

Consumer Preference Study of Characteristics of Hawaiian Koa Wood Bowls

Eini C. Lowell^{*1}, Katherine Wilson², Jan Wiedenbeck³,
Catherine Chan², J. B. Friday⁴, and Nicole Evans²

Abstract

Koa (Acacia koa A. Gray), a species endemic to the Hawaiian Islands, has ecological, cultural, and economic significance. Its wood is prized globally but today, most woodworkers only use koa wood from dead and dying old-growth trees. The general perception of wood from young-growth koa is that it lacks the color and figure of old-growth wood and is thus less appealing to consumers. To evaluate consumer preference of koa attributes, a conjoint choice experiment was conducted using randomly combined levels of attributes, including color, figure (curl), and price, with six identically shaped bowls from which respondents selected their preferences. The survey was conducted at six locations on O'ahu (372 respondents) to poll a variety of koa product consumers. Latent class analysis software was used to separate respondents into distinct classes based on expressed preferences. The results identified five classes of respondents. Class 1 (24% of respondents) showed significant preference for lower prices, medium color, and non-curl bowls. Class 2 (22% of respondents) showed significant preference for light colored and curly bowls. Class 3 (20% of respondents) showed significant preference for light or medium colored and curly bowls. Class 4 (19% of respondents) significantly preferred lower prices and light or medium colored bowls. Class 5 (15% of respondents) also significantly preferred lower prices but they significantly preferred darker colored and curly bowls as well. Opportunities exist for koa woodworkers to create products manufactured from young-growth koa wood that appeal to different market segments. The ability to substitute young-growth koa for the decreasing supply of old-growth wood can aid in promoting active management of the species.

Keywords: *Acacia koa*, conjoint choice, Hawaii, consumer preferences, wood products, young-growth

1.0 Introduction

Endemic to Hawai'i, koa (*Acacia koa* A. Gray) wood is prized internationally for its attributes of color and figure (curl; Figure 1). Koa's reputation has been built primarily on wood cut from old-growth trees. The price for koa

is one of the highest in the world (Elevitch et al. 2006), particularly for highly figured lumber. Color and figure are two characteristics that play an important role in determining the price of each piece of wood (Dudley and Yamasaki 2000). Koa's value is evidenced by the small sizes of pieces manufactured and marketed. For example, pen blanks as small as ¾ inch by ¾ inch by 5.5 inch are sawn and sold. Branches and stumps are also used to create products. Woodworkers and craftspeople in Hawai'i use variations in these attributes to create one-of-a kind products – everything from large pieces of furniture and sculptures to salad servers and pens. Woodworkers delight in working with koa's variable grain, curly figure, and color to create uniquely beautiful products. People value the presence of koa in their homes and buildings with appearance preferences varying as much as the wood itself.

1 USDA Forest Service, Pacific Northwest Research Station, 620 SW Main St. Suite 400, Portland, OR 97205

2 College of Tropical Agricultural and Human Resources, University of Hawai'i at Mānoa, 1910 East-West Road, Honolulu, HI 96822

3 USDA Forest Service, Northern Research Station, 301 Hardwood Lane, Suite B, Princeton, WV 24740

4 College of Tropical Agricultural and Human Resources, University of Hawai'i at Mānoa, Cooperative Extension Service, 875 Komohana Street, Hilo, HI 96720

* Corresponding author: Email: elowell@fs.fed.us; Tel: (503) 808-2072

Acknowledgements: The authors would like to thank the Hawai'i Forest Industry Association for allowing surveys to be conducted during their annual Woodshow. We appreciate the assistance of Cassie Zhang, a graduate student at the University of Hawai'i, who aided in conducting the surveys and analyzing the data. The authors would like to acknowledge and thank Timothy Allen Shafto for turning the bowls used in this study.

However, availability of the old-growth resource is decreasing. More than two decades ago, Shehata (1993) had forecast that koa would no longer be available to the forest products industry in approximately 14 years as a result of unsustainable harvesting, disease, and decay, coupled with high demand for koa logs. While not quite as dire as the prediction, koa harvest on private lands continues but is largely limited to dead, dying, and downed trees. There is no current harvesting of koa from state or federal public lands, with the exception of harvesting for cultural uses. As an example, recent timber sale contracts on lands administered by the Department of Hawaiian Homelands (DHHL 2014) have specified that no healthy koa trees, defined as vigorous trees with full crowns and little or no dieback, would be disturbed or harvested. Therefore, most old-growth stock comes from private lands. These supply limitations only increase koa's value.

