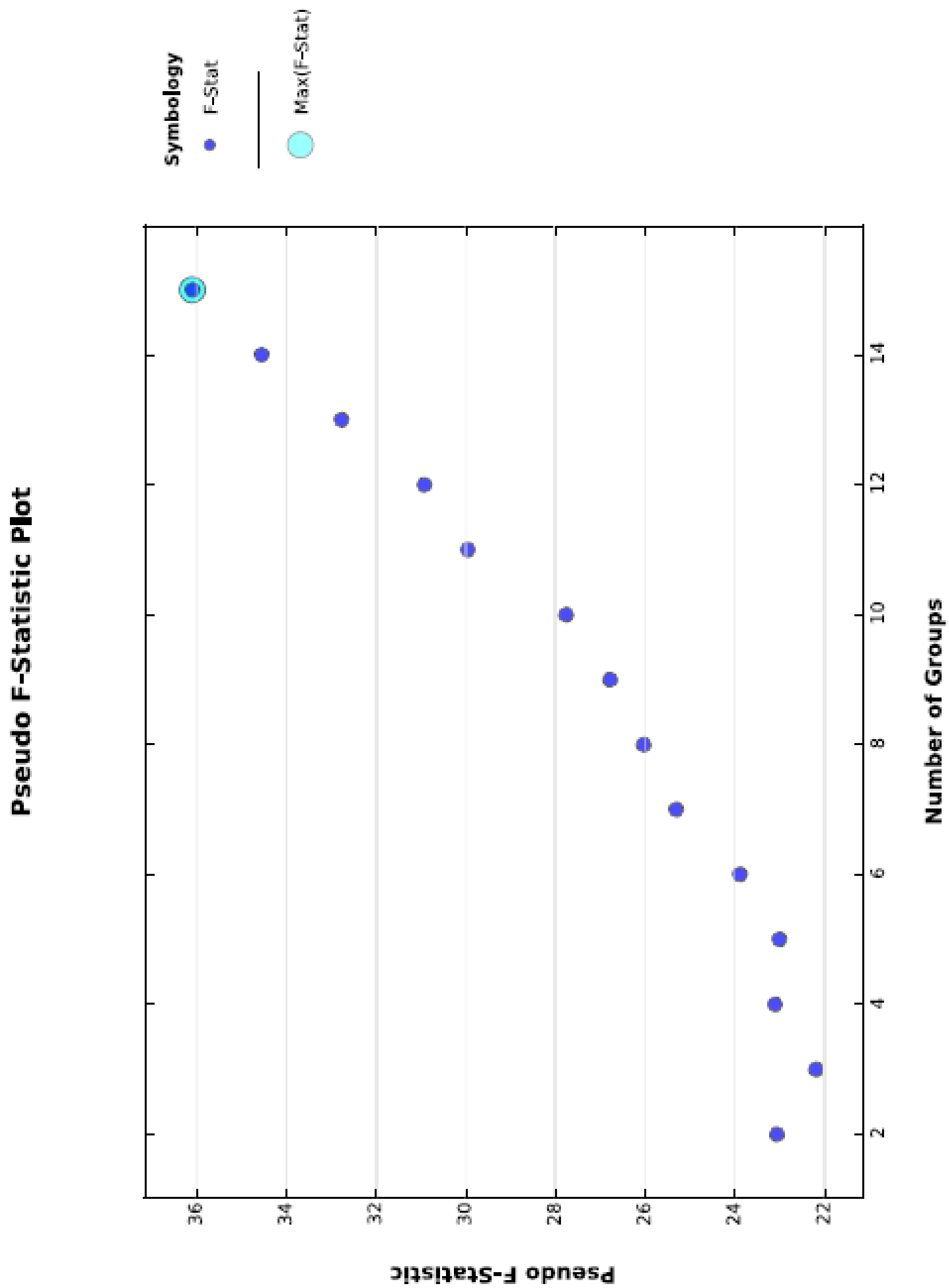
Variable-Wise Summary (cont.)

MAX_WIDTH: R2 = 0.86

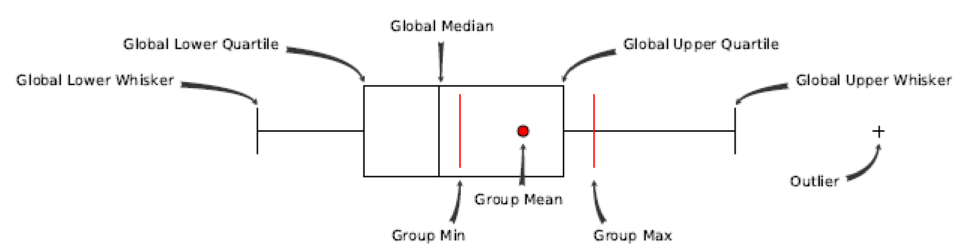
Group	Mean	Std. Dev.	Min	Max	Share
1	0.5800	0.0000	0.5800	0.5800	0.0000
2	1.2000	0.0000	1.2000	1.2000	0.0000
3	0.3000	0.0000	0.3000	0.3000	0.0000
4	0.4117	0.0731	0.3302	0.5400	0.2208
5	0.6765	0.0406	0.6100	0.7200	0.1158
6	1.2000	0.0000	1.2000	1.2000	0.0000
7	0.6412	0.0607	0.5500	0.7200	0.1789
8	0.3700	0.0700	0.3000	0.4400	0.1474
9	0.4717	0.0488	0.4000	0.5400	0.1474
10	0.3000	0.0000	0.3000	0.3000	0.0000
11	0.4850	0.0050	0.4800	0.4900	0.0105
12	0.4225	0.0779	0.3000	0.4900	0.2000
13	0.6262	0.0409	0.5900	0.7100	0.1263
14	0.4063	0.0577	0.2500	0.5500	0.3158
15	0.5693	0.0712	0.4900	0.7500	0.2737
Total	0.4970	0.1547	0.2500	1.2000	1.0000




Parallel Box Plot
MAX_LENGTH
MAX_WIDTH
−2
−1
0
1
2
3
4
5
Standardized Values

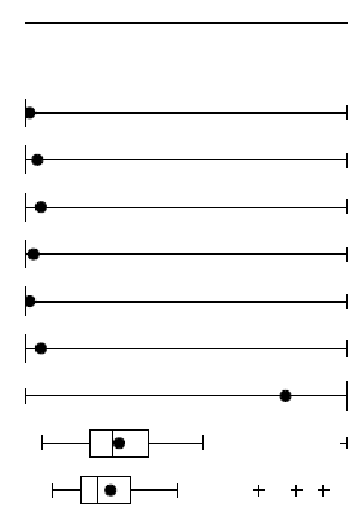

Pseudo F-Statistic Plot
Symbology
F-Stat
Max(F-Stat)
Pseudo F-Statistic
36
34
32
30
28
26
24
22
2
4
6
8
10
12
14
Number of Groups

Group-Wise Summary



Overall Variable Statistics: Count = 84, Std. Distance = 2.1241, SSD = 99.4031

Variable	Mean	Std. Dev.	Min	Max	R2
PEAT_BOG	0.0119	0.1085	0.0000	1.0000	1.0000
SALTWATER_SH	0.0357	0.1856	0.0000	1.0000	1.0000
RIVER	0.0476	0.2130	0.0000	1.0000	1.0000
CREEK	0.0238	0.1525	0.0000	1.0000	1.0000
SWAMP	0.0119	0.1085	0.0000	1.0000	1.0000
POND	0.0476	0.2130	0.0000	1.0000	1.0000
LAKE	0.8095	0.3927	0.0000	1.0000	0.9241
MAX_WIDTH	0.4915	0.1413	0.2500	1.2000	0.5205
MAX_LENGTH	5.7049	2.0410	3.1500	15.0000	0.3720

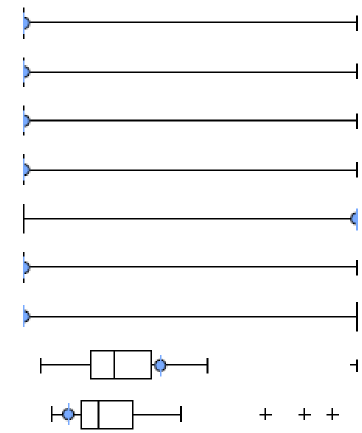


Subsample 3

Group-Wise Summary (cont.)

Group 1: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	0.0000	0.0000	0.0000	0.0000	0.0000
SALTWATER_SH	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
CREEK	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	1.0000	0.0000	1.0000	1.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_WIDTH	0.6100	0.0000	0.6100	0.6100	0.0000
MAX_LENGTH	3.8600	0.0000	3.8600	3.8600	0.0000



Group 2: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	1.0000	0.0000	1.0000	1.0000	0.0000
SALTWATER_SH	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
CREEK	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000

Group-Wise Summary (cont.)

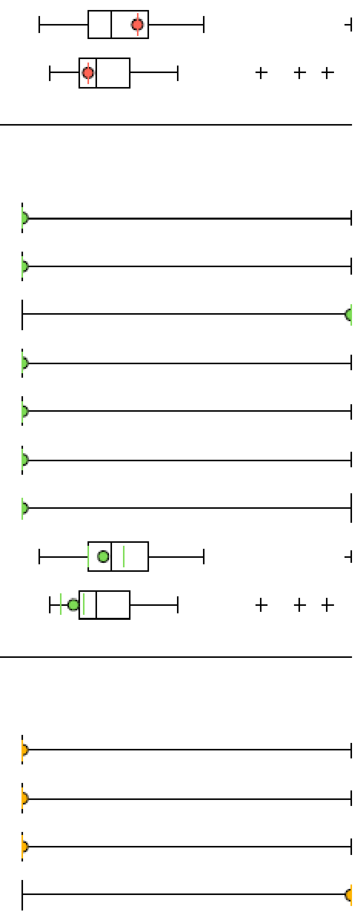
Variable	Mean	Std. Dev.	Min	Max	Share
MAX_WIDTH	0.5500	0.0000	0.5500	0.5500	0.0000
MAX_LENGTH	4.8000	0.0000	4.8000	4.8000	0.0000

Group 3: Count = 3, Std. Distance = 0.3923, SSD = 0.4208

Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	0.0000	0.0000	0.0000	0.0000	0.0000
SALTWATER_SH	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	1.0000	0.0000	1.0000	1.0000	0.0000
CREEK	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_WIDTH	0.4460	0.0455	0.4000	0.5080	0.1137
MAX_LENGTH	4.1725	0.3897	3.6576	4.6000	0.0795

Group 4: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	0.0000	0.0000	0.0000	0.0000	0.0000
SALTWATER_SH	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
CREEK	1.0000	0.0000	1.0000	1.0000	0.0000

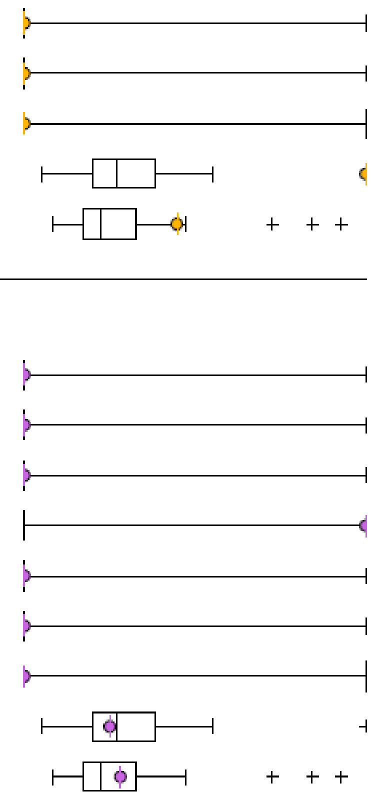


Group-Wise Summary (cont.)

Variable	Mean	Std. Dev.	Min	Max	Share
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_WIDTH	1.2000	0.0000	1.2000	1.2000	0.0000
MAX_LENGTH	8.2500	0.0000	8.2500	8.2500	0.0000

Group 5: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

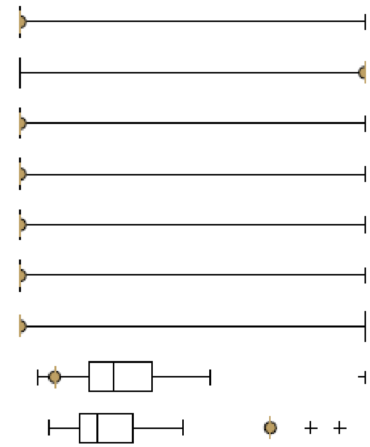
Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	0.0000	0.0000	0.0000	0.0000	0.0000
SALTWATER_SH	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
CREEK	1.0000	0.0000	1.0000	1.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_WIDTH	0.4500	0.0000	0.4500	0.4500	0.0000
MAX_LENGTH	5.9400	0.0000	5.9400	5.9400	0.0000



Group-Wise Summary (cont.)

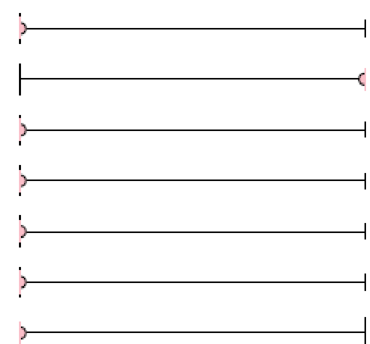
Group 6: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	0.0000	0.0000	0.0000	0.0000	0.0000
SALTWATER_SH	1.0000	0.0000	1.0000	1.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
CREEK	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_WIDTH	0.3000	0.0000	0.3000	0.3000	0.0000
MAX_LENGTH	12.1700	0.0000	12.1700	12.1700	0.0000



Group 7: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	0.0000	0.0000	0.0000	0.0000	0.0000
SALTWATER_SH	1.0000	0.0000	1.0000	1.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
CREEK	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000



Group-Wise Summary (cont.)

