# Effects of Children on the Single Mother's Labor Force Participation

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An economic approach is used to investigate effects of children on single mother's labor force participation. Results of logit analyses showed that compared to her married counterpart, the single mother is more likely to participate in the labor force when she is older, or has more education, but less likely when considering number and age of children. Age differential between mother and first child negatively influences labor force participation of single and married mothers.

The presence of children influences women's labor force participation, which can be observed in both married-couple (Gordon and Kammeyer, 1980) and single mother families (Rexroat, 1990). Compared to married mothers, single mothers face dual responsibilities for parenting children and earning the family income with little outside support (Weiss, 1979). Little research is found to address the unique characteristics of single-mother's labor force participation, even though this knowledge will be very helpful in the formulation of related education programs and policies to assist vulnerable single mothers and their children to achieve a better life.

The purpose of this paper is to investigate any unique effects of children on single mother's labor force participation, compared to her married counterpart. An economic approach, holding to the basic assumptions of maximizing behavior, market equilibrium, and stable preference, as proposed by Becker (1976) and developed by Gronau (1973), will be followed in this study.

The mother's labor force participation is closely related with the mother's prices of market time and household time. Previous studies noted the influence of the presence of children on mothers' labor force participation, but they did not either provide direct evidence of the price women place on the household time (Cain, 1966; Mincer, 1962), or concentrate on effects of children on the mother's labor force participation (Gramm, 1975; Gerner and Zick, 1983; Zick and Bryant, 1983).

Gronau (1973) developed a unique method for predicting mothers' labor force participation considering the effects of children's age and number. He conceptually distinguished the difference of determinants between a mother's market time and household time. Another unusual feature of his approach is an explicit treatment of variation in preferences among the population (Hall, 1973).

To a great degree, this paper is a replication of Gronau's study in which most variables are specified as the same as Gronau's. But our study focuses on the single mother, while Gronau's concentrated on the married mother. Also, two important variables have been added to our empirical model: the spacing of various children and the timing of the first child relative to the mother's age. Becker (1981) notes these two factors as influencing life cycle stages, but ignores them when building his theory of demand for children. Gronau (1973) also mentions these two factors as relevant to the value of mother's time, but he does not incorporate them into his empirical model.

## Theoretical Model

Becker (1965) made an important contribution to utility theory with his seminal article on the allocation of time. Because of his pioneering work, time, along with goods, is incorporated into utility theory, and household activities can be studied with this extended utility model. According to Becker (1965; 1981), a family is both a consuming unit and a producing unit. As a producing unit, a family produces commodities needed by family members. These commodities could be physical entities, psychological feelings, or some special, propinquiously produced goods, such as children. Becker believes that children as a "commodity" can be treated as durables for a family, but Gronau (1973) argues that it is more appropriate to take the services needed for raising children as

the home produced commodity. For the purpose of this study, Gronau's definition is employed.

In order to produce commodities, a family combines market goods, family member's time, and human capital into household production. Assuming that a single mother family produces two commodities, let C=children, and Z=other commodities. In any given period, the utility equation of the family becomes,

$$U=U(C, Z).$$

Assuming that children do not contribute to the production of the commodity, the above utility equation is subject to the following budget constraint:

$$\pi_c(X_c, T_c)C+\pi_z(X_z, T_z)Z=I,$$

where, I is the full income of the family, $\pi_c(X_c, T_c)$ is the price of children, which is the function of the time and goods provided by the single mother for rearing children. Then, $\pi_z(X_z, T_z)$ is the price of producing other commodities, which is a function of the mother's time and money (for market goods) used in household production.

Given $\pi_c$, $\pi_z$ and I, the optimal quantities of C and Z are determined by the budget constraint and the usual marginal utility condition:

$$MU_c/MU_z=\pi_c/\pi_z.$$

The demand for children could depend on the relative price of children and full income. Here children are assumed to be normal goods, which implies that an increase in the relative price of children will decrease the demand for children. Because the price of children is a function of the mother's time and money (used to buy market goods), characteristics relevant to children that influence time and goods needed for rearing children will influence the mother's labor force participation.

Before discussing the relationship of the value of the single mother's time and characteristics of children, we should clarify the determinants of the value of the single mother's time. According to Gronau (1973), women's time is distributed between two sectors: nonmarket and market. In the market, the supply of women's time responds to the wage rate. But for women only in the nonmarket sector, the supply of women's time is infinitely inelastic, and the shadow price of women's time, in the absence of market opportunities, is demand determined.

The determinants of the demand for women's time in the household consists of the derived demand for time used in each of its household activities, which in turn depends on the commodity prices, which depend on the prices of time and goods inputs to produce the commodity, and the technology employed. A change in any of these parameters will shift the derived demand curve and change the shadow price of time. All possible influential factors may be summarized by the woman's characteristics such as her age, education level, wage rate or the value of time, and her environment's characteristics, such as other family income, and those of her children and husband. In the case of a single mother family, the husband's effect is ignored even though the ex-husband, the late husband, or the boyfriend will have possible effects. This treatment is reasonable because even in a married-couple family, the husband's effect on the value of the wife's time is much smaller than the effect which results from the wife's characteristics (Gronau, 1973).

Some characteristics of women result in a change of productivity, which in turn influence the value of her time. "Home experience" is the variable one would like to use to capture the effect of "on-the-job training" on the mother's value of time. Age may be a proxy for this variable. Education is another possible source of change in productivity. It is difficult to predict the effect of the mother's age and education however, because of the complex relationship between time demand and changes in productivity (Gronau, 1973).