Koa, while having cultural and ecological significance, also plays an important role in the Hawaiian economy. Koa products were estimated to comprise 75 percent of the total value of all Hawaiian grown wood products sold by Hawaiian retailers in 2001 (Friday et al. 2006), contributing an estimated \$18 million to the Hawaiian economy. Sustainability of this endemic tree is a major concern and requires active management of young-growth trees (Baker et al. 2009). Interest in establishing koa plantations is limited, as little economic benefit is reaped in the time between planting and harvest, which can be as long as 80 years. Further, a market for young-growth koa has yet to be established (Pejchar and Press 2006). The ability to market products made from young-growth koa will provide an incentive for active management in young-growth stands.

Bumgardner and Bowe (2002) concluded that species perception is an integral part of consumer preference. It is thought that the name "koa," by itself, has market recognition and creates desirability. The inability of many consumers to identify wood species was documented by Bowe and Bumgardner (2004) and Bumgardner et al. (2007), which can be relevant in assessing the market potential of koa products derived from younger trees. For example, mahogany, cherry, and black walnut species that, like koa, are highly regarded for their rich and somewhat darker colors, were correctly identified only 22, 20, and 45 percent of the time, respectively, by consumers (Bowe and Bumgardner 2004). If the name "koa" evokes a positive image and desirability, even when



Figure 1. An *Acacia koa* board depicting a curl pattern in the timber. Photo credit: J.B. Friday

visual recognition of the wood is uncertain, using koa from young-growth trees in products may be acceptable for many consumers.

Appearance attributes, such as color and figure, also influence consumer preferences and perceptions. Color and figure have been identified as key attributes in creating and marketing koa products. Curl is an almost iridescent sheen that is only occasionally present in trees. One observation suggests that even when a tree has curl, it is found in only approximately 10% of the wood (Woodshop News 2009). Loudat et al. (1996) estimate that only 5% of lumber will be of higher grades with curl. Woodworkers desire the old-growth koa trees because of the wood density, color (darker and more variation), and presence of curl (Dudley and Yamasaki 2000). In contrast, young-growth koa trees are perceived to be lighter in color and lacking in curl, however, Loudat et al. (1996) reported curl and figure in 20-year-old koa. In a study by Bumgardner and Bowe (2002), consumers thought darker color woods reflected higher value than lighter color woods and lighter color was associated with modern or contemporary designs. Results such as these suggest that opportunities exist for producing and marketing koa products from both young- and old-growth trees.

The importance of wood product price and origin have been shown to be important in consumer preference studies. Individual consumers surveyed in Guangzhou, China indicated a preference for gift baskets made from koa as being more important than price or

product origin, while basket price was more important to business buyers (Chan-Halbrendt et al. 2006). For both groups of buyers, price was the second-most important consideration. Donovan and Nicholls (2003) found that consumers would pay a higher price for an Alaskan made end table over one that was manufactured in China. For secondary manufacturers using Eastern white pine (*Pinus strobus* L.), lumber quality and the region of origin had the largest influence on purchasing decisions (Alderman et al. 2007).

Conjoint analysis is an approach used to discern consumer preferences among attributes that, when considered together, distinguish a product or service. Choice-based conjoint analysis is a conjoint approach in which respondents are presented with a manageable number (often three) of product options to choose from at one time. The survey participant chooses the product having the bundle of attribute levels that they are most likely to purchase. Green and Srinivasan (1978) described conjoint choice analysis as having the ability to determine how certain product attributes affect whether a consumer is likely to purchase an item while also quantifying attribute significance to the purchasing decision.

Preference can be described as an additive function of attributes using the part-worth model (Cattin and Wittinek 1982). Therefore, in designing the conjoint experiment, it is important to limit the number of attributes being measured, as higher numbers of attributes require respondents to make trade-offs among important attributes. Green and Sirinivisan (1978) found that if there are more than six attributes to decide among, people will have difficulties evaluating individual attributes.