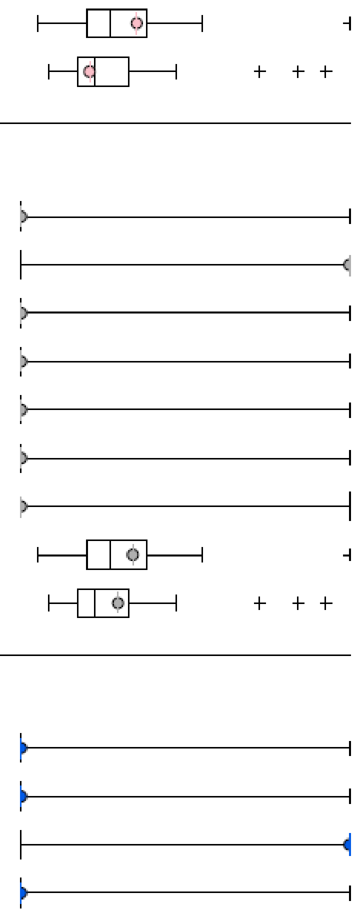
Variable	Mean	Std. Dev.	Min	Max	Share
MAX_WIDTH	0.5520	0.0000	0.5520	0.5520	0.0000
MAX_LENGTH	4.9200	0.0000	4.9200	4.9200	0.0000

Group 8: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	0.0000	0.0000	0.0000	0.0000	0.0000
SALTWATER_SH	1.0000	0.0000	1.0000	1.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
CREEK	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_WIDTH	0.5400	0.0000	0.5400	0.5400	0.0000
MAX_LENGTH	6.1300	0.0000	6.1300	6.1300	0.0000

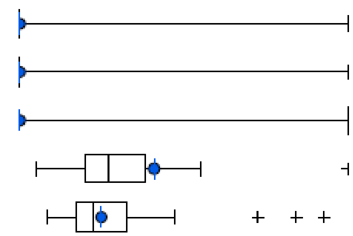
Group 9: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	0.0000	0.0000	0.0000	0.0000	0.0000
SALTWATER_SH	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	1.0000	0.0000	1.0000	1.0000	0.0000
CREEK	0.0000	0.0000	0.0000	0.0000	0.0000



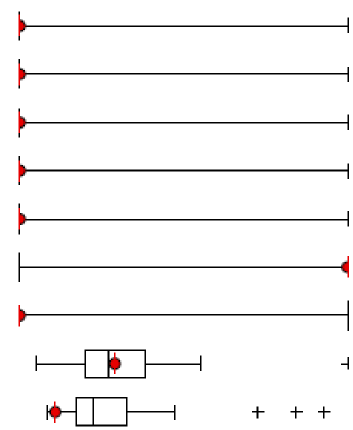
Group-Wise Summary (cont.)

Variable	Mean	Std. Dev.	Min	Max	Share
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_WIDTH	0.6100	0.0000	0.6100	0.6100	0.0000
MAX_LENGTH	5.4900	0.0000	5.4900	5.4900	0.0000



Group 10: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

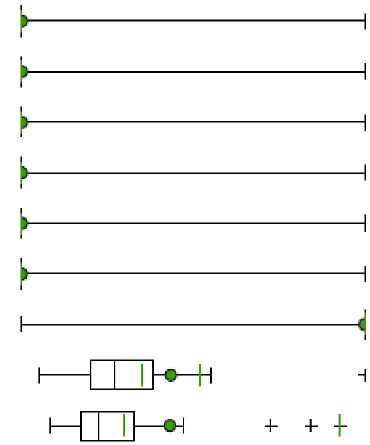
Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	0.0000	0.0000	0.0000	0.0000	0.0000
SALTWATER_SH	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
CREEK	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	1.0000	0.0000	1.0000	1.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_WIDTH	0.4900	0.0000	0.4900	0.4900	0.0000
MAX_LENGTH	3.5200	0.0000	3.5200	3.5200	0.0000



Group-Wise Summary (cont.)

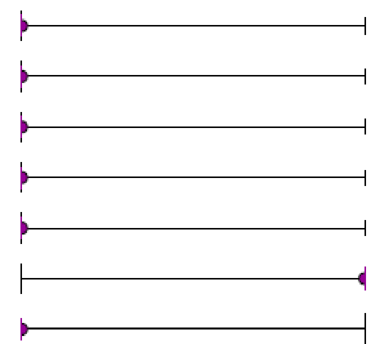
Group 11: Count = 10, Std. Distance = 2.4150, SSD = 15.5193

Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	0.0000	0.0000	0.0000	0.0000	0.0000
SALTWATER_SH	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
CREEK	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	1.0000	0.0000	1.0000	1.0000	0.0000
MAX_WIDTH	0.6350	0.0552	0.5500	0.7200	0.1789
MAX_LENGTH	8.0490	2.4143	6.2000	15.0000	0.7426



Group 12: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	0.0000	0.0000	0.0000	0.0000	0.0000
SALTWATER_SH	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
CREEK	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	1.0000	0.0000	1.0000	1.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000



Group-Wise Summary (cont.)

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_WIDTH	0.4200	0.0000	0.4200	0.4200	0.0000
MAX_LENGTH	4.1000	0.0000	4.1000	4.1000	0.0000

Group 13: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

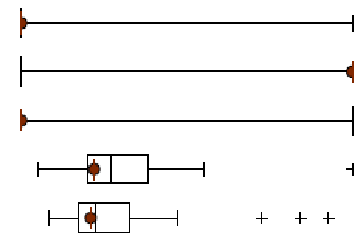
Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	0.0000	0.0000	0.0000	0.0000	0.0000
SALTWATER_SH	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
CREEK	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	1.0000	0.0000	1.0000	1.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_WIDTH	0.4000	0.0000	0.4000	0.4000	0.0000
MAX_LENGTH	5.5700	0.0000	5.5700	5.5700	0.0000

Group 14: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	0.0000	0.0000	0.0000	0.0000	0.0000
SALTWATER_SH	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
CREEK	0.0000	0.0000	0.0000	0.0000	0.0000

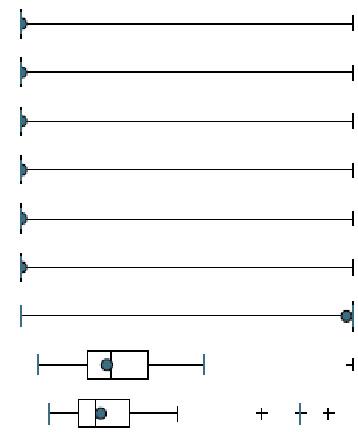
Group-Wise Summary (cont.)

Variable	Mean	Std. Dev.	Min	Max	Share
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	1.0000	0.0000	1.0000	1.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_WIDTH	0.4200	0.0000	0.4200	0.4200	0.0000
MAX_LENGTH	4.9300	0.0000	4.9300	4.9300	0.0000



Group 15: Count = 59, Std. Distance = 1.6608, SSD = 83.4629

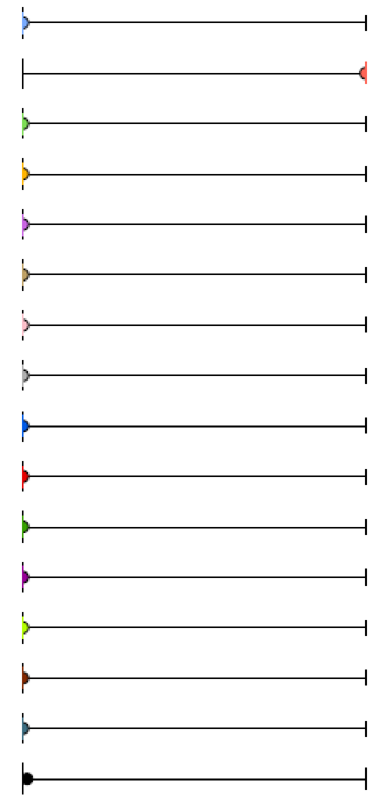
Variable	Mean	Std. Dev.	Min	Max	Share
PEAT_BOG	0.0000	0.0000	0.0000	0.0000	0.0000
SALTWATER_SH	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
CREEK	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	0.9831	0.1291	0.0000	1.0000	1.0000
MAX_WIDTH	0.4586	0.1140	0.2500	0.7500	0.5263
MAX_LENGTH	5.3649	1.6518	3.1500	13.8000	0.8987



Variable-Wise Summary

PEAT_BOG: R2 = 1.00

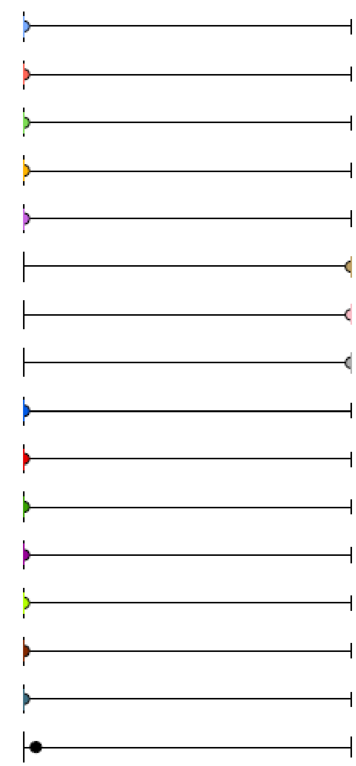
Group	Mean	Std. Dev.	Min	Max	Share
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	1.0000	0.0000	1.0000	1.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000
11	0.0000	0.0000	0.0000	0.0000	0.0000
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.0000	0.0000	0.0000	0.0000
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0119	0.1085	0.0000	1.0000	1.0000



Variable-Wise Summary (cont.)

SALTWATER_SH: R2 = 1.00

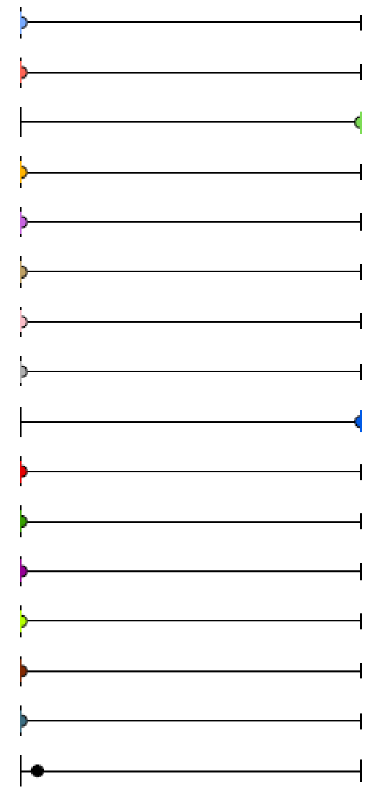
Group	Mean	Std. Dev.	Min	Max	Share
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	1.0000	0.0000	1.0000	1.0000	0.0000
7	1.0000	0.0000	1.0000	1.0000	0.0000
8	1.0000	0.0000	1.0000	1.0000	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000
11	0.0000	0.0000	0.0000	0.0000	0.0000
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.0000	0.0000	0.0000	0.0000
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0357	0.1856	0.0000	1.0000	1.0000



Variable-Wise Summary (cont.)

RIVER: R2 = 1.00

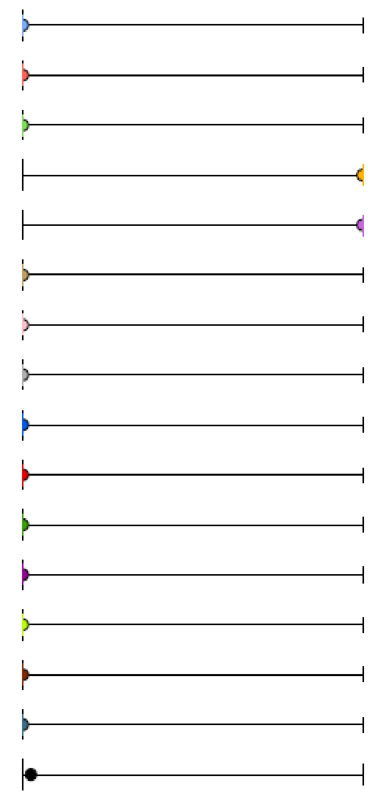
Group	Mean	Std. Dev.	Min	Max	Share
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	1.0000	0.0000	1.0000	1.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000
9	1.0000	0.0000	1.0000	1.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000
11	0.0000	0.0000	0.0000	0.0000	0.0000
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.0000	0.0000	0.0000	0.0000
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0476	0.2130	0.0000	1.0000	1.0000



Variable-Wise Summary (cont.)

CREEK: R2 = 1.00

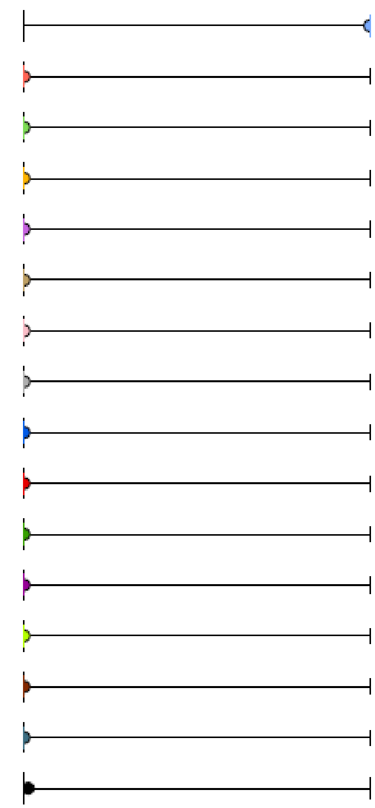
Group	Mean	Std. Dev.	Min	Max	Share
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	1.0000	0.0000	1.0000	1.0000	0.0000
5	1.0000	0.0000	1.0000	1.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000
11	0.0000	0.0000	0.0000	0.0000	0.0000
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.0000	0.0000	0.0000	0.0000
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0238	0.1525	0.0000	1.0000	1.0000



Variable-Wise Summary (cont.)