If production functions are linear homogeneous, it has been shown that an increase in the initial endowment of nonhuman capital increases the demand for all inputs and the shadow price of mother's time (Gronau, 1971). If this notion can be applied in the case of the single mother, other family income will influence the value of her time. A difference between the single mother and the married mother should be noted here. In a married-couple family the mother's income usually is one of two financial sources (the other is the father's income). But in a single mother family the financial source is mainly the mother's income. Thus married family income, excluding mother's earning, is usually larger, perhaps much larger, than that of a single mother family. There is some evidence that married family income, excluding mother's earning, has a positive effect on the value of the mother's time (Gronau, 1973). In terms

of the single mother family, Becker (1981) suggests the same relationship by addressing the income effect on the demand for children.

Now we are ready to analyze the effect of children on the value of mother's time. If a child is an absolute home-time-intensive commodity (time-intensive commodity, in short), which means,

$$X_c = 0,$$

the mother's labor force participation behavior will be influenced mainly by the time constraints.

If a child is an absolute market-goods-intensive commodity (goods-intensive commodity, in short), which means,

$$T_c = 0,$$

the mother's behavior will be influenced mainly by the income constraints. In the real world, the inputs of rearing a child will be some combination of time and goods. But some characteristics of children do influence the combination of time and goods, and will bias the combination toward a time-intensive commodity or a goods-intensive commodity. It follows that these characteristics will influence the value of the mother's time and the labor force participation of the mother.

The number and age of children will influence the amount of time and goods used for rearing children. The increase of number of children will demand more time and goods offered by the single mother. Because of the relative scarcity of time, the price of time of the mother will be more precious. Children in different age groups have different demands for time and goods inputs. A younger child seems more likely to be a time-intensive commodity, while an older child becomes more independent in producing services for him/her self, but also becomes a more goods-intensive. Gronau's (1977) explanation of this phenomenon is that the profitability of home production diminishes and, eventually, the family relies solely on market (and publicly provided goods, such as schools) on the margin. A single mother will be more likely to stay home when her children are young and more likely to participate in the labor force when her children grow older.

Timing is defined as the difference between a mother's age and her first child's age. It seems that the greater this age differential, the more possible it becomes for the mother to stay home to rear children. Longer timing implies a larger accumulation of wealth so that she can afford to stay home. However, an implied longer working experience that results in a higher wage rate offer in the labor market could, conceivably, have the opposite effect.

Spacing is defined here as the average interval between various children. Because closer spacing results in benefits from economies of scale both in terms of time and goods, and decreases the relative price of children, it will influence the value of the mother's time. However, it is hard to predict the direction of the effect of spacing without considering other characteristics of children. Time and goods benefit from closer spacing may be larger when children are younger than when they grow older. Variations in timing may also differentially affect the quantity of benefits resulting from closer spacing. A previous study shows that spacing of children in two-parent two-child households negatively influenced the mothers' potential wage rate (Zick and Bryant, 1983), which implies a negative effect of this variable on the mothers' labor force participation.

In summary, the determinants of the value of single mother's time could be mother's age, education, other family income (excluding the mother's earning), number of children, timing of the first child, and spacing of various children.

**Empirical Model**

Estimating the value of single mother's time follows an approach proposed by Gronau (1973). A basic assumption of this approach is that the price of time in the nonmarket sector (household) assigned to women in the labor force is the same as that for women out of the labor force. Assume that W is the price of time for nonmarket sector women with certain characteristics, $\mu$ is the mean value of time of all women sharing the set of nonmarket characteristics, and $\epsilon$ is the random deviation from this mean. We have:

$$W = \mu + \epsilon.$$

Assuming that W* is the potential wage, the woman participates in the labor market if W*>W, that is, if

$$W* - \mu \geq \epsilon,$$

and otherwise she remains a full-time homemaker.

Based on the discussion in the

previous section, we propose that the mean price of a woman's time is associated with her age (A), education (E), other family income (I), number of children (C), timing of the first child (T), and spacing of various children (S), and assume that these variables affect $\mu$ in an additive fashion:

$$\mu = \beta_0 + \beta_1 A + \beta_2 E + \beta_3 I + \beta_4 C + \beta_5 T + \beta_6 S.$$

The mother participates in the labor force if

$$W^* - (\beta_0 + \beta_1 A + \beta_2 E + \beta_3 I + \beta_4 C + \beta_5 T + \beta_6 S) \geq \epsilon.$$

If $\epsilon$ has a Weibull distribution, a logit model can be applied, and the maximum-likelihood estimators $\beta_i$ (i=0, 1, ..., 6) will be gained (Chow, 1983).

Since $W^*$ is usually unknown, assume that we know the mean $\mu^*$ and $\epsilon^*$, the random deviation of the potential wage of women with one of certain market characteristics (such as age and education), where

$$W^* = \mu^* + \epsilon^*.$$

In this case, the prerequisite for entry into the labor force is,

$$\mu^* - \mu \geq \epsilon - \epsilon^* = \epsilon'.$$

If $\epsilon$ and $\epsilon^*$ are independent Weibull, we can still apply the logit analysis (Chow, 1983).

Usually $\mu^*$ is also unknown. Gronau (1973) offered three ways to estimate $\mu^*$: (1) assuming $\mu^*$ is a function of the woman's age and education, (2) assuming $\mu^*$ is the average wage rate of the women in the sample, (3) estimating $\mu^*$ from data on wage rates and labor-force participation rates. Because Gronau's results were very similar when these three methods were compared, only the first approach is used in this paper. The relationship between the mean wage offer and mother's age and education is postulated as follows,

$$\mu^* = \alpha_0 + \alpha_1 A + \alpha_2 E.$$

When this relationship is introduced into the prerequisite of the entry into the labor force, we have,

$$-[ (\beta_0 - \alpha_0) + (\beta_1 - \alpha_1) + A(\beta_2 - \alpha_2) E + \beta_3 I + \beta_4 C + \beta_5 T + \beta_6 S] \geq \epsilon'.$$

We can apply the logit analysis to estimate

$$X = a_0 + a_1 A + a_2 E + a_3 + a_4 C + a_5 T + a_6 S,$$

to obtain the maximum likelihood estimators $a_i$ for $(\beta_i - \alpha_i)$ (i=0, 1, 2), and $a_i$ for $\beta_i$ (i=3,4,5,6). We can estimate the effects of all these variables on the probability of mother's labor participation. However, we can not separate the effect of mother's age and education on the mean price of time from their effect on the mean wage offer (Gronau, 1973).