Conjoint analysis does have limitations; as reported by Cattin and Wittinek (1982), results reveal respondents' intent-to-purchase, not actual purchase behavior. Non-choice based conjoint approaches, in which potential consumers rate or rank different versions of a product with which they are presented, do not mimic actual consumer purchase decisions, and are therefore thought to be less reliable.

Conjoint analysis has been used to assess various attributes of wood furniture, including environmental attributes in purchasing wood products (Aguilar and Cai 2010, Bigsby and Ozanne 2002, Anderson and Hansen 2004, Osburg et al. 2016). Wang et al. (2004) assessed design, price, density of character marks, and guarantee policy; the researchers found that design was most

important to consumers and price was second most important. A similar result was reported by Liker et al. (2016), who found that kitchen furniture consumers were more concerned with design and manufacturer than they were with price.

The major objectives of this study were to evaluate whether a potential market exists for a product manufactured from young-growth koa trees based on three attributes (color, figure, and price) using conjoint choice analysis for identifying consumer preferences and to describe attribute importance of different consumer groups.

2.0 Experimental Methods

2.1 Sample Design

A choice-based conjoint experiment was used to measure preferences for koa attributes thought to differ between old-growth and young-growth wood products. The conjoint choice survey was designed using Sawtooth Software® (2014). This software was used to design the experiment and is capable of quantitatively measuring preferences for different attributes as well as their levels. Based on the survey data collected, a set of preference scores (part-worth utilities) was generated for attributes of interest.

This project specifically looks at the different characteristics of koa wood that drive consumer choices. Three characteristics, or attributes, were identified: color, figure (the figure of interest is a curly grain pattern, referred to as "curl"), and price. An 8-inch diameter koa bowl was chosen to represent these attributes, as bowls are versatile and a common koa product that both Hawaii residents and visitors would potentially purchase for personal use or as a gift.

Different levels of each attribute were determined after discussing the project with several koa wood products manufacturers. Three levels of color (light, medium, and dark), two levels of figure (with and without curl), and four prices (\$400, \$500, \$600, and \$700) were used in the survey (see Table 1), yielding 24 possible combinations. Koa wood ranges in color, with older koa trees typically having a darker heartwood (see Figure 2). Levels of color and figure were based on the typical characteristics of each attribute. Prices were based on retail value set by the woodworkers and the actual selling price of the bowls. A lighter bowl with no curl figure will sell at a low price (e.g. \$400) while a figured bowl will sell at a much

Table 1. Identified attributes and levels that drive consumers' choices when purchasing a koa product

Attributes	Price per bowl (\$)	Color of bowl	Figure of bowl
Levels	400	Light	Not Curly
	500	Medium	Curly
	600	Dark	
	700		

higher price (e.g. \$700). Six 8-inch diameter koa bowls were produced from light, medium, and dark wood, either with or without curl, for display (see Figure 3).

From the 24 possible combinations of attributes, Sawtooth Software® (2014) created two sets of 12 efficient and unique profiles (sometimes referred to as tasks), each containing randomly selected combinations of the predefined levels of the three attributes. Each profile set was printed on a laminated card and had three options (sometimes referred to as concepts or products) consisting of random combinations of levels for each attribute (see Figure 4, for example). Each option included a photograph of koa wood with different levels of color, figure, and price, and for each profile set, respondents could pick only one option in each task. The respondents did not rate or rank the options in each task. The choice each respondent makes requires a tradeoff among attribute levels. Respondents were not given the option of “none” to choose when they did not like any of the three given options in a profile. This forces each respondent to make a trade-off on attribute preferences, thus providing more information on their preferences. This approach creates more data per respondent and requires a smaller sample size than a conjoint choice survey with the option of “none” in each profile.

Each respondent was given either profile set A, which consisted of tasks 1 through 12, or profile set B, which consisted of tasks 13 through 24 (see Table 2). Survey profiles were distributed alternately to get an equal number of respondents completing Profiles A and B. In addition to the photographs used on the cards, respondents were also asked to pick their favorite bowl from the six on display without consideration of price (Figure 3).

2.2 Sampling

Surveys were conducted at six locations on O'ahu. The island of O'ahu was chosen because it hosts the largest number of visitors to Hawai'i annually (Munekiyo &



Figure 2. Heartwood color in (a) lumber sawn from a young-growth tree exhibiting significant proportion of lighter heartwood color and (b) lumber sawn from an old-growth tree exhibiting significant proportion of darker heartwood color. Photo credit: 2(a) J.B. Friday, 2(b) E.C. Lowell.