SWAMP: R2 = 1.00

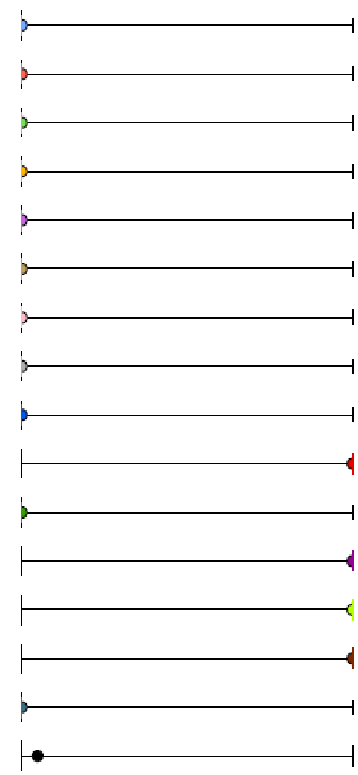
Group	Mean	Std. Dev.	Min	Max	Share
1	1.0000	0.0000	1.0000	1.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000
11	0.0000	0.0000	0.0000	0.0000	0.0000
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.0000	0.0000	0.0000	0.0000
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0119	0.1085	0.0000	1.0000	1.0000



Variable-Wise Summary (cont.)

POND: R2 = 1.00

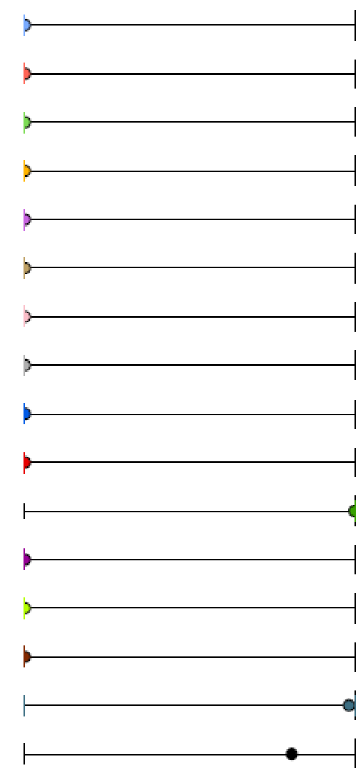
Group	Mean	Std. Dev.	Min	Max	Share
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000
10	1.0000	0.0000	1.0000	1.0000	0.0000
11	0.0000	0.0000	0.0000	0.0000	0.0000
12	1.0000	0.0000	1.0000	1.0000	0.0000
13	1.0000	0.0000	1.0000	1.0000	0.0000
14	1.0000	0.0000	1.0000	1.0000	0.0000
15	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0476	0.2130	0.0000	1.0000	1.0000



Variable-Wise Summary (cont.)

LAKE: R2 = 0.92

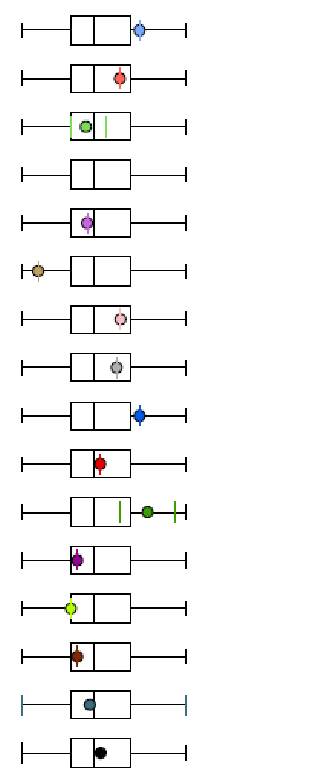
Group	Mean	Std. Dev.	Min	Max	Share
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000
11	1.0000	0.0000	1.0000	1.0000	0.0000
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.0000	0.0000	0.0000	0.0000
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.9831	0.1291	0.0000	1.0000	1.0000
Total	0.8095	0.3927	0.0000	1.0000	1.0000



Variable-Wise Summary (cont.)

MAX_WIDTH: R2 = 0.52

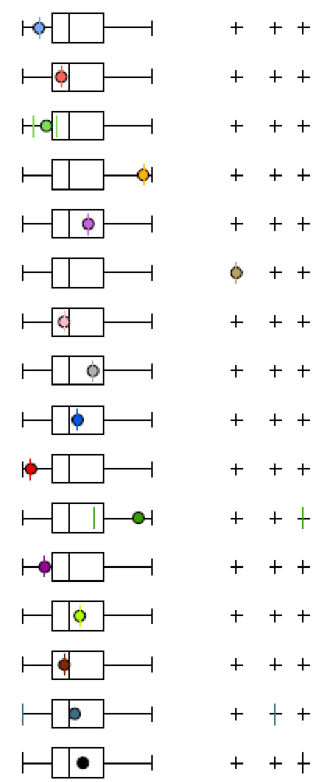
Group	Mean	Std. Dev.	Min	Max	Share
1	0.6100	0.0000	0.6100	0.6100	0.0000
2	0.5500	0.0000	0.5500	0.5500	0.0000
3	0.4460	0.0455	0.4000	0.5080	0.1137
4	1.2000	0.0000	1.2000	1.2000	0.0000
5	0.4500	0.0000	0.4500	0.4500	0.0000
6	0.3000	0.0000	0.3000	0.3000	0.0000
7	0.5520	0.0000	0.5520	0.5520	0.0000
8	0.5400	0.0000	0.5400	0.5400	0.0000
9	0.6100	0.0000	0.6100	0.6100	0.0000
10	0.4900	0.0000	0.4900	0.4900	0.0000
11	0.6350	0.0552	0.5500	0.7200	0.1789
12	0.4200	0.0000	0.4200	0.4200	0.0000
13	0.4000	0.0000	0.4000	0.4000	0.0000
14	0.4200	0.0000	0.4200	0.4200	0.0000
15	0.4586	0.1140	0.2500	0.7500	0.5263
Total	0.4915	0.1413	0.2500	1.2000	1.0000

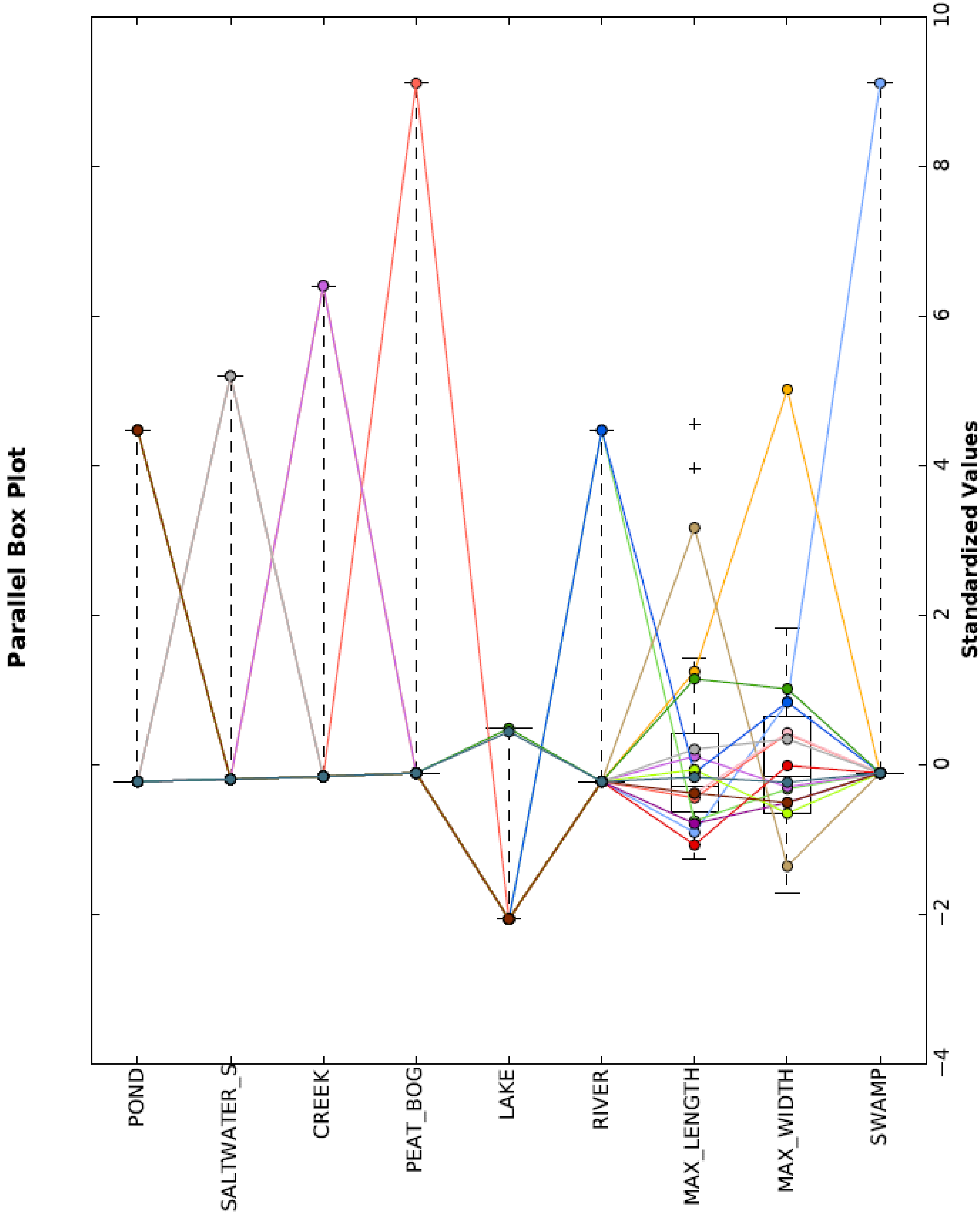


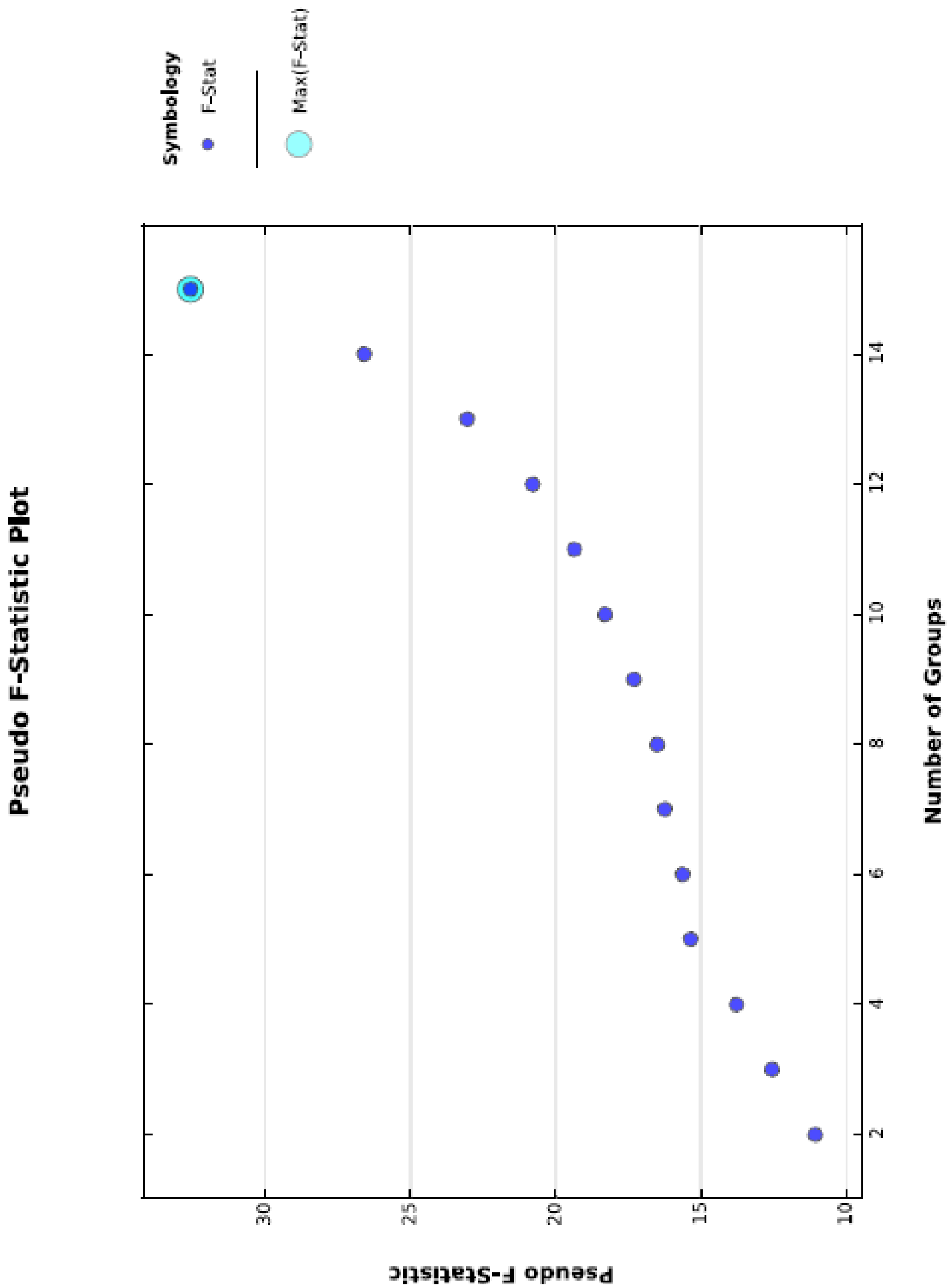
Variable-Wise Summary (cont.)