## Estimations

The data used in this study are from the March 1988 Current Population Survey (Bureau of Census, 1988). Single mothers having at least one child under 18 are chosen and a sample of 3,729 is included in this study. Singles include widowed (8.4%), divorced (45.6%), separated (20.4%), and never married (25.6%).

In order to make comparisons, we also do a logit analysis on a sample of married women, with the presence of spouses and children under 18, from the same data set. The sample size is 15,849 and variable specifications are the same as those used in the single mother's sample, with minor necessary adjustments.

The dependent variable in this study is categorical: 1 means the mother is in the labor force (having a full-time job, a part-time job, or actively looking for a job), and 0 means the mother is out of the labor force (full-time student, homemaker, retiree, etc.). Independent variables are defined as follows. Other family income equals the family income from all sources minus mother's earning. Mother's age is defined by three dummy variables, with mother's age group 30-49 as a base. Mother's education is also defined by three dummy variables, with mother's education group "high school" as a base. Numbers of children in various age groups are represented by four variables.

The timing of the first child is defined as the difference between the age of the mother and the age of her oldest child living in the household. The spacing of various children is defined as,

$$\frac{\text{oldest child's age} - \text{youngest child's age}}{\text{family size} - 2}.$$

A mother with one child is assigned a value of 0.

## Results and Discussion

The results from the sample of married mothers (Table 1) confirm Gronau's findings (1973) in terms of direction of effects. The results from the sample of single mothers (Table 1) are very similar to those found in the sample of married mothers, but there

Table 1
Determinants of Mothers' Labor Force Participation

| Variable | Unit | Logit Coefficients | |
| --- | --- | --- | --- |
| | | Single | Married |
| Constant | | 2.3744* | 2.6831* |
| Other income | $10K/yr | -.3623* | -.1440* |
| Age<30 | Dummy | -.5303* | -.3804* |
| Age>49 | Dummy | -.0994 | -.4246* |
| Ed-elem. | Dummy | -1.4266* | -.8618* |
| Ed-college | Dummy | 1.1303* | .6723* |
| Child<3 | Number | -1.0124* | -.7621* |
| Child 3-5 | Number | -.6856* | -.5538* |
| Child 6-11 | Number | -.3864* | -.3150* |
| Child 12-17 | Number | -.1858* | -.1976* |
| Timing | 10 yrs | -.2197* | -.3732* |
| Spacing | 1 yr | -.0179 | -.0061 |
| | | | |
| Likelihood ratio test | | 3824* | 18914* |
| Sample size | | 3729 | 15849 |

*Significant at the .05 level

are some deviations which suggest the unique behavior of single mothers.

Other family income negatively affects both types of mothers' labor force participation. This negative effect on the single mother is over twice that for the married mother, which implies the financial vulnerability of the single mother.

Married mother's age usually has an inverted U-shape effect on labor force participation. But in the case of single mothers, the "age 50+" group does not show a difference from the "age 30-49" group. This suggests that the value of single mothers' time does not increase when they get older. Perhaps the average income of older single mothers is lower relative to older married mothers, so that these single mothers have to work to obtain adequate income.

Education shows a positive effect on both types of mothers' labor force participation. The intensity of the education effect on the single mother is stronger than that of the married mother. Thus, the value of time in household production is relatively lower for single mothers who are older and better educated, when compared to her married counterpart.

Composition of children's age and number has negative effects on mothers' labor force participation. But it seems very clear that the effects are not evenly distributed between children's different age groups. Younger children show larger effects than older children. In Gronau's study, children of age 12-17 show significant positive effects on the married mother's labor force

participation, a finding we did not replicate. Comparatively, we do observe that the single mother is more likely to stay home than is the married mother as a result of number of children in several age groups (especially children under 6), other variables held constant. Perhaps the married mother benefits from her husband's time substitute, while the single mother lacks this time grant, or any other substitute.

Timing of the first child shows a negative effect on both types of mothers' labor force participation. A possible explanation is that the later a woman rears a child, the more precious the child, and the higher the quality of desired inputs. This is consistent with Becker's (1981) theory of the tradeoff of quantity and quality of children.

Spacing does not show an influence on mothers' labor force participation but the coefficients have negative signs which are consistent with a previous study (Zick and Bryant, 1983). The failure to find spacing effects may come from three sources. The first one is the limitation of the data set. The average number of children under 18 in this sample is two. The second is that spacing can not be observed in a completed series of children in these families, but only among those born to date and living at home. The third is that spacing does not affect behavior independently but interacts with other variables to influence behavior.

Using estimated logit coefficients, we calculated probabilities of "average" mothers' labor force participation (Table 2). Basically, the probability of labor force participation is almost 75 percent for the "average" single mother, in contrast to 70 percent for the "average" married mother. Given other conditions, the single mother is more likely than her married counterpart to work out of the home in terms of her age, or composition of children's age and number. But in terms of mothers' educational attainment, the single mother is more likely to stay home when she has less than a high school diploma, and is more likely to work out when she has been educated in college.

Marginal changes of the probabilities of mothers' labor force participation are calculated in two ways. For a categorical variable, the changed probability is the difference between those of two consecutive groups, while for a continuous variable, the change is figured following Pindyck and Daniel (1981).