Figure 3. The six koa bowls on display at Hawai'i's Woodshow 2014 in Honolulu, HI. Photo credit: William Weaver.

Profile 1. If these koa bowls were your only options, which would you choose?

Attribute	Option A	Option B	Option C
Figure	Not curly	Curly	Not curly
Color	Light	Medium	Dark
			
Price(\$)	\$500	\$700	\$400

Figure 4. Example of a choice task created by Sawtooth Software® that was presented to respondents. Each respondent must choose only one koa bowl, Option A, B, or C, based on the attributes they prefer.

Table 2. Profile sets used in data collection; sets 1-12 were used in version A of the questionnaire and sets 12-24 were used in version B. Code definitions: N vs C – not curly vs. curly; L vs M vs. D – light, medium or dark colored wood; 4 vs. 5 vs. 6 vs. 7 – \$400 vs. \$500 vs. \$600 vs. \$700 per bowl.

Profile Set I.D.	Option 1	Option 2	Option 3
1	NL5	CM7	ND4
2	CL4	CD6	NM5
3	CD7	CM4	NL6
4	NM7	CD5	NL6
5	CL5	ND7	CM6
6	ND4	NM5	CL7
7	CD5	CL4	NM6
8	NL7	CM6	ND4
9	NL7	ND6	CM4
10	CD5	NM4	CL6
11	CD7	CM4	NL5
12	NL7	ND6	CM5
13	ND5	CL4	NM7
14	NM4	CD7	CL6
15	CM5	ND6	NL4
16	CD6	NL5	CM7
17	CD4	CL7	NM6
18	NM5	CL6	ND4
19	NM6	CL5	ND7
20	NL4	CD5	CM7
21	NL7	CM6	ND5
22	CD6	CL4	NM7
23	CD4	NL6	NM5
24	ND4	CM7	CL5

Hiraga, Inc. 2014). A total of 372 people over the age of 18 were surveyed. Incomplete surveys were removed, as the software cannot use partial data. Missing data occurred in 34 surveys (approximately 9% of the total sample), resulting in a final sample size of 338 surveys. Surveys took place in August 2014 and February through April 2015 at diverse locations: a shopping mall, a hiking trail (popular trail for both residents and tourists), a university, a military facility, and an event hosted at a public school, and Hawaii's Woodshow 2014 in Honolulu. Our goal was to sample at diverse locations to obtain insights from a variety of respondents, including locations frequented by both residents and tourists. Prior to taking the survey, the purpose of the research project was described to each respondent. There was also additional written material (handouts and posters) available to them. All respondents took the survey voluntarily.

The survey consisted of the 12-question profile set with a follow up demographic section. The demographic section contained questions regarding age, gender, socioeconomic level, and residence, as well as consumer-related questions, such as whether the participant had ever purchased koa products, how much they spend on gifts each year, and if they were a woodworker. These questions were used in the conjoint analysis to determine whether these demographic factors influenced respondents' preferences.

2.3 Analysis

Latent GOLD® software (Statistical Innovations 2014) was used for the analysis. This program uses an iterative approach for refining the estimate of respondent preferences with maximum likelihood implemented as the decision criterion. Results were analyzed using a latent class analysis, which finds average part-worth utilities for classes, with classes (clusters) comprised of respondents that expressed relatively similar preferences. The criterion used to select the optimal number of preference classes within a sample is based on the Bayesian Information Criterion statistic (BIC). After running the latent class analysis, the model with the smallest BIC is usually chosen. Typically, no more than 5 classes are run in order to find the smallest BIC, as more than 5 classes will produce some very small market segments with minimal differences in preferences. Latent GOLD® was also used to evaluate which attribute level variables influence each consumer groups' preferences.