MAX_LENGTH: R2 = 0.37

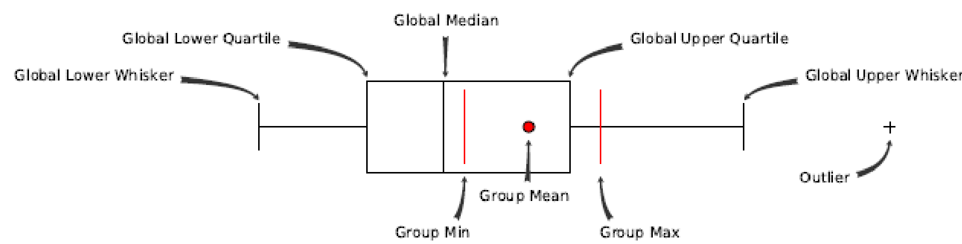
Group	Mean	Std. Dev.	Min	Max	Share
1	3.8600	0.0000	3.8600	3.8600	0.0000
2	4.8000	0.0000	4.8000	4.8000	0.0000
3	4.1725	0.3897	3.6576	4.6000	0.0795
4	8.2500	0.0000	8.2500	8.2500	0.0000
5	5.9400	0.0000	5.9400	5.9400	0.0000
6	12.1700	0.0000	12.1700	12.1700	0.0000
7	4.9200	0.0000	4.9200	4.9200	0.0000
8	6.1300	0.0000	6.1300	6.1300	0.0000
9	5.4900	0.0000	5.4900	5.4900	0.0000
10	3.5200	0.0000	3.5200	3.5200	0.0000
11	8.0490	2.4143	6.2000	15.0000	0.7426
12	4.1000	0.0000	4.1000	4.1000	0.0000
13	5.5700	0.0000	5.5700	5.5700	0.0000
14	4.9300	0.0000	4.9300	4.9300	0.0000
15	5.3649	1.6518	3.1500	13.8000	0.8987
Total	5.7049	2.0410	3.1500	15.0000	1.0000




Parallel Box Plot
POND
SALTWATER_S
CREEK
PEAT_BOG
LAKE
RIVER
MAX_LENGTH
MAX_WIDTH
SWAMP
−4
−2
0
2
4
6
8
10
Standardized Values

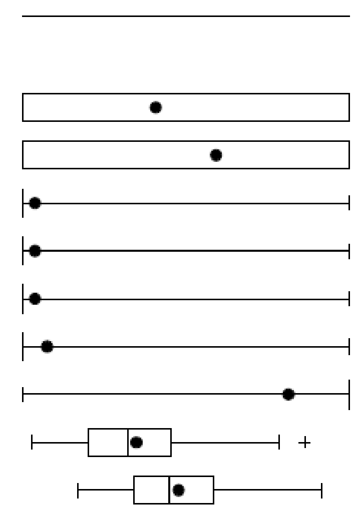

Pseudo F-Statistic Plot
Symbology
F-Stat
Max(F-Stat)
Pseudo F-Statistic
30
25
20
15
10
Number of Groups
2
4
6
8
10
12
14

Group-Wise Summary



Overall Variable Statistics: Count = 27, Std. Distance = 1.5604, SSD = 4.6929

Variable	Mean	Std. Dev.	Min	Max	R2
NOP	0.4074	0.4914	0.0000	1.0000	1.0000
OP	0.5926	0.4914	0.0000	1.0000	1.0000
BOG	0.0370	0.1889	0.0000	1.0000	1.0000
RIVER	0.0370	0.1889	0.0000	1.0000	1.0000
SWAMP	0.0370	0.1889	0.0000	1.0000	1.0000
POND	0.0741	0.2619	0.0000	1.0000	1.0000
LAKE	0.8148	0.3884	0.0000	1.0000	1.0000
MAX_LENGTH	5.0880	1.2696	3.1500	8.1900	0.9285
MAX_WIDTH	0.4863	0.1164	0.3000	0.7500	0.8977

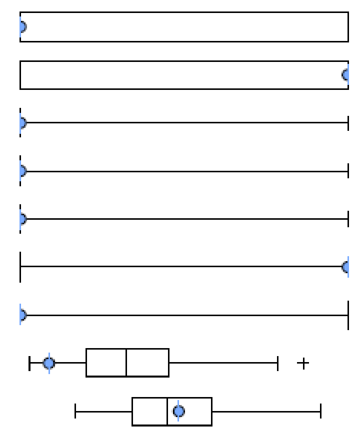


Subsample 4

Group-Wise Summary (cont.)

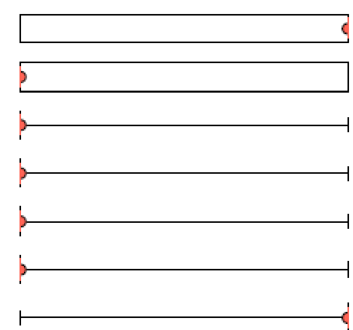
Group 1: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
NOP	0.0000	0.0000	0.0000	0.0000	0.0000
OP	1.0000	0.0000	1.0000	1.0000	0.0000
BOG	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	1.0000	0.0000	1.0000	1.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_LENGTH	3.5200	0.0000	3.5200	3.5200	0.0000
MAX_WIDTH	0.4900	0.0000	0.4900	0.4900	0.0000



Group 2: Count = 2, Std. Distance = 0.5252, SSD = 0.3752

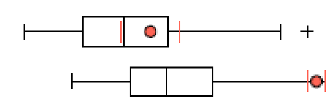
Variable	Mean	Std. Dev.	Min	Max	Share
NOP	1.0000	0.0000	1.0000	1.0000	0.0000
OP	0.0000	0.0000	0.0000	0.0000	0.0000
BOG	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	1.0000	0.0000	1.0000	1.0000	0.0000



Group-Wise Summary (cont.)

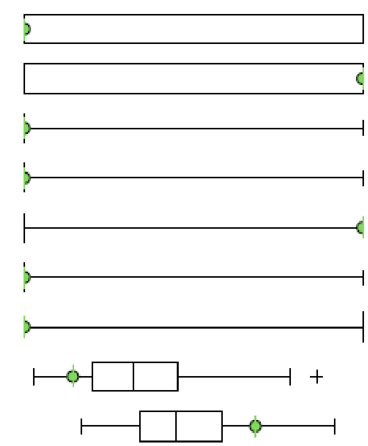
Group 2: Count = 2, Std. Distance = 0.5252, SSD = 0.3752

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	5.4050	0.5250	4.8800	5.9300	0.2083
MAX_WIDTH	0.7350	0.0150	0.7200	0.7500	0.0667



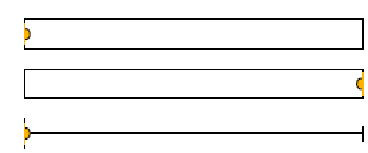
Group 3: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
NOP	0.0000	0.0000	0.0000	0.0000	0.0000
OP	1.0000	0.0000	1.0000	1.0000	0.0000
BOG	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	1.0000	0.0000	1.0000	1.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_LENGTH	3.8600	0.0000	3.8600	3.8600	0.0000
MAX_WIDTH	0.6100	0.0000	0.6100	0.6100	0.0000



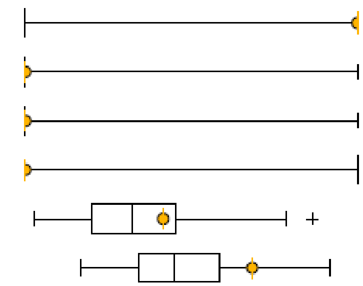
Group 4: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
NOP	0.0000	0.0000	0.0000	0.0000	0.0000
OP	1.0000	0.0000	1.0000	1.0000	0.0000
BOG	0.0000	0.0000	0.0000	0.0000	0.0000



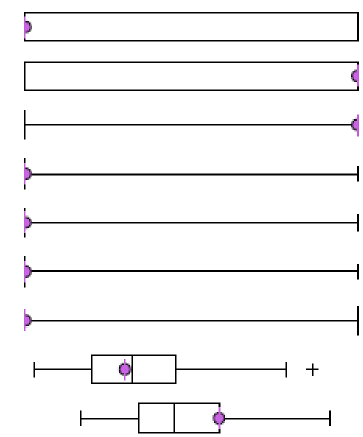
Group-Wise Summary (cont.)

Variable	Mean	Std. Dev.	Min	Max	Share
RIVER	1.0000	0.0000	1.0000	1.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_LENGTH	5.4900	0.0000	5.4900	5.4900	0.0000
MAX_WIDTH	0.6100	0.0000	0.6100	0.6100	0.0000



Group 5: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

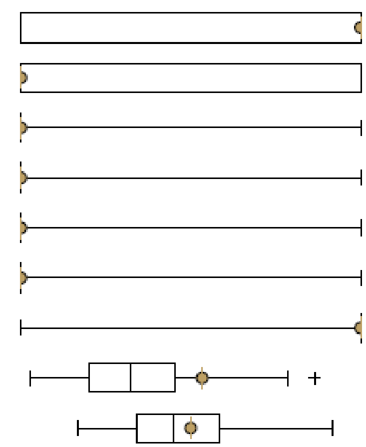
Variable	Mean	Std. Dev.	Min	Max	Share
NOP	0.0000	0.0000	0.0000	0.0000	0.0000
OP	1.0000	0.0000	1.0000	1.0000	0.0000
BOG	1.0000	0.0000	1.0000	1.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_LENGTH	4.8000	0.0000	4.8000	4.8000	0.0000
MAX_WIDTH	0.5500	0.0000	0.5500	0.5500	0.0000



Group-Wise Summary (cont.)

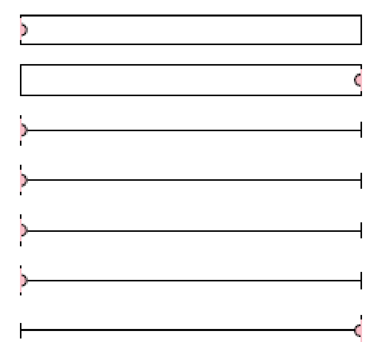
Group 6: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
NOP	1.0000	0.0000	1.0000	1.0000	0.0000
OP	0.0000	0.0000	0.0000	0.0000	0.0000
BOG	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	1.0000	0.0000	1.0000	1.0000	0.0000
MAX_LENGTH	6.2000	0.0000	6.2000	6.2000	0.0000
MAX_WIDTH	0.5000	0.0000	0.5000	0.5000	0.0000



Group 7: Count = 5, Std. Distance = 0.4877, SSD = 1.2942

Variable	Mean	Std. Dev.	Min	Max	Share
NOP	0.0000	0.0000	0.0000	0.0000	0.0000
OP	1.0000	0.0000	1.0000	1.0000	0.0000
BOG	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	1.0000	0.0000	1.0000	1.0000	0.0000



Group-Wise Summary (cont.)

Group 7: Count = 5, Std. Distance = 0.4877, SSD = 1.2942

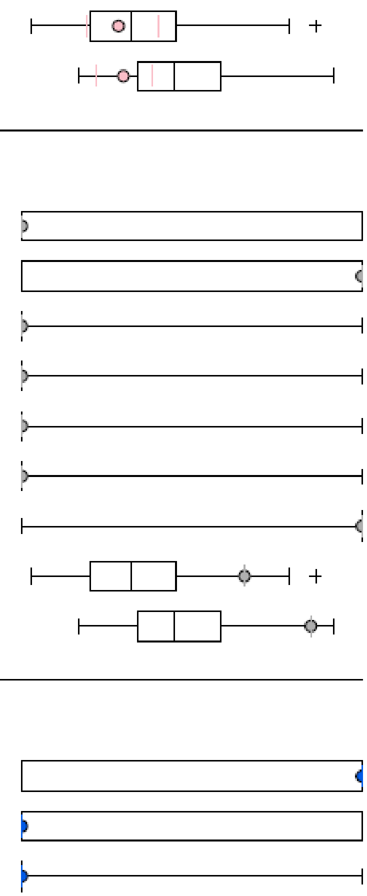
Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	4.7060	0.4861	4.1400	5.4000	0.2500
MAX_WIDTH	0.3790	0.0390	0.3302	0.4300	0.2218

Group 8: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
NOP	0.0000	0.0000	0.0000	0.0000	0.0000
OP	1.0000	0.0000	1.0000	1.0000	0.0000
BOG	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	1.0000	0.0000	1.0000	1.0000	0.0000
MAX_LENGTH	6.9300	0.0000	6.9300	6.9300	0.0000
MAX_WIDTH	0.7100	0.0000	0.7100	0.7100	0.0000

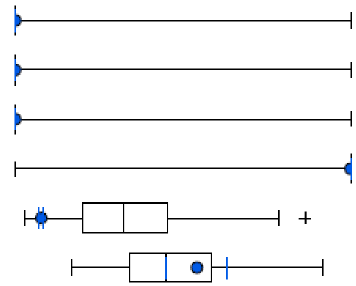
Group 9: Count = 2, Std. Distance = 0.0680, SSD = 0.4488

Variable	Mean	Std. Dev.	Min	Max	Share
NOP	1.0000	0.0000	1.0000	1.0000	0.0000
OP	0.0000	0.0000	0.0000	0.0000	0.0000
BOG	0.0000	0.0000	0.0000	0.0000	0.0000



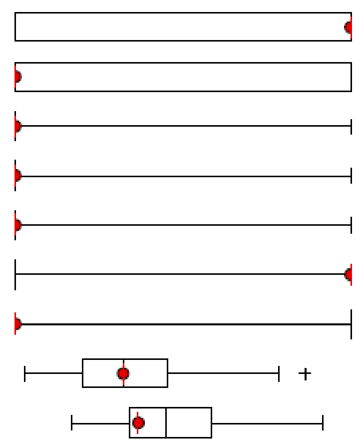
Group-Wise Summary (cont.)