Table 2
Predicted Probabilities of Mother's
Labor Force Participation
--------------------------------------
| Variable | Single | Married |
|---|---|---|
| **Average Mother\*** | **.746** | **.691** |
| Mother's age | | |
| <30 | .634 | .605 |
| **30-49\*** | **.746** | **.691** |
| >49 | .727 | .594 |
| Mother's ed. | | |
| elementary | .414 | .486 |
| **high school\*** | **.746** | **.691** |
| college | .901 | .814 |
| No. of children by age | | |
| <3 | .655 | .636 |
| 3-5 | .724 | .682 |
| 6-11 | .780 | .732 |
| 12-17 | .812 | .754 |

\* Data in bold represent probabilities of "average" mothers. Representative values of an "average" single mother: age 30-49, annual other family income $4,977, high school finished, with one child age 6-11 and one child age 12-17, first childbearing age 23, and having her second child 2.1 years later. An "average" married mother has the same characteristics as those of the single mother, except for the annual other family income $31,547, first childbearing age 24, and having her second child 2.4 years later.

Table 3
Marginal Changes of Predicted
Probabilities of Mother's Labor Force
Participation
--------------------------------------
| Change | Single | Married |
|---|---|---|
| Income:+$5,000 | -.034 | -.015 |
| Mother's age: | | |
| <30 to 30-49 | .113 | .086 |
| 30-49 to >49 | -.019 | -.097 |
| Mother's ed.: | | |
| elem.to high schl. | .332 | .205 |
| high schl.to coll. | .155 | .123 |
| No. of children by age: | | |
| +1 child<3 | -.192 | -.163 |
| +1 child3-5 | -.130 | -.118 |
| +1 child6-11 | -.073 | -.067 |
| +1 child12-18 | -.035 | -.042 |
| Timing: +10 year | -.042 | -.080 |
| Spacing: +1 year | -.003 | -.001 |

Results (Table 3) showed that the single mother is more likely to stay home when other family income increases by $5,000, she has one more child under 12 or has her next child one year later; while she is more likely to work out when she gets older, and has postponed her first childbearing for 10 year. Education showed dramatic influences on marginal changes of the probabilities of single mother's labor force participation. Given other conditions, the odds of the single mother's participating in the labor force will be increased by 33 percent if she enters high school. The same figure for the married mother is 20.5 percent.

Table 4
Effects of Interaction Terms on
Mothers' Labor Force Participation
--------------------------------------
| Interaction Term | Logit Coefficients | |
|---|---|---|
| | Single | Married |
| Spacing & | | |
| child's age<3 | -.0196 | .0147 |
| child's age 3-5 | -.0657\* | -.0198 |
| child's age 6-11 | .0029 | -.0118 |
| child's age 12-17 | .0020 | -.0001 |
| Mother's school year & | | |
| child's age<3 | .1211\* | .0369\* |
| child's age 3-5 | .0506 | .0120 |
| child's age 6-11 | .0535\* | .0381\* |
| child's age 12-17 | .0789\* | .0464\* |
| Likelihood ratio test | 3813\* | 18875\* |
| Sample size | 3729 | 15849 |

\*Significant at the .05 level

Adding two sets of variables to the existing models, we examined interactions between mother's education, child spacing, and composition of children's age and number (Table 4).

The interaction of mother's schooling and number of children with ages younger than three or older than six positively influences the labor force participation of both types of mothers, a result consistent with Gronau's study (1973). These results suggest that the positive effects of mothers' education outweigh the negative effects of composition of children's age and number. The single mother is more likely than her married counterpart to stay home when she has more young children or a higher education level. This phenomenon is consistent with the notion that a woman with a higher education level will want higher quality children and will respond to the lack of quality time substitutes. The interaction of child spacing and the number of children in a given age group has no effect on the value of time of a married mother.

Summary and Recommendations

New information from findings of this study can be summarized as: compared to the married mother, the single mother is more likely to participate in the labor force when she gets older, or has a higher education level, but is more likely to stay home when considering number of children in different age groups. Another piece of new information is that the timing of the first child has a negative effect on labor force participation of both types of mothers.

Results of this study suggest

several issues for further investigation. Spacing of the first child does not show a significant effect on mothers' labor force participation in this study and in a previous research (Gerner and Zick, 1983). But this variable significantly influences mothers' price of house work time (Zick and Bryant 1983) and mothers' working hours (Gerner and Zick, 1983). This suggests that spacing may play a role in mothers' labor force participation. Perhaps children who have moved out of the household should be counted when specifying the spacing variable. Desired quality of children is not treated directly in this study because of the lack of necessary information, but it is very important factor for understanding mother's labor force participation. Becker (1981) proved, theoretically, that the trade-off between quantity and quality will influence the demand for children. A reasonable inference is that it also could influence the value of the mother's time. In this study, we use mothers' age and education to serve two functions: to determine the price of time of mothers in the nonmarket sector, and to estimate the potential wage offer in the market sector. Empirical evidence appears to show that these two variables may be a better measure of the later. Further study might specify variables other than mother's age and education, to capture the determinants of the household productivity.

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# Employment Status of Wife and Service Expenditures

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Data from the Bureau of Labor Statistics Consumer Expenditure Surveys were used to investigate factors influencing household expenditures for services in the United States. There were significant differences between families with full-time working wives and other families (non-working and part-time working wives). Household production variables had a significant impact on service expenditures in all instances though the magnitude of the effect varied by the wife's employment status.

Increased labor force participation by married women has been one of the major social and economic changes in the United States in the past two decades. Labor force participation rates by married women increased from 31 percent in 1960 to 57 percent in 1988 (U.S. Department of Commerce). For married women aged 25-34 with husband present these rates have increased from 28 percent in 1960 to 69 percent in 1988. The corresponding figures for women aged 35-44 are 36 percent and 73 percent respectively. Increases have also been obtained for married women with children under six. Labor force participation rates for these women have increased from 19 percent in 1960 to 57 percent in 1988 (U.S. Department of Commerce). According to some analysts the percentage of women in the labor force suggests that by 1995, over 80 percent of all mothers with children at home will be working (Bureau of National Affairs 1986).