The underlying test performed within the Latent GOLD® analysis module is a standard normal probability test (Z-test; Statistical Innovations 2014). This test assumes that parameters in the models for each of the identified clusters are approximately normally distributed. A neutral preference rating (also known as an attribute utility value) expressed for a tested attribute (e.g., curl vs. no curl) would have a mean of zero. The Z-value indicates the number of standard deviations the zero, or neutral result, is from the parameter mean. In addition to using the Z-test to identify attributes within different clusters that are significant, the sign of the Z-value indicated whether the members of the cluster have a generally positive or negative orientation toward the presented attribute. The relative importance of different attributes for each cluster is calculated by determining the total range for each attribute's utility value, summing these totals for all three attributes (color, curl, and price), and dividing each attribute's range by the sum of ranges. This

information is useful in identifying whether there may be ways to segment the market to meet the expressed preferences of specific consumer groups.

3.0 Results and Discussion

3.1 Demographics

The total sample of 338 respondents was 52% female and 48% male. Of the 338 respondents, 119 respondents (35%) were visiting Hawai'i (see Table 3). The majority of respondents had heard of koa before (76%) but only slightly more than half (52%) had actually purchased a koa product. The vast majority of respondents (95%) had at least some college education, with 42% holding a Masters or higher academic degree. Household income varied; only 12% of respondents made less than \$30,000 per year while 39% of respondents made more than \$90,000 per year. Respondents ranged in age from 18 to 68+, with an average age of 44 years old. The 28 to

Table 3. Socio-demographic profile of all respondents

Variable	Category	<i>N</i> ^a	Percent respondents
Gender	Female	177	52
	Male	160	48
Residence	Hawai'i	219	65
	Other US	89	26
	Other country	30	9
Age (years)	18-27	64	19
	28-37	87	26
	38-47	46	14
	48-57	51	15
	58-67	55	16
	68 and older	35	10
Education	Completed some K-12	7	2
	High School Graduate/GED	11	3
	Some College	58	17
	College graduate	122	36
	Graduate degree	140	42
Household income (US \$)	\$29,999 and below	40	12
	\$30,000 - \$59,999	86	25
	\$60,000 - \$89,999	69	20
	\$90,000 and up	132	39
	Declined to answer	11	4

^a Total *n* may not add up to sample size of 338, as respondents were allowed to leave demographic questions blank if desired.

37 year-old age group comprised the largest number of respondents when grouped by age.

3.2 Latent GOLD® results

The software used identifies consumer groups or clusters (called classes) that are distinct and have different preferences in koa bowl attributes. Results for one to five classes are provided by the software. In this case, the model containing five classes was chosen as the best model for characterizing consumer preferences because it had the lowest Bayesian Information Criterion (BIC) statistic. Each of the five classes demonstrated a distinct preference and represented at least 15% of the sample population. In unique cases, the model with the lowest BIC is not selected because a class may be too small or may have preferences that are too similar to those of another class. In this case, 15% of the sample represented about 50 people, which we considered a meaningful number of respondents. There was not much difference among classes with regard to the proportion of respondents; the largest class, Class 1, was made up of 24% of respondents, while the smallest class, Class 5, was made up of 15% of respondents (see Table 4).

Table 4 shows the reported Z-values for all attributes in each class from the Latent GOLD® analysis (Statistical Innovations 2014). A significant (0.05 level) and positive Z-value (denoted by an asterisk) indicates a statistically significant preference for that attribute. If an attribute has a negative significance, then the respondent class did not prefer bowls exhibiting that attribute. Non-significance denotes no preference for that attribute by that class.

Class 1, made up of the largest number of respondents (24%), significantly preferred lower prices, medium color,

and bowls without curl. This class significantly did not prefer light colored bowls or bowls with curl. Class 2, which included 22% of respondents, had no price preference but significantly preferred light colored bowls and bowls with curl. This class also significantly did not prefer dark colored bowls or non-curly bowls. Class 3 had similar preferences to Class 2. Class 3, representing 20% of respondents, significantly preferred light or medium colored bowls and did not have a significant price preference. This class also preferred the bowls with curl. Class 4, with a similar number of respondents to Class 3, significantly preferred lower prices and light or medium colored bowls. This class significantly did not like dark colored bowls and had no preference in figure. Class 5, with the least number of respondents (15%), significantly preferred lower prices, dark colored bowls, and bowls with curl. Class 5 significantly did not like non-curly bowls.

Latent GOLD® also derives the importance of each attribute based upon respondents' answers to the 12 profile questions. Table 5 indicates the attribute importance (in percentages) for each of the five classes. Figure was the most important attribute (explaining 48% of the measured preference) when choosing a bowl for Class 1, followed closely by color (40%). Color was, by far, the most important attribute for Class 2 (82%). Color, followed by figure, were both important attributes for Class 3. Price was the most important attribute for Class 4, followed by color. Figure was the most important attribute for Class 5 (57%), followed by price.