Variable	Mean	Std. Dev.	Min	Max	Share
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	1.0000	0.0000	1.0000	1.0000	0.0000
MAX_LENGTH	3.4600	0.0400	3.4200	3.5000	0.0159
MAX_WIDTH	0.5250	0.0550	0.4700	0.5800	0.2444



Group 10: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

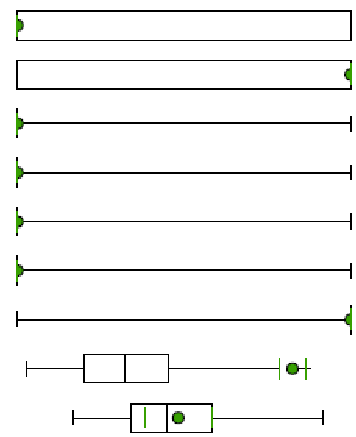
Variable	Mean	Std. Dev.	Min	Max	Share
NOP	1.0000	0.0000	1.0000	1.0000	0.0000
OP	0.0000	0.0000	0.0000	0.0000	0.0000
BOG	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	1.0000	0.0000	1.0000	1.0000	0.0000
LAKE	0.0000	0.0000	0.0000	0.0000	0.0000
MAX_LENGTH	4.9300	0.0000	4.9300	4.9300	0.0000
MAX_WIDTH	0.4200	0.0000	0.4200	0.4200	0.0000



Group-Wise Summary (cont.)

Group 11: Count = 2, Std. Distance = 0.2425, SSD = 0.6002

Variable	Mean	Std. Dev.	Min	Max	Share
NOP	0.0000	0.0000	0.0000	0.0000	0.0000
OP	1.0000	0.0000	1.0000	1.0000	0.0000
BOG	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	1.0000	0.0000	1.0000	1.0000	0.0000
MAX_LENGTH	7.9550	0.2350	7.7200	8.1900	0.0933
MAX_WIDTH	0.4900	0.0600	0.4300	0.5500	0.2667



Group 12: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
NOP	0.0000	0.0000	0.0000	0.0000	0.0000
OP	1.0000	0.0000	1.0000	1.0000	0.0000
BOG	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	1.0000	0.0000	1.0000	1.0000	0.0000

Group-Wise Summary (cont.)

Group 12: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

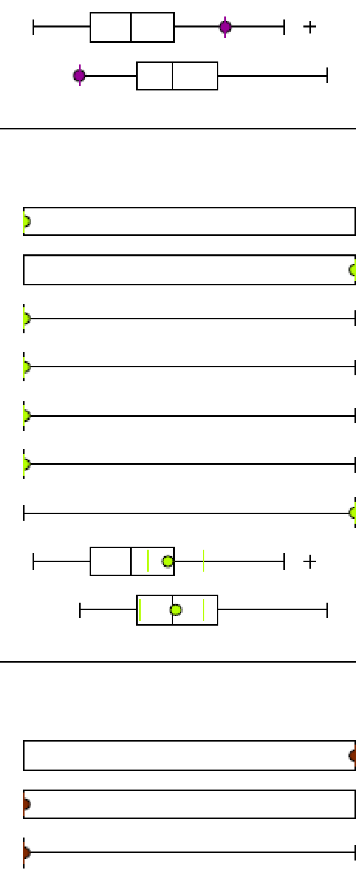
Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	6.6500	0.0000	6.6500	6.6500	0.0000
MAX_WIDTH	0.3000	0.0000	0.3000	0.3000	0.0000

Group 13: Count = 3, Std. Distance = 0.4596, SSD = 0.9021

Variable	Mean	Std. Dev.	Min	Max	Share
NOP	0.0000	0.0000	0.0000	0.0000	0.0000
OP	1.0000	0.0000	1.0000	1.0000	0.0000
BOG	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	1.0000	0.0000	1.0000	1.0000	0.0000
MAX_LENGTH	5.6067	0.4571	5.2300	6.2500	0.2024
MAX_WIDTH	0.4750	0.0481	0.4100	0.5250	0.2556

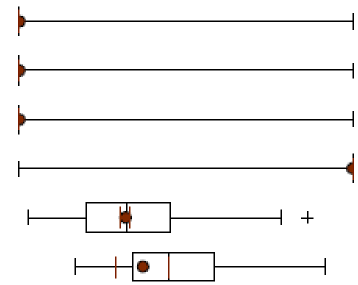
Group 14: Count = 2, Std. Distance = 0.0974, SSD = 0.3422

Variable	Mean	Std. Dev.	Min	Max	Share
NOP	1.0000	0.0000	1.0000	1.0000	0.0000
OP	0.0000	0.0000	0.0000	0.0000	0.0000
BOG	0.0000	0.0000	0.0000	0.0000	0.0000



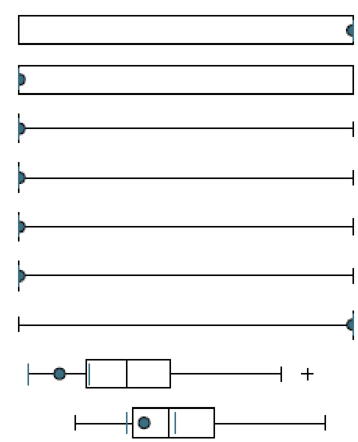
Group-Wise Summary (cont.)

Variable	Mean	Std. Dev.	Min	Max	Share
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	1.0000	0.0000	1.0000	1.0000	0.0000
MAX_LENGTH	4.9150	0.0850	4.8300	5.0000	0.0337
MAX_WIDTH	0.4225	0.0475	0.3750	0.4700	0.2111



Group 15: Count = 3, Std. Distance = 0.4584, SSD = 0.7301

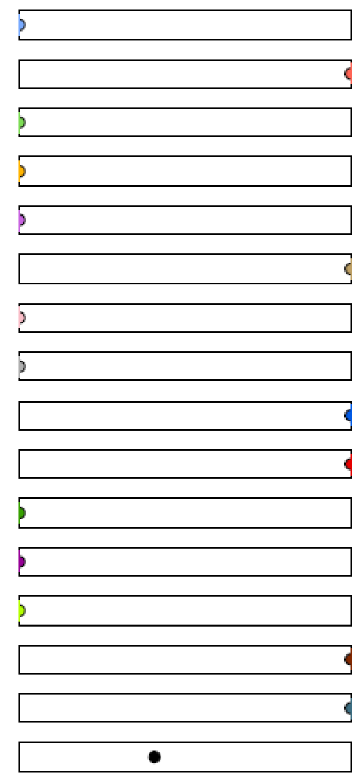
Variable	Mean	Std. Dev.	Min	Max	Share
NOP	1.0000	0.0000	1.0000	1.0000	0.0000
OP	0.0000	0.0000	0.0000	0.0000	0.0000
BOG	0.0000	0.0000	0.0000	0.0000	0.0000
RIVER	0.0000	0.0000	0.0000	0.0000	0.0000
SWAMP	0.0000	0.0000	0.0000	0.0000	0.0000
POND	0.0000	0.0000	0.0000	0.0000	0.0000
LAKE	1.0000	0.0000	1.0000	1.0000	0.0000
MAX_LENGTH	3.7257	0.4567	3.1500	4.2672	0.2217
MAX_WIDTH	0.4246	0.0393	0.3937	0.4800	0.1918



Variable-Wise Summary

NOP: R2 = 1.00

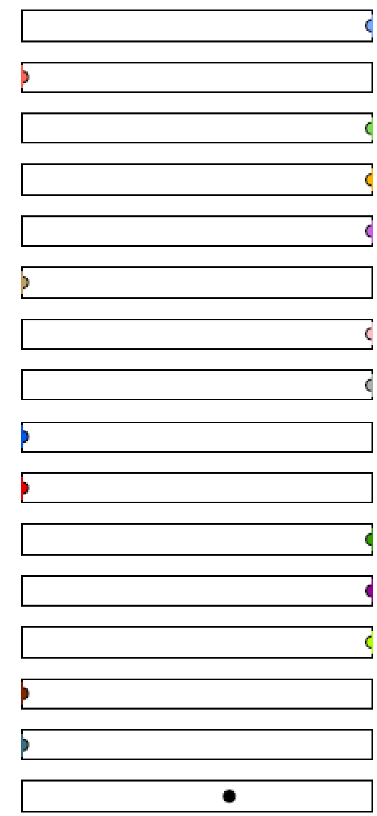
Group	Mean	Std. Dev.	Min	Max	Share
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	1.0000	0.0000	1.0000	1.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	1.0000	0.0000	1.0000	1.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000
9	1.0000	0.0000	1.0000	1.0000	0.0000
10	1.0000	0.0000	1.0000	1.0000	0.0000
11	0.0000	0.0000	0.0000	0.0000	0.0000
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.0000	0.0000	0.0000	0.0000
14	1.0000	0.0000	1.0000	1.0000	0.0000
15	1.0000	0.0000	1.0000	1.0000	0.0000
Total	0.4074	0.4914	0.0000	1.0000	1.0000



Variable-Wise Summary (cont.)

OP: R2 = 1.00

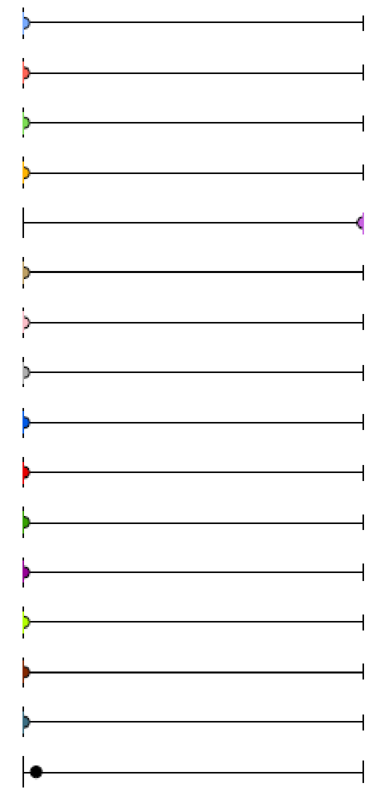
Group	Mean	Std. Dev.	Min	Max	Share
1	1.0000	0.0000	1.0000	1.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	1.0000	0.0000	1.0000	1.0000	0.0000
4	1.0000	0.0000	1.0000	1.0000	0.0000
5	1.0000	0.0000	1.0000	1.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000
7	1.0000	0.0000	1.0000	1.0000	0.0000
8	1.0000	0.0000	1.0000	1.0000	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000
11	1.0000	0.0000	1.0000	1.0000	0.0000
12	1.0000	0.0000	1.0000	1.0000	0.0000
13	1.0000	0.0000	1.0000	1.0000	0.0000
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.5926	0.4914	0.0000	1.0000	1.0000



Variable-Wise Summary (cont.)

BOG: R2 = 1.00

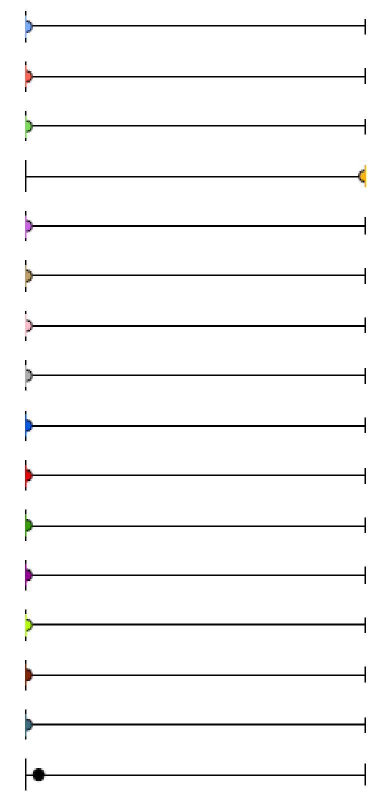
Group	Mean	Std. Dev.	Min	Max	Share
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000	0.0000
5	1.0000	0.0000	1.0000	1.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000
11	0.0000	0.0000	0.0000	0.0000	0.0000
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.0000	0.0000	0.0000	0.0000
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0370	0.1889	0.0000	1.0000	1.0000



Variable-Wise Summary (cont.)

RIVER: R2 = 1.00

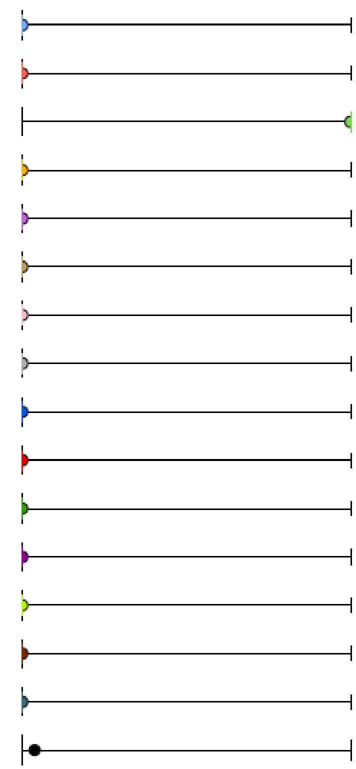
Group	Mean	Std. Dev.	Min	Max	Share
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	1.0000	0.0000	1.0000	1.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000
11	0.0000	0.0000	0.0000	0.0000	0.0000
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.0000	0.0000	0.0000	0.0000
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0370	0.1889	0.0000	1.0000	1.0000



Variable-Wise Summary (cont.)