The increase in labor force participation rates by women has led to a number of studies concerning the major strategies that might be used by working wives to reduce time pressures (Strober and Weinberg 1980, Nichols and Fox 1983). These strategies include substituting capital equipment for household labor, and substituting paid labor for household labor.

There have been several studies on the first strategy which indicated that working wife and non-working wife households did not differ in their purchase of time-saving durables. Less work has been done on the second strategy with the exception of food away from home studies. Ballante and Foster (1984) focused on the relationship between wife's employment status and expenditures on time-saving services using data from the 1972-73 BLS Consumer Expenditure Survey. The results of their analysis indicated that income, family life cycle and the number of weeks worked by the wife had a significant impact on total service expenditures. Dummy variables were used to measure the employment status of wife (full-time, part-time or non-working). The employment status was significant in the case of full-time working wives.

A later study used Logit analysis to analyze purchases of twelve home producible commodities including car repair, home repair, housecleaning, food preparation, clothing repair and day care (Weagley and Norum 1989). The sample was confined to husband-wife households where both spouses worked outside the home. The authors used a more detailed version of the household production model and their independent variables included wages and hours worked of both husband and wife, net worth, age of wife, number of young children and teenagers and health satisfaction. The authors found that wages, in particular the wife's wages, were an important determinant of expenditures for six of the twelve commodities. They also noted that local market conditions might affect the degree to which the commodities could be purchased in the marketplace and hence substituted for home producible commodities.

A third study by Dardis, Soberon-Ferrer and Tsay (1989) extended the research by Ballante and Foster but

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included the wages and hours worked of both husband and wife to measure the impact of household production variables on service expenditures. The analysis was confined to two-earner husband-wife families and used data from the 1984-85 Consumer Expenditures Survey. The authors found that all four work related variables had a significant impact on total service expenditures in addition to family life cycle and location.

A final study by Jacobs, Shipp and Brown (1989) also used data from the 1984-86 Consumer Expenditures Survey to analyze expenditure patterns of working and non-working wife households. Dummy variables were used to measure the employment status of the wife with part-time defined as working "fewer than 35 hours per week or working full-time for part of the year" while full-time was defined as working "35 hours or more per week for at least 50 weeks" (p. 20). The authors found that the employment status of the wife had a significant impact on child care and food away from home expenditures once the effect of other variables such as household income, family life cycle and location were held constant.

The objectives of this research were to investigate the impact of the wife's employment status and household production variables on household expenditures for services in the United States. It builds on earlier research but differs in that it includes both working wife households (full-time and part-time) and non-working wife households and obtains an implicit value of time for non-working wives. It also investigates whether the three groups of households should be separated or combined in the analysis of service expenditure decisions.

### Procedure

The household production model is discussed first followed by the dependent and independent variables. The estimation of an imputed wage for non-working wives follows. The statistical analysis and data used in the analysis are given in the last two sections.

#### Household Production Model

The household production model was used to identify the major explanatory variables for services expenditures (Becker 1965; Michael and Becker 1973). The model used in this study differs from that proposed by Becker in one major respect. The household decision process is treated as sequential in which household members first enter the labor force to achieve a certain income level and then make expenditure decisions in accordance with income and time constraints. Thus, hours worked by both husband and wife are treated as exogenous variables. This procedure is based on the fact that many workers face institutional constraints on hours of work and cannot change jobs readily due to imperfect mobility, or imperfect information (Killingsworth 1983, pp. 46-66, Deaton and Muellbauer 1980, p. 286; Mishan 1967, p. 115; Mishan 1977, p. 210). It could also be argued that social and economic changes in the past decades have affected the employment decisions of husbands and wives so that both are made simultaneously. The earnings of wives are treated as permanent rather than as secondary or transitory in this simultaneous decision. The characteristics of the model are as follows:

$$\text{Utility Function :}$$
$$U = u(Z_1, Z_2, \ldots, Z_n) \qquad (1)$$

$$\text{Production Function :}$$
$$Z_i = z_i(x_i, t_i, E) \qquad (2)$$

$$\text{Market Goods Constraint :}$$
$$p_i x_i = w t_w + V = Y \qquad (3)$$

$$\text{Time Constraints :}$$
$$T = t_w + t_i \qquad (4)$$

where

$Z_i$ = commodity or activity produced in the household, $i = 1,2\ldots,n$

$x_i$ = vector of market goods used in the production of $Z_i$

$t_i$ = vector of time inputs used in the production of $Z_i$

$p_i$ = price vector of $x_i$

$w$ = wage rate vector

$t_w$ = vector of time inputs used in market production

$V$ = unearned income

$Y$ = household income

$T$ = total time available for household and market production, and

$E$ = technology of household production.

The demand for household services based on the household production model is as follows:

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$$p_i x_i = x_i(t_w, w, V, D, L, E) \quad (5)$$

where

$p_i x_i$ = expenditures on service i

D = vector of preferences and service needs

L = location, a proxy for service costs and service availability

and the other terms are as defined earlier.

The two variables D and L are designed to hold preferences, service needs and service costs constant since these may vary across households. Their inclusion is required to achieve the "ceteris paribus" conditions when data from different households in different locations are used (Phlips 1983).

The three household production variables ($t_w$, w, V) are hypothesized to have a positive impact on service expenditures assuming that Z is a normal commodity or activity and that the market goods ($x_i$) are not inferior factors of production (Varian 1979, p. 50). Thus, an increase in these variables will increase household income, increase the demand for $Z_i$ and encourage the substitution of $x_i$ for $t_i$ since the total time for household production (and leisure activities) is limited (Becker 1965, Michael and Becker 1973).