Socio-demographic and consumer-related questions were analyzed using Latent GOLD® to examine which, if any, variables influenced each class's preference choices. Based on respondents' answers, only three variables significantly influenced preferences (see Table 6). Based on

Table 4. Model estimates for consumer preferences as shown by z-values. (*) is statistically significant at the 0.05 level, (-) symbol indicates a negative preference

Attribute (class size)	Class 1 (24%)	Class 2 (22%)	Class 3 (20%)	Class 4 (19%)	Class 5 (15%)
Price	-2.928*	1.418	-0.991	-9.484*	-5.989*
Color					
Light	-8.042*	13.402*	9.242*	3.164*	-1.858
Medium	9.747*	0.851	8.027*	8.419*	-1.393
Dark	-0.127	-8.485*	-11.752*	-10.024*	3.409*
Figure					
Non-curly	13.929*	-2.702*	-11.551*	-0.583	-10.465*
Curly	-13.929*	2.702*	11.551*	0.583	10.465*

Table 5. Attribute importance by percent for each class. Bold text indicates the attribute of highest importance to each class

Attribute	Class 1	Class 2	Class 3	Class 4	Class 5
	----- percent -----				
Price	11.1	7.2	4.3	56.1	28.4
Color	40.2	82.4	51.2	42.0	14.3
Figure	48.7	10.4	44.5	1.9	57.2

Table 6. Significant explanatory variables influencing consumer preferences as shown by z-values. (*) is statistically significant at the 0.05 level.

Attribute	Class 1	Class 2	Class 3	Class 4	Class 5
Attended Woodshow ¹	-2.737*	-2.072*	1.213	-1.779	5.146*
Gift expenditure ²	-0.161	0.324	1.696	-1.974	2.674*
Age ³	-1.523	2.942*	2.012*	-0.701	-1.987*

Variable definition:

¹Coded 1 for respondents who did attend the Hawaii's Woodshow 2014.

²Continuous variable of how much money respondents spent on gifts per year.

³Continuous variable of respondent's age.

Z-test results, the three explanatory variables included: Woodshow attendance, estimated annual expenditures on gifts, and respondent age. It is interesting to note that the previous purchase of a koa product and woodworking experience were not found to be significantly related to attribute preferences.

Table 6 indicates that significantly different attributes were associated with different classes. Both age and expenditures (annual gift purchases) were treated as continuous variables. Class 1 and Class 2 respondents were significantly less likely to be attendees of the Hawaii's Woodshow 2014. Further, Class 2 respondents were significantly more likely to be older respondents. This same trend with regard to age was also significantly associated with respondents in Class 3. No other variables influenced this Class's preferences. Class 4 had no significant socio-demographic variables associated with their preferences. Respondents comprising Class 5 were significantly more likely to have attended the Hawaii's Woodshow 2014; these respondents also spent significantly more money on gifts each year. Younger respondents were significantly associated with Class 5's preferences. Education was not found to be a significant distinguishing variable for any of the classes.

At the end of the survey, respondents identified which of the six displayed bowls was their favorite. Figure 5 shows that there was not a majority favorite but that most respondents favored a curly bowl of any color. This mirrors the class results, as three of the classes

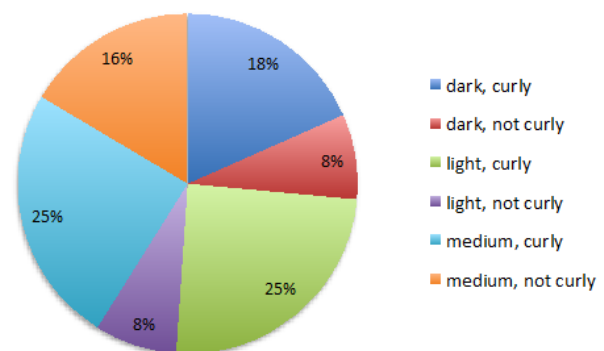


Figure 5. Respondents' favorite bowl based on color and figure excluding price.

significantly preferred the figured bowl, one class had no preference in figure, and only one class did not prefer the curly figure. There was no statistical difference between residents and visitors with regard to which of the six displayed bowls respondents preferred.