SWAMP: R2 = 1.00

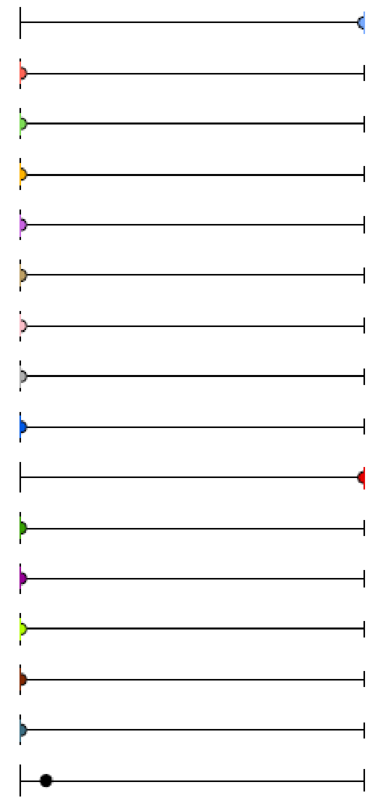
Group	Mean	Std. Dev.	Min	Max	Share
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	1.0000	0.0000	1.0000	1.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000
11	0.0000	0.0000	0.0000	0.0000	0.0000
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.0000	0.0000	0.0000	0.0000
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0370	0.1889	0.0000	1.0000	1.0000



Variable-Wise Summary (cont.)

POND: R2 = 1.00

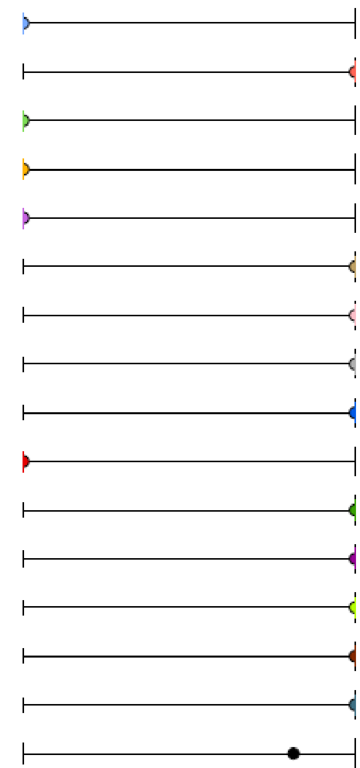
Group	Mean	Std. Dev.	Min	Max	Share
1	1.0000	0.0000	1.0000	1.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000
7	0.0000	0.0000	0.0000	0.0000	0.0000
8	0.0000	0.0000	0.0000	0.0000	0.0000
9	0.0000	0.0000	0.0000	0.0000	0.0000
10	1.0000	0.0000	1.0000	1.0000	0.0000
11	0.0000	0.0000	0.0000	0.0000	0.0000
12	0.0000	0.0000	0.0000	0.0000	0.0000
13	0.0000	0.0000	0.0000	0.0000	0.0000
14	0.0000	0.0000	0.0000	0.0000	0.0000
15	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0741	0.2619	0.0000	1.0000	1.0000



Variable-Wise Summary (cont.)

LAKE: R2 = 1.00

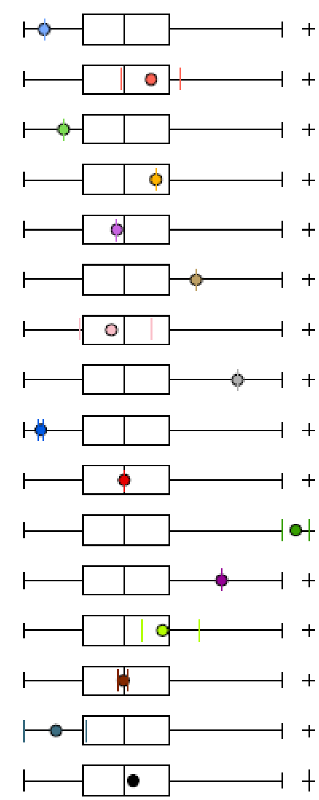
Group	Mean	Std. Dev.	Min	Max	Share
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	1.0000	0.0000	1.0000	1.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000	0.0000
5	0.0000	0.0000	0.0000	0.0000	0.0000
6	1.0000	0.0000	1.0000	1.0000	0.0000
7	1.0000	0.0000	1.0000	1.0000	0.0000
8	1.0000	0.0000	1.0000	1.0000	0.0000
9	1.0000	0.0000	1.0000	1.0000	0.0000
10	0.0000	0.0000	0.0000	0.0000	0.0000
11	1.0000	0.0000	1.0000	1.0000	0.0000
12	1.0000	0.0000	1.0000	1.0000	0.0000
13	1.0000	0.0000	1.0000	1.0000	0.0000
14	1.0000	0.0000	1.0000	1.0000	0.0000
15	1.0000	0.0000	1.0000	1.0000	0.0000
Total	0.8148	0.3884	0.0000	1.0000	1.0000



Variable-Wise Summary (cont.)

MAX_LENGTH: R2 = 0.93

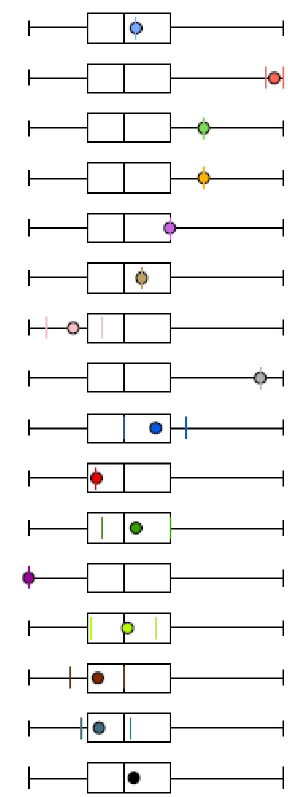
Group	Mean	Std. Dev.	Min	Max	Share
1	3.5200	0.0000	3.5200	3.5200	0.0000
2	5.4050	0.5250	4.8800	5.9300	0.2083
3	3.8600	0.0000	3.8600	3.8600	0.0000
4	5.4900	0.0000	5.4900	5.4900	0.0000
5	4.8000	0.0000	4.8000	4.8000	0.0000
6	6.2000	0.0000	6.2000	6.2000	0.0000
7	4.7060	0.4861	4.1400	5.4000	0.2500
8	6.9300	0.0000	6.9300	6.9300	0.0000
9	3.4600	0.0400	3.4200	3.5000	0.0159
10	4.9300	0.0000	4.9300	4.9300	0.0000
11	7.9550	0.2350	7.7200	8.1900	0.0933
12	6.6500	0.0000	6.6500	6.6500	0.0000
13	5.6067	0.4571	5.2300	6.2500	0.2024
14	4.9150	0.0850	4.8300	5.0000	0.0337
15	3.7257	0.4567	3.1500	4.2672	0.2217
Total	5.0880	1.2696	3.1500	8.1900	1.0000

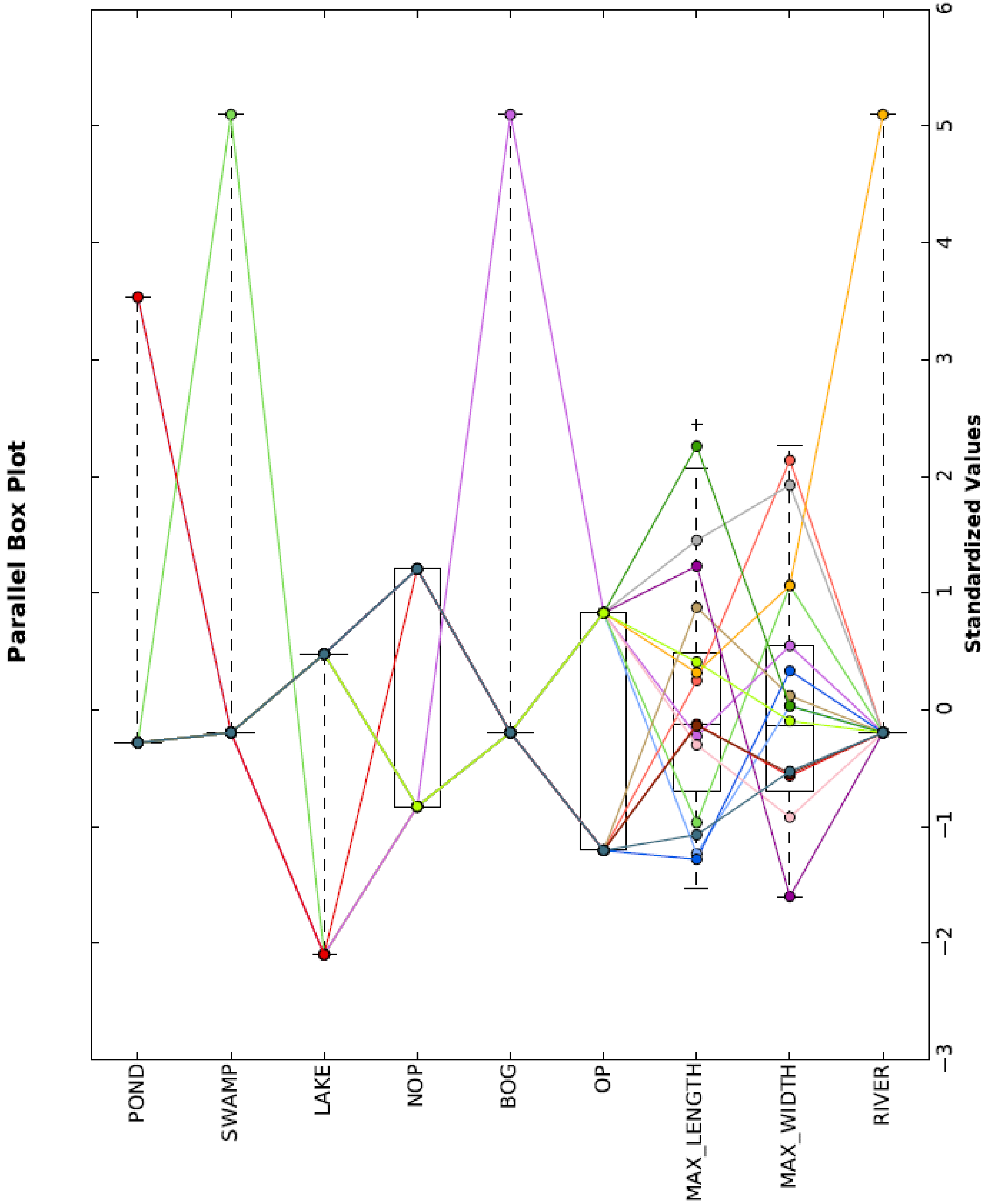


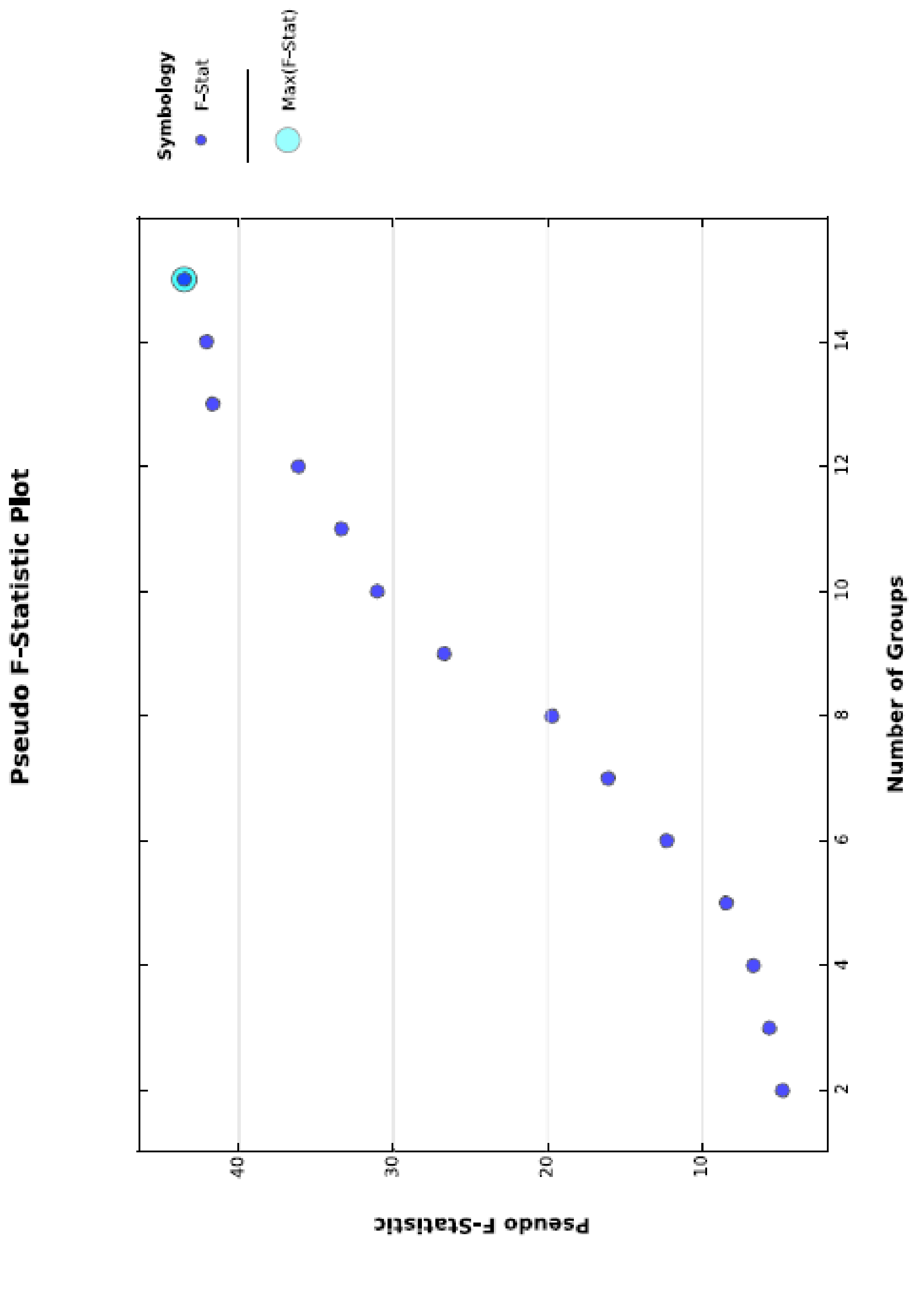
Variable-Wise Summary (cont.)