## Dependent and Independent Variables

The dependent variables is household expenditures on total services which includes child care, clothing care, domestic services and food away from home. All of these categories reflect time-buying activities.

The primary independent variables of interest are the household production variables. However, a rigorous analysis of the effects of these variables on service expenditures requires that allowances be made for variations in preferences, service needs and service costs of households. These demand shifters include family life cycle, race of household head, geographic location and home ownership. The hypothesized effects of the independent variables on service expenditures are discussed in the following section.

Household Production Variables. These variables include the wage rate, time spent in market production and unearned income. Unearned income includes rental and interest income,

unemployment insurance, welfare payments and food stamps, and pensions. The coefficients for the wage rate, work hours and unearned income are expected to be positive.

Family Life Cycle Variables. These variables include the age of husband, the number of children aged 0 to 2 and 3 to 5 and the number of persons in the household excluding children under six. Both age and age squared were used in order to take the curvilinear relationship between age and service expenditures into consideration (Weagley and Norum 1989, Jacobs, Shipps and Brown 1989). A positive coefficient for age and a negative coefficient for age squared would indicate a U-shaped curve with expenditures first increasing with age and then decreasing. The number of children/persons in the household is expected to increase the demand for services.

Race of Household Head. This variable is included to allow for differences in tastes and preferences. It is hypothesized that black families will spend less on total services than other families (Ballante and Foster 1984).

Location. Urbanization is the only location variable since data for regions are not provided for rural households. It is included to allow for variations in service costs (and service availability) in urban and rural areas. It is hypothesized that families living in urban areas will be more likely to substitute paid labor for household labor than families living in rural areas (Dardis, Soberon-Ferrer and Tsay, 1989).

Home Ownership. According to Garman and Forgue (1988), the cash outflow of renters is usually smaller than that of homeowners so that they may have more to spend on clothing care and food away from home than homeowners. However, home ownership had a positive impact on total service expenditures in the study by Ballante and Foster (1984). It was hypothesized that it would have a positive impact on total service expenditures.

## Estimating an Imputed Wage for non-Working Wives

A two stage procedure was adopted to estimate the imputed wage for non-working wives following the work by Killingsworth (1983). In the first stage an ordered probit analysis was used to estimate the probability of

working for all wives in the sample.
The probit equation was as follows:

$$Pr(work) = f(X,Z) \qquad (6)$$

where Pr (work) reflects the probability
that the wife will work full-time, part-
time or not at all, X is a vector of
"wage variables" or human capital
variables and Z is a vector of taste
variables which also influence the work
decision. The human capital variables
were age and education of wife and work
experience. Data on labor force
experience were not available so that
the number of children aged 0-2 and 3-5
were used as proxies for work
experience. The number of children in
both age groups were expected to reduce
labor force participation in previous
years and hence labor force experience.
The Z variables were family size
(excluding the number of children under
six), race, home ownership, location,
unearned income and husband's income.

A variable lambda ($\lambda$) which adjusts
for sample selection bias, was obtained
from the Probit analysis and was
calculated for each individual in the
sample. In the second stage a wage
equation was estimated for all working
wives as follows:

$$\ln(w) = g(X, \lambda) \qquad (7)$$

where w = wage rate and the other
variables are as defined earlier. The
imputed wage for non-working wives was
then obtained from the coefficients of
the X variables in the wage equation.

Statistical Analysis

Ordinary Least Squares (OLS) was
used to examine the impact of
explanatory variables on the demand for
services since there were no zero
observations on the dependent variable.
The F-statistic and t-statistics were
used to determine the significance of
the model and the individual
coefficients respectively. The Wald
test was used to test the significance
of sets of regressors such as household
production or family life cycle
variables (Green 1990).

Separate analyses were performed
for families with full-time, part-time
and non-working wives in order to
determine if there were differences
between the three groups. The hours
worked by the wife were excluded in
these analyses. Full-time was defined
as working 35 hours a week or more. The
equality between the sets of
coefficients in the three groups was
tested using the Wald test. The three

groups of families were combined or
analyzed separately in the OLS analysis
depending on the results of the Wald
test.

Data Used in the Analysis

Quarterly data from the 1984 and
1985 Bureau of Labor Statistics
Interview Panel Consumer Expenditure
Surveys (CES) were used in the analysis.
A rotating panel of approximately 5,000
households is interviewed each quarter
for five quarters. Two years of data
were required to yield an adequate
sample size for this study. The
analysis was confined to husband-wife
households where the husband worked.
Complete data for four successive
quarters were available for 1,215
households.

Results

Sample Characteristics

Annual service expenditures ranged
from $1,259 for non-working wife
households to $1,464 and $1,955 for
part-time and full-time working wife
households respectively. Sample
characteristics are given in Table 1.
The actual or imputed hourly wages for
wives range from $4.68 for non-working
wives to $8.12 for full-time working
wives. The order is reversed for
husbands with the highest hourly wage
($13.12) occurring for husbands with
non-working wives. These households
also have a higher unearned income than
the other two groups of households.
Other differences between the three
groups of households occur with respect
to age of husband and wife, the number
of children aged 0-2 and 3-5, race and
location. In contrast, there are small
differences with respect to the number
of hours worked by the husband
suggesting that the wife's employment
status may play a major role in the
decision to substitute paid labor for
household labor.

Comparison of Three Household Groups

The results of the Wald test
indicated that there were no differences
between households with non-working and
part-time working wives. However, there
were significant differences between
full-time working wife households and
other households. Accordingly separate
regressions were run for households with
full-time working wives and for other
households.

## Results of the OLS Service Expenditure Analysis

The results of the OLS service expenditure analysis are given in Table 2. The F statistics indicate that the model is significant in explaining variations in the dependent variable while the adjusted $R^2$ ranges from 0.29 to 0.33.