4.0 Conclusion

Five consumer groups with distinct koa characteristic preferences were identified in this study. Class 1 preferred lower prices, medium color, and non-curly bowls. Class 2 preferred light colored and curly bowls. Class 3 did not have a price preference and preferred light or medium colored and curly bowls. Class 4 preferred lower prices and light or medium colored bowls. Class

5 also preferred lower prices but they preferred darker colored and curly bowls. The results show that a small consumer group preferred the darker colored bowls while the majority did not prefer the darker color but preferred the lighter or medium color instead. These results indicate that variation in consumer preferences for different combinations of koa attributes exist. The anecdotal idea that consumers only want dark, figured koa products did not hold true in this study. Most consumer groups preferred lower prices but price did not significantly influence two of the five consumer groups.

This study also highlights how socio-demographic characteristics, such as resident versus visitor, and consumer actions, such as whether the respondent had previously purchased a koa product, may or may not influence consumer preferences. The two variables that were associated with certain class preferences included respondent age and whether the respondent had attended the Hawaii's Woodshow 2014. Respondents who attended the Woodshow were associated with Class 5 preferences: darker, curly bowls at a lower price. This demonstrates that this specific consumer group follows the woodworkers perception that darker, curly koa is more desirable. This Class was the smallest of all the classes (15% of respondents) and indicates that only a minority of the market prefers darker, curly koa wood, thus contradicting previous perceptions of consumer preferences.

Young-growth koa, which is generally lighter in color and less figured, can be used to produce products, in this case bowls, and still appeal to consumers. This is encouraging news to land managers who wish to sustain koa on the landscape for ecological, cultural, and economic reasons. Old-growth koa as a raw material source for woodworkers can be very expensive, if available at all. The ability of woodworkers to use less expensive, young-growth koa is a market advantage. By demonstrating that products manufactured from young-growth koa are marketable to a segment of the population, opportunities are created to pursue reforestation and management of koa stands and develop silvicultural programs for their sustainability.

Each product a consumer purchases has specific environmental impacts based on where the product's raw materials originate. Wood products range in their environmental impacts, based on the species and age of trees, location, and harvesting regime. Consumer

preferences for different wood characteristics can influence the magnitude of environmental impact associated with wood product markets. For koa, the environmental impacts are magnified, given how culturally and ecologically important the species is in Hawai'i. Koa woodworkers can use these results to design and create pieces for market segments that occupy a similar market niche to these small koa bowls. Through substitution of young-growth koa for the decreasing supply of old-growth wood, the legacy of koa wood can be sustained.

5.0 References

- Aguilar, F.X., & Cai, Z. 2010. Conjoint effect of environmental labeling, disclosure of forest of origin and price on consumer preferences for wood products in the US and UK. *Ecological Economics*, 70(2), pp. 308-316.
- Alderman, D., Smith, R., & Bowe, S. 2007. Eastern white pine secondary manufacturers: Consumption, markets, and marketing. *Forest Products Journal*, 57(10), 28.
- Anderson, R.C., & Hansen, E.N. 2004. The impact of environmental certification on preferences for wood furniture: A conjoint analysis approach. *Forest Products Journal*, 54(3), 42.
- Baker, P.J., Scowcroft, P.G., & Ewel, J.J. 2009. Koa (*Acacia koa*) Ecology and Silviculture. PSW-GTR-211. 129 pp.
- Bigsby, H., & Ozanne, L.K. 2002. The purchase decision: Consumers and environmentally certified wood products. *Forest Products Journal*, 52(7/8), 100.
- Bowe, S.A., & Bumgardner, M.S. 2004. Consumer Perceptions and Knowledge of Common Furniture Woods. In *USDA Forest Service: Proceedings 14th Central Hardwood Conference. Northeast Research Station*, pp. 404-410.
- Bumgardner, M., Nicholls, D., & Donovan, G. 2007. Effects of species information and furniture price on consumer preferences for selected woods. *Wood and Fiber Science*, 39(1), pp. 71-81.
- Bumgardner, M.S., & Bowe, S.A. 2002. Species selection in secondary wood products: Implications for product design and promotion. *Wood and Fiber Science*, 34(3), pp. 408-418.
- Cattin, P. & Wittink, D.R. 1982. Commercial use of conjoint analysis: A survey. *The Journal of Marketing*, (46), pp. 44-53.
- Chan-Halbrendt, C., Yu, J., Keung, H., Lin, T., & Ferguson, C. 2006. Guangzhou Buyers Preference for Premium Hawaiian Grown Product Gift Baskets. *International Food and Agribusiness Management Review*, 9(4), pp. 45-59.
- Department of Hawaiian Homelands (DHHL). 2014. "Koa salvage and reforestation project." RFP-14-HHL-007. Retrieved from <http://dhhl.hawaii.gov/wp-content/uploads/2014/04/RFP-14-HHL-007.pdf>. Last accessed October 14, 2016.
- Donovan, G., & Nicholls, D. 2003. Consumer preferences and willingness to pay for character-marked cabinets from Alaska birch. *Forest Products Journal*, 53(11/12), 27.
- Dudley, N.S. & Yamasaki, J. 2000. A guide to determining wood properties of *Acacia koa*. *Forestry Report*, 3. Hawaii Agricultural Research Center, Hilo, HI. 5 pp.
- Elevitch, C.R., Wilkinson, K.M. & Friday, J.B. 2006. *Acacia koa (koa) and Acacia koaia (koai 'a). Traditional trees of Pacific Islands: Their culture, environment, and use. Permanent Agriculture Resources, Holualoa*, pp.1-28.