MAX_WIDTH: R2 = 0.90

Group	Mean	Std. Dev.	Min	Max	Share
1	0.4900	0.0000	0.4900	0.4900	0.0000
2	0.7350	0.0150	0.7200	0.7500	0.0667
3	0.6100	0.0000	0.6100	0.6100	0.0000
4	0.6100	0.0000	0.6100	0.6100	0.0000
5	0.5500	0.0000	0.5500	0.5500	0.0000
6	0.5000	0.0000	0.5000	0.5000	0.0000
7	0.3790	0.0390	0.3302	0.4300	0.2218
8	0.7100	0.0000	0.7100	0.7100	0.0000
9	0.5250	0.0550	0.4700	0.5800	0.2444
10	0.4200	0.0000	0.4200	0.4200	0.0000
11	0.4900	0.0600	0.4300	0.5500	0.2667
12	0.3000	0.0000	0.3000	0.3000	0.0000
13	0.4750	0.0481	0.4100	0.5250	0.2556
14	0.4225	0.0475	0.3750	0.4700	0.2111
15	0.4246	0.0393	0.3937	0.4800	0.1918
Total	0.4863	0.1164	0.3000	0.7500	1.0000

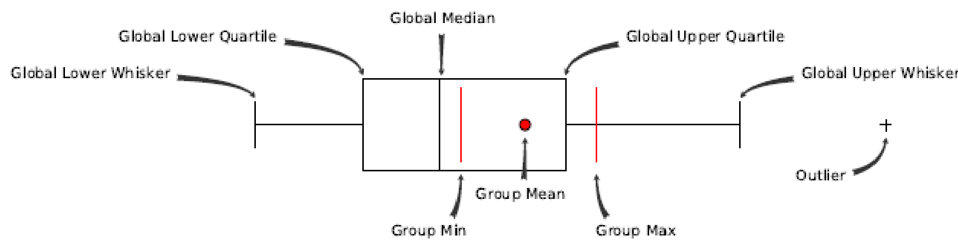



Parallel Box Plot
POND
SWAMP
LAKE
NOP
BOG
OP
MAX_LENGTH
MAX_WIDTH
RIVER
−3
−2
−1
0
1
2
3
4
5
6
Standardized Values



Pseudo F-Statistic Plot
Symbology
F-Stat
Max(F-Stat)
Pseudo F-Statistic
40
30
20
10
Number of Groups
2
4
6
8
10
12
14

Group-Wise Summary



Overall Variable Statistics: Count = 52, Std. Distance = 1389.7597, SSD = 17.7093

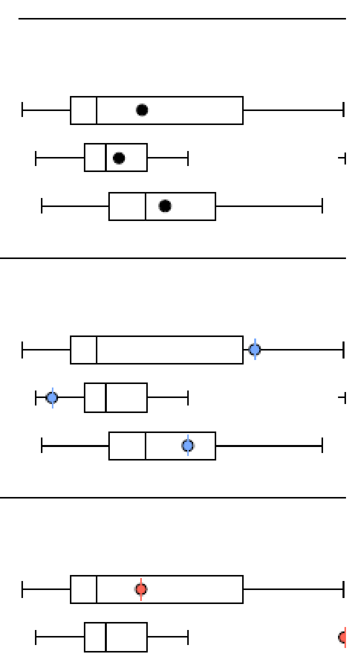
Variable	Mean	Std. Dev.	Min	Max	R2
CONVENTIONAL	1885.6346	1389.7591	30.0000	4990.0000	0.9364
MAX_WIDTH	0.5063	0.1502	0.2500	1.2000	0.8676
MAX_LENGTH	5.6890	1.2937	3.4200	8.6000	0.8555

Group 1: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
CONVENTIONAL	3620.0000	0.0000	3620.0000	3620.0000	0.0000
MAX_WIDTH	0.3000	0.0000	0.3000	0.3000	0.0000
MAX_LENGTH	6.1100	0.0000	6.1100	6.1100	0.0000

Group 2: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
CONVENTIONAL	1870.0000	0.0000	1870.0000	1870.0000	0.0000
MAX_WIDTH	1.2000	0.0000	1.2000	1.2000	0.0000



Subsample 5

Group-Wise Summary (cont.)

Group 2: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
MAX_LENGTH	8.2500	0.0000	8.2500	8.2500	0.0000

Group 3: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

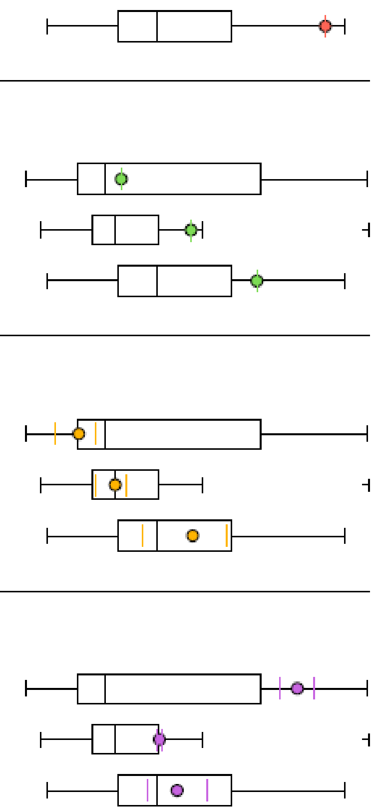
Variable	Mean	Std. Dev.	Min	Max	Share
CONVENTIONAL	1420.0000	0.0000	1420.0000	1420.0000	0.0000
MAX_WIDTH	0.6860	0.0000	0.6860	0.6860	0.0000
MAX_LENGTH	7.0600	0.0000	7.0600	7.0600	0.0000

Group 4: Count = 3, Std. Distance = 249.9786, SSD = 1.0406

Variable	Mean	Std. Dev.	Min	Max	Share
CONVENTIONAL	806.6667	249.9778	460.0000	1040.0000	0.1169
MAX_WIDTH	0.4667	0.0403	0.4100	0.5000	0.0947
MAX_LENGTH	5.9467	0.6373	5.0600	6.5300	0.2838

Group 5: Count = 2, Std. Distance = 240.0006, SSD = 0.3912

Variable	Mean	Std. Dev.	Min	Max	Share
CONVENTIONAL	3970.0000	240.0000	3730.0000	4210.0000	0.0968
MAX_WIDTH	0.5950	0.0050	0.5900	0.6000	0.0105
MAX_LENGTH	5.6750	0.5250	5.1500	6.2000	0.2027



Group-Wise Summary (cont.)

Group 6: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
CONVENTIONAL	4990.0000	0.0000	4990.0000	4990.0000	0.0000
MAX_WIDTH	0.3937	0.0000	0.3937	0.3937	0.0000
MAX_LENGTH	4.2672	0.0000	4.2672	4.2672	0.0000

Group 7: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

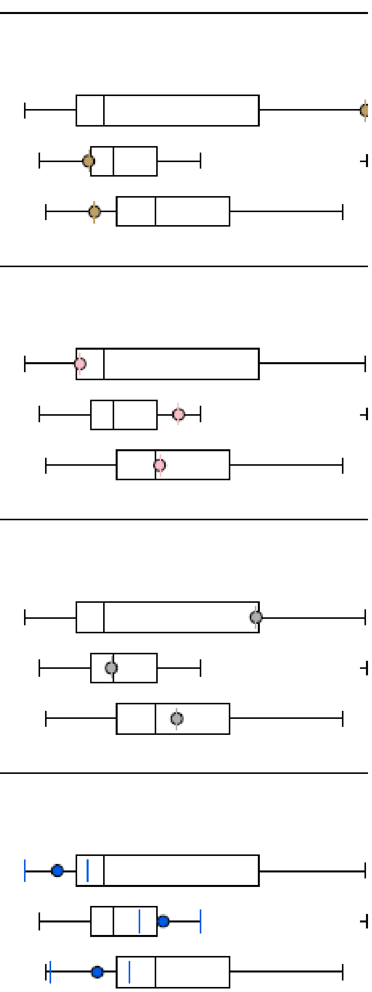
Variable	Mean	Std. Dev.	Min	Max	Share
CONVENTIONAL	845.0000	0.0000	845.0000	845.0000	0.0000
MAX_WIDTH	0.6550	0.0000	0.6550	0.6550	0.0000
MAX_LENGTH	5.4000	0.0000	5.4000	5.4000	0.0000

Group 8: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
CONVENTIONAL	3400.0000	0.0000	3400.0000	3400.0000	0.0000
MAX_WIDTH	0.4600	0.0000	0.4600	0.4600	0.0000
MAX_LENGTH	5.7000	0.0000	5.7000	5.7000	0.0000

Group 9: Count = 4, Std. Distance = 355.6578, SSD = 1.7344

Variable	Mean	Std. Dev.	Min	Max	Share
CONVENTIONAL	516.2500	355.6574	30.0000	945.0000	0.1845
MAX_WIDTH	0.6100	0.0671	0.5400	0.7200	0.1895
MAX_LENGTH	4.3150	0.5315	3.5000	4.8800	0.2664



Group-Wise Summary (cont.)

Group 10: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
CONVENTIONAL	430.0000	0.0000	430.0000	430.0000	0.0000
MAX_WIDTH	0.4000	0.0000	0.4000	0.4000	0.0000
MAX_LENGTH	7.0300	0.0000	7.0300	7.0300	0.0000

Group 11: Count = 10, Std. Distance = 453.7723, SSD = 5.4098

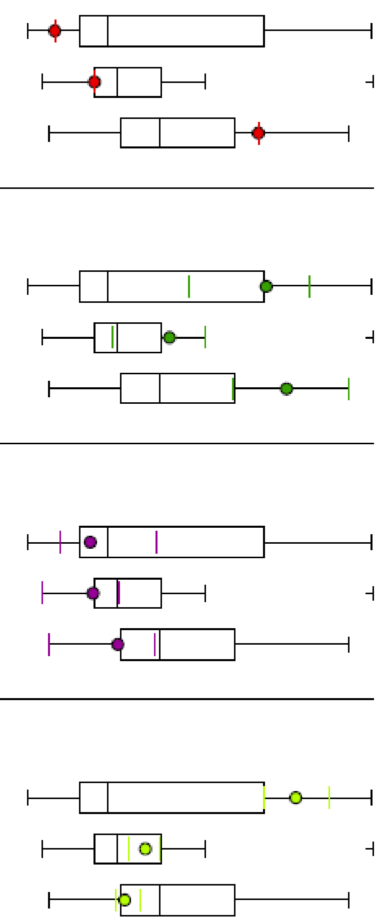
Variable	Mean	Std. Dev.	Min	Max	Share
CONVENTIONAL	3471.0000	453.7720	2370.0000	4090.0000	0.3468
MAX_WIDTH	0.6160	0.0750	0.4500	0.7200	0.2842
MAX_LENGTH	7.5170	0.5568	6.6000	8.6000	0.3861

Group 12: Count = 15, Std. Distance = 386.1379, SSD = 5.0753

Variable	Mean	Std. Dev.	Min	Max	Share
CONVENTIONAL	941.5333	386.1376	500.0000	1903.0000	0.2829
MAX_WIDTH	0.3962	0.0501	0.2500	0.4700	0.2316
MAX_LENGTH	4.6047	0.5007	3.4200	5.2300	0.3494

Group 13: Count = 3, Std. Distance = 379.8538, SSD = 0.4731

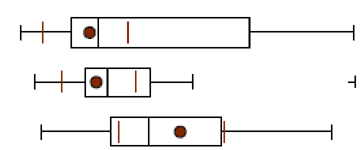
Variable	Mean	Std. Dev.	Min	Max	Share
CONVENTIONAL	3896.6667	379.8538	3440.0000	4370.0000	0.1875
MAX_WIDTH	0.5467	0.0368	0.5000	0.5900	0.0947
MAX_LENGTH	4.7233	0.1960	4.5700	5.0000	0.0830



Group-Wise Summary (cont.)