The results for the household production variables are of interest in several respects. First, all five variables are significant for both groups of households though the level of significance for the wage rate of the wife is higher for full-time working wife household than for other households. Second, all five variables have a positive impact on service expenditures as hypothesized. Finally, the impact of both work variables varies by the wife's employment status as shown by a comparison of wage and work hour elasticities of demand which are given in Table 3. The wife's wage elasticity of demand for services is 0.35 for full-time working wife households compared to 0.09 for other households. The corresponding values for the wife's work hours elasticity of demand are 0.71 and 0.04. The elasticity values for husbands and wives are fairly similar in the case of full-time working wife households while there are considerable differences in the case of other households. The unearned income elasticities of demand range from 0.01 to 0.02.

The two groups of households also differ with respect to the impact of family life cycle variables. While the number of children aged 3-5 has a positive and significant impact on service expenditures in both instances, the two age variables are only significant for full-time working wife households. Service expenditures first increase with age as hypothesized and then decrease. This finding is in keeping with the greater work responsibilities of two-earner households and the need to substitute paid labor for household labor when the wife works full-time. The number of children aged 0-2 also had a significant impact on service expenditures for full-time working wife households reflecting the greater use of child care services for such households. In contrast, family size was only significant for part-time and non-working wife households.

The three remaining variables are race, location and home ownership. Black households and rural households spent less on services than other households and the coefficients were significant in all instances. Home ownership was only significant in the case of part-time, non-working wife households where its impact was positive. This result was also obtained by Ballante and Foster (1984) for all households.

The significance of two variable sets (household production and family life cycle) was also examined using the Wald test. The two variable sets were significant for both groups of households.

## Discussion

One of the major findings of this analysis was that there was a significant difference between full-time working wife households and other households. Thus, a combined group analysis with dummy variables to reflect the employment status of wife would have been inappropriate since the results of the Wald test indicated that there were differences between the two household groups with respect to slopes as well as intercepts.

The results of this analysis provide strong support for the household production model and the need to consider both time and budget constraints in the service expenditure decision. All five household production variables had a positive and significant impact on service expenditures in all instances though the magnitude of the effect varied by the wife's work status. Thus, the impact of a change in wages or work hours of the wife was considerably greater for full-time working wife households than for other households. The wife's wage elasticity of demand for services was 0.35 for full-time working wife households compared to 0.09 for other households. The corresponding values for the wife's work hours elasticity of demand were 0.71 and 0.04. The fact that the elasticity values for husbands and wives were fairly similar in the case of full-time working wife households is in keeping with the greater contribution of full-time working wives to household income.

Family life cycle variables also played a role, particularly for full-time working wife households. The fact that age was only significant for these households is interesting and may reflect the greater time constraints of two-earner households over the life cycle. The set of family life cycle variables had a significant impact on

service expenditures for both groups of households.

The remaining variables were included to account for differences in tastes, service needs, and service costs between households. They had a significant impact on service expenditures in five out of six instances.

In conclusion, the household production model used in this analysis provided a reasonable degree of explanation for variations in the dependent variable. The breakdown of total household income into separate components permitted a more detailed investigation of the impact of time and budget constraints on service expenditures by different groups of households. An extension of the analysis to the demand for specific service categories would provide additional information concerning the demand for services. Thus, the wife's time constraints may play a major role in the case of child care for full-time working wife households while both time and budget constraints may be of equal importance in the case of other service categories such as food away from home.

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Table 1
Sample Characteristics

| | | Mean or Percentage | | |
| Variable | Name | Full-time | Part-time | Non-working |
|---|---|---|---|---|
| Unearned Income | UNINC | $1,175.30 | $1,472.15 | $2,806.42 |
| Hourly Wage (wife) | WAGEW | $8.12 | $7.43 | $4.68[a] |
| Hours Worked (wife) | HOURW | 2,139.60 | 1,166.84 | 0.00 |
| Hourly Wage (husband) | WAGWH | $11.51 | $12.45 | $13.12 |
| Hours Worked (husband) | HOURH | 2,321.09 | 2,327.79 | 2,366.08 |
| Age of Husband, Years | AGEH | 39.70 | 41.56 | 43.69 |
| No. of Children, 0-2 | CHLD1 | 0.13 | 0.09 | 0.29 |
| No. of Children, 3-5 | CHLD2 | 0.14 | 0.22 | 0.26 |
| No. of Persons excluding children under 6 | FSIZE | 3.04 | 3.45 | 3.25 |
| Race of Husband[b] | BLACK | 16.08 | 10.90 | 6.37 |
| Location | RURAL | 12.38 | 8.33 | 11.00 |
| Home Ownership | OWNER | 81.15 | 80.77 | 79.34 |
| Age of Wife, Years | AGEW | 37.61 | 38.73 | 41.25 |
| Education of Wife, Years | EDUW | 13.39 | 13.04 | 12.14 |

[a]Estimated.
[b]Race of husband and wife were identical in nearly all instances.

Table 2
Results of OLS Service Expenditures Analysis[a]

| | Full-time | | Part-time/Non-working | |
| Independent Variable | Coefficient | t-ratio | Coefficient | t-ratio |
|---|---|---|---|---|
| Constant | -4,273.82 | 4.820*** | -1,727.35 | 3.577*** |
| UNINC | 0.03 | 2.355** | 0.05-01 | 2.289** |
| WAGEW | 85.21 | 2.868*** | 22.69 | 1.895* |
| HOURW | 0.65 | 2.606*** | 0.17 | 2.794*** |
| WAGEH | 58.37 | 4.294*** | 60.01 | 7.081*** |
| HOURH | 0.54 | 3.723*** | 0.43 | 4.555*** |
| AGEH | 76.14 | 2.120** | 12.54 | 0.625 |
| (AGEH)$^2$ | -0.94 | 2.247** | -0.03 | 0.115 |
| CHLD1 | 699.94 | 3.595*** | 36.78 | 0.486 |
| CHLD2 | 1,188.05 | 6.766*** | 167.46 | 2.523** |
| FSIZE | 47.59 | 1.053 | 71.33 | 2.786*** |
| BLACK (non-black) | -353.37 | 2.602*** | -257.48 | 2.359** |
| RURAL (urban) | -257.68 | 2.497** | -299.64 | 3.843** |
| OWNER (renter) | 211.41 | 1.528 | 143.42 | 2.047** |
| F | | 21.12*** | | 22.29*** |
| $\bar{R}^2$ | | 0.33 | | 0.29 |

***Significant at the 0.01 level.
** Significant at the 0.05 level.
* Significant at the 0.10 level.
[a]Reference group for three dummy variables are given in parentheses.