- Friday, J.B., Yangida, J.F., Illukpitiya, P., Mamiit, R.J. & Edwards, Q. 2006. Characteristics of Hawai'i's retail forest industry in 2001. Honolulu, HI.
- Green, P.E., & Srinivasan, V. 1978. Conjoint analysis in consumer research: Issues and outlook. *Journal of Consumer Research*, 5(2), pp. 103-123.
- Liker, B., Stirn, L.Z., Bučar, D.G. & Hrovatin, J. 2016. Examination of Decision Factors in the Process of Buying Kitchen Furniture Using Conjoint Analysis. *Wood Industry/Drvna Industrija*, 67(2), pp.141-147.
- Loudat, T.A., Kanter, R. & Revenue, C.T. 1996. The economics of commercial koa culture in Hawaii. In *Koa: A decade of growth. Proceedings of the Hawaii Forest Industry Association Annual Symposium, Honolulu*, pp. 124-154.
- Munekiyo & Hiraga, Inc. 2014. Tourism Market Study – Banyan Drive, Hilo, Hawaii. Retrieved from <http://files.hawaii.gov/dlnr/Id/Kanoelehua/5-Kanoelehua-Market-Study-Report-July-2014.pdf>. Last accessed November 16, 2016.
- Osburg, V.S., Strack, M. & Toporowski, W. 2016. Consumer acceptance of Wood-Polymer Composites: A conjoint analytical approach with a focus on innovative and environmentally concerned consumers. *Journal of Cleaner Production*, 110, pp.180-190.
- Pejchar, L., & Press, D.M. 2006. Achieving conservation objectives through production forestry: The case of Acacia koa on Hawaii Island. *Environmental Science and Policy*, 9(5), pp. 439-447.
- Sawtooth Software [Computer Software]. 2014. CBC/Web Version 8.0 Base, CBC/HB Version 5.0, CBC Latent Class Version 4.0. Retrieved from <http://www.sawtoothsoftware.com/>
- Shehata, S. A. 1993. The impact of koa on the state economy. J. Haw. Pac. Agri. Retrieved from https://hilo.hawaii.edu/academics/cafnrm/research/documents/J_Haw_12_000.pdf. Last accessed July 28, 2017.
- Statistical Innovations [Computer Software]. 2014. LG Choice 5.0. Retrieved from <http://www.statisticalinnovations.com/>
- Wang, Q., Shi, G., & Chan-Halbrendt, C. 2004. Market potential for fine furniture manufactured from low-grade hardwood: Evidence from a conjoint analysis in the northeastern United States. *Forest Products Journal*, 54(5), pp. 19.
- Woodshop News. 2009. Koa is highly sought and high-priced. Essex, CT. Retrieved from <http://www.woodshopnews.com/news/wood-markets/498038-koa-is-highly-sought-and-high-priced>. Last accessed November 16, 2016.