Group 14: Count = 8, Std. Distance = 325.9295, SSD = 3.5849

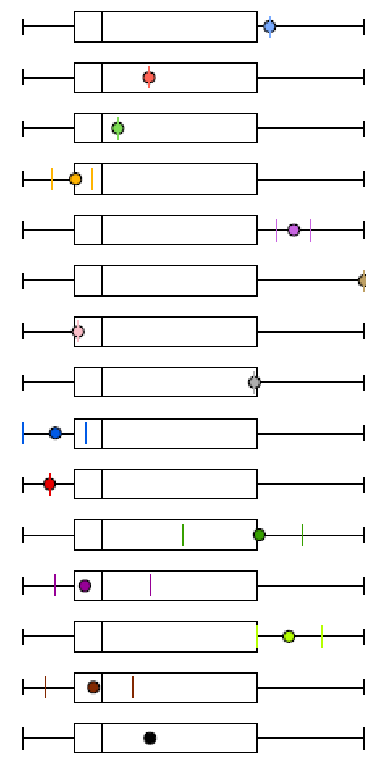
Variable	Mean	Std. Dev.	Min	Max	Share
CONVENTIONAL	1066.2500	325.9290	370.0000	1635.0000	0.2550
MAX_WIDTH	0.4325	0.0657	0.3302	0.5500	0.2314
MAX_LENGTH	5.8937	0.5815	4.8000	6.6700	0.3610



Variable-Wise Summary

CONVENTIONAL: R2 = 0.94

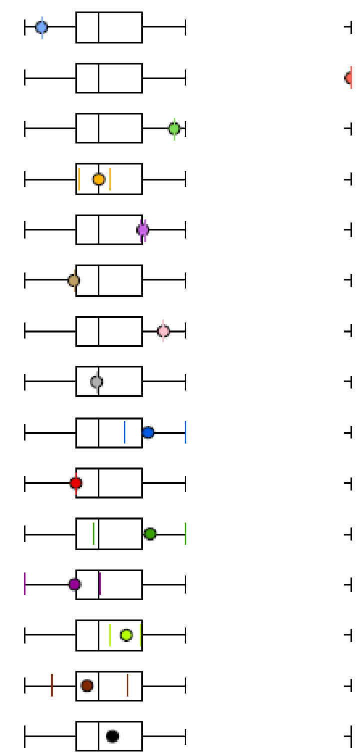
Group	Mean	Std. Dev.	Min	Max	Share
1	3620.0000	0.0000	3620.0000	3620.0000	0.0000
2	1870.0000	0.0000	1870.0000	1870.0000	0.0000
3	1420.0000	0.0000	1420.0000	1420.0000	0.0000
4	806.6667	249.9778	460.0000	1040.0000	0.1169
5	3970.0000	240.0000	3730.0000	4210.0000	0.0968
6	4990.0000	0.0000	4990.0000	4990.0000	0.0000
7	845.0000	0.0000	845.0000	845.0000	0.0000
8	3400.0000	0.0000	3400.0000	3400.0000	0.0000
9	516.2500	355.6574	30.0000	945.0000	0.1845
10	430.0000	0.0000	430.0000	430.0000	0.0000
11	3471.0000	453.7720	2370.0000	4090.0000	0.3468
12	941.5333	386.1376	500.0000	1903.0000	0.2829
13	3896.6667	379.8538	3440.0000	4370.0000	0.1875
14	1066.2500	325.9290	370.0000	1635.0000	0.2550
Total	1885.6346	1389.7591	30.0000	4990.0000	1.0000



Variable-Wise Summary (cont.)

MAX_WIDTH: R2 = 0.87

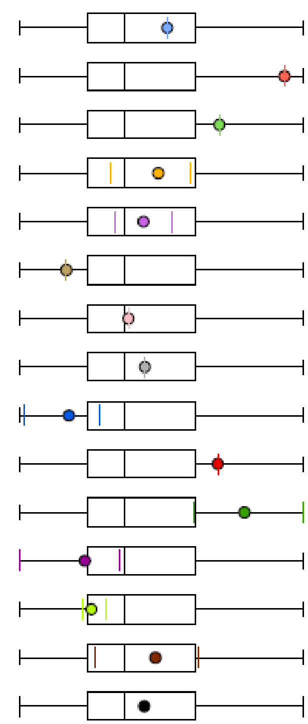
Group	Mean	Std. Dev.	Min	Max	Share
1	0.3000	0.0000	0.3000	0.3000	0.0000
2	1.2000	0.0000	1.2000	1.2000	0.0000
3	0.6860	0.0000	0.6860	0.6860	0.0000
4	0.4667	0.0403	0.4100	0.5000	0.0947
5	0.5950	0.0050	0.5900	0.6000	0.0105
6	0.3937	0.0000	0.3937	0.3937	0.0000
7	0.6550	0.0000	0.6550	0.6550	0.0000
8	0.4600	0.0000	0.4600	0.4600	0.0000
9	0.6100	0.0671	0.5400	0.7200	0.1895
10	0.4000	0.0000	0.4000	0.4000	0.0000
11	0.6160	0.0750	0.4500	0.7200	0.2842
12	0.3962	0.0501	0.2500	0.4700	0.2316
13	0.5467	0.0368	0.5000	0.5900	0.0947
14	0.4325	0.0657	0.3302	0.5500	0.2314
Total	0.5063	0.1502	0.2500	1.2000	1.0000

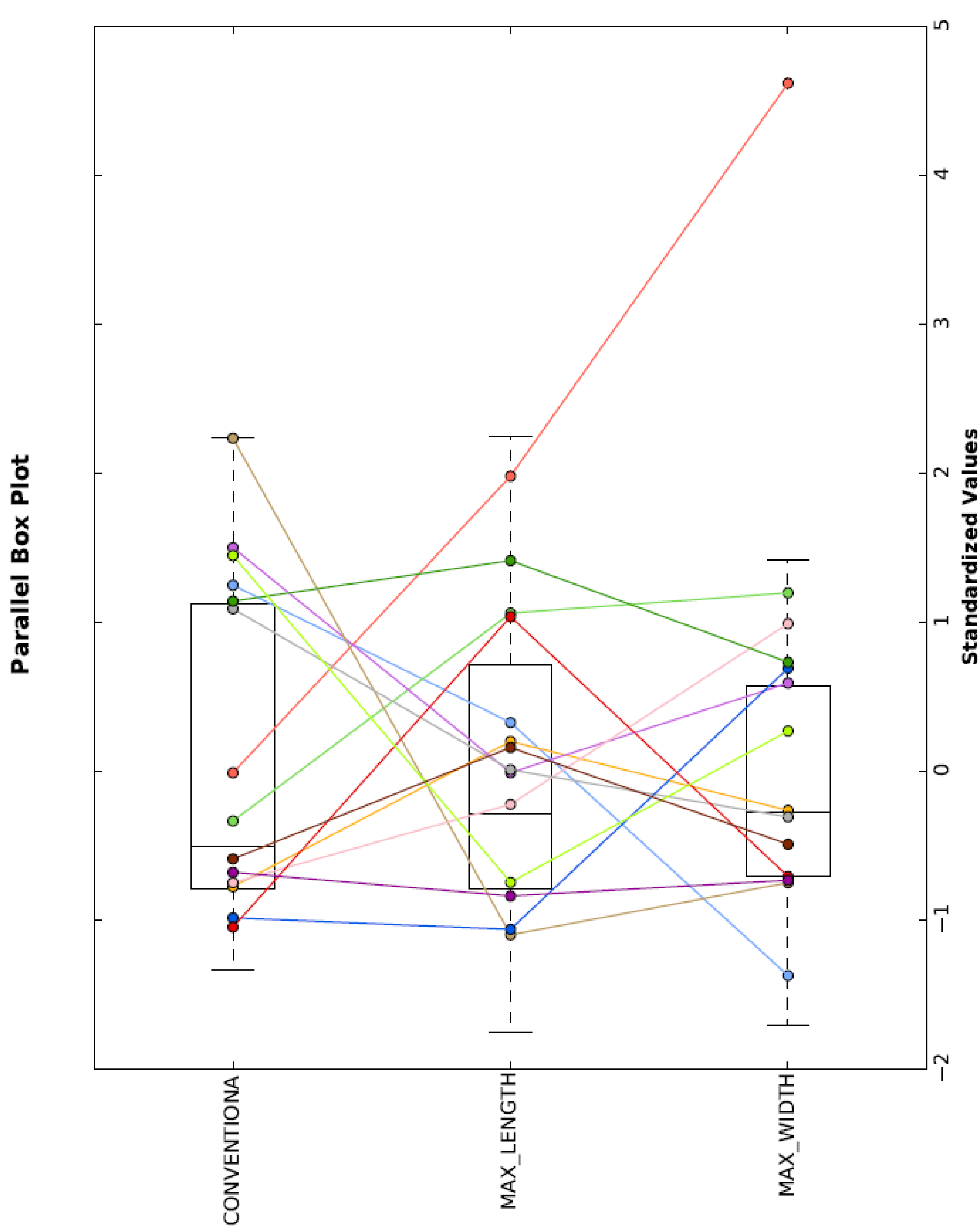


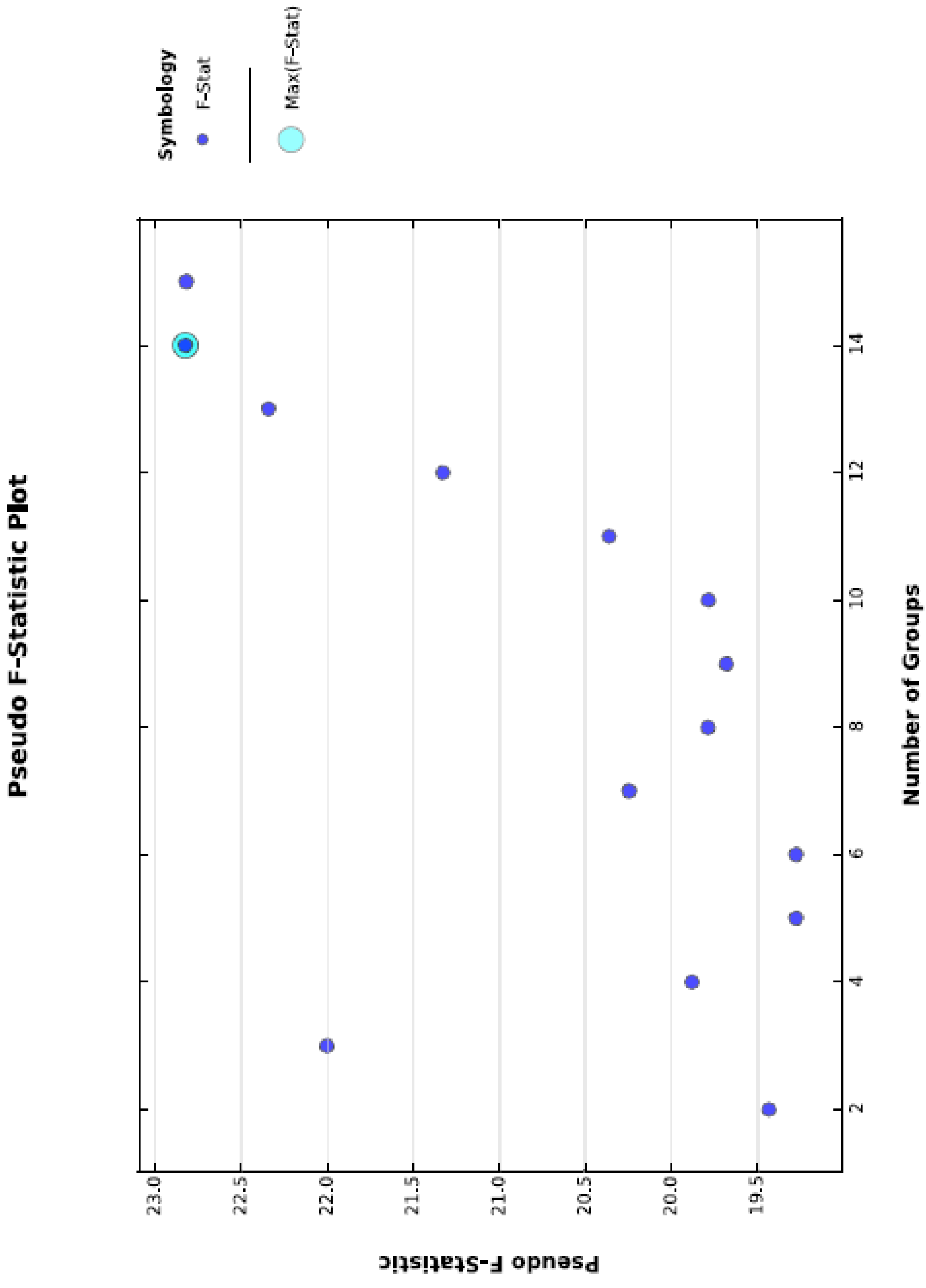
Variable-Wise Summary (cont.)

MAX_LENGTH: R2 = 0.86

Group	Mean	Std. Dev.	Min	Max	Share
1	6.1100	0.0000	6.1100	6.1100	0.0000
2	8.2500	0.0000	8.2500	8.2500	0.0000
3	7.0600	0.0000	7.0600	7.0600	0.0000
4	5.9467	0.6373	5.0600	6.5300	0.2838
5	5.6750	0.5250	5.1500	6.2000	0.2027
6	4.2672	0.0000	4.2672	4.2672	0.0000
7	5.4000	0.0000	5.4000	5.4000	0.0000
8	5.7000	0.0000	5.7000	5.7000	0.0000
9	4.3150	0.5315	3.5000	4.8800	0.2664
10	7.0300	0.0000	7.0300	7.0300	0.0000
11	7.5170	0.5568	6.6000	8.6000	0.3861
12	4.6047	0.5007	3.4200	5.2300	0.3494
13	4.7233	0.1960	4.5700	5.0000	0.0830
14	5.8937	0.5815	4.8000	6.6700	0.3610
Total	5.6890	1.2937	3.4200	8.6000	1.0000




Parallel Box Plot
CONVENTIONA
MAX_LENGTH
MAX_WIDTH
−2
−1
0
1
2
3
4
5
Standardized Values



Pseudo F-Statistic Plot
Symbology
F-Stat
Max(F-Stat)
Pseudo F-Statistic
23.0
22.5
22.0
21.5
21.0
20.5
20.0
19.5
Number of Groups
2
4
6
8
10
12
14