Table 3
Elasticities of Demand for Services[a]

| Variable | Full-time | Part-time/Non-working |
|---|---|---|
| UNINC | 0.02 | 0.01 |
| WAGEW | 0.35 | 0.09 |
| HOURW | 0.71 | 0.04 |
| WAGEH | 0.34 | 0.60 |
| HOURH | 0.64 | 0.78 |

[a]Elasticities are computed at the mean for respective variables.

# Locus of Control, Gap Between the Standard and Level of Living and Satisfaction with the Gap: A Path Model Replication

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The path models investigate the relationships among demographic variables, locus of control, the gap between standard and level of living, and the satisfaction with that gap. A random and economically stressed farm sample were included. The more internal control respondents experienced, the smaller was the gap. The smaller the gap, the higher was the satisfaction. Household size had a direct effect on locus of control and an indirect effect on the gap and satisfaction.

The standard and level of living are important concepts in family management theory because this theory has stipulated for a long time that one of the most important motivators to change in families is dissatisfaction due to the gap between the actual level of living and the desired standard of living (Beutler & Owen, 1980; Beutler, Owen, & Hefferan, 1988; Crawford & Beutler, 1983; Deacon & Firebaugh, 1981; Devine, 1924; Gross, Crandall, & Knoll, 1980; Hoyt, 1938; Kyrk, 1953; Liston, 1970; Paolucci, Hall, & Axinn, 1977; Rice & Tucker, 1986). However, not much attention has been paid in family management literature to the prediction of the gap between the standard and level of living or the satisfaction with the gap.

This trend has continued despite the fact that Schlater in 1970 pointed out that increased research must be conducted in the area of level of living so that further enrichment could be provided for family life. Schlater also stipulated that research on the level of living presented one of the greatest challenges. In 1973, Hafstrom and Dunsing stated that additional work was needed on the concept, level of living. At that time, the authors raised a series of questions surrounding the concept. More than a decade later, Michalos (1986) still pronounced the need for more resources to be designated toward gap theory explanations.

In addition, it is important that family management researchers investigate the relationships among locus of control, the gap between standards and levels, and satisfaction with the gap. The interaction of these concepts is crucial within a financial counseling environment. The interaction among these variables can influence a client's motivation in even small increments so as to impact the success of financial counseling efforts.

The purpose of this study is to replicate a path model that investigated the relationships among selected demographic variables, locus of control, the gap between the standard and level of living, and the satisfaction with that gap. The initial sample on which the model was tested was a random sample of farm women. A sample of farm men and women under economic stress is used in this study because it has some distinct characteristics from the initial one and if the findings of the path model are similar, there would be additional support for both the model and the hypotheses. A comparison of the findings from the two samples is done to provide further evidence to support the family management theoretical proposition mentioned earlier.

## Literature Review

It is important to first clarify the distinctions between the central concepts that are the focus of the study. Davis (1945) defined level as that which is actually experienced, enjoyed, or suffered by the individual or group; the standard is the level that is urgently desired or striven for. Gratification is received with success in reaching the standard while frustration is felt if the standard is not reached.

Consumption, according to Davis (1945), is a sort of aggregate of the food, fuel, and the nondurable goods used up, the services of houses, automobiles, clothing, and other durable and semidurable goods utilized, and the services of human beings used, by an individual or group, in a given period of time. Level of living, on the other hand, is a more global measure. The level of living, according to Davis (1945), is made up of a complex combination of consumption, working conditions, possessions, freedoms, and atmosphere, and the balance or harmony among them, in relation to needs and felt wants.

The discrepancy between the standard and level of living affects the degree to which economic well-being has been perceived by individuals and families to be adequate (Deacon & Firebaugh, 1981). Families have felt poor when their incomes were insufficient or barely sufficient to provide what, by their standards, was essential (Kyrk, 1953).

The literature that addresses the standard or level of living incorporates either one or the other concept in their study. Hafstrom and Dunsing (1973) and Hefferan (1971) studied level of living. Hahn (1972) investigated both the level of living and standard of living aspirations. However, none of the studies included a measure that assesses the perceived magnitude of the gap between the

standard and level of living which is the focus of this study.

Satisfaction is a function of, determined by, or explainable in terms of the perceived gap (discrepancy) between one thing and another. Michalos (1986) states that there are at least six different gap-theoretical explanations. The one used in this study is the goal-achievement gap theory. It states that satisfaction is a function of the perceived gap between what one actually has and what one wants to have. This gap theory, according to Michalos, may be identified by talking about the perceived gap between what a particular person has now and has as a goal.

There are various factors that might affect the relationship between the perceived magnitude in the gap between the standard and level of living and the satisfaction with the gap. Whether a person considers the discrepancy a short-term or long-term event could determine the level of satisfaction with it. Many adults who become full-time students again after several years in the labor market are often willing to accept a larger gap because they expect that gap to decrease after they complete their educational program. As a result, their satisfaction level may be higher than one might expect for the magnitude of the gap.

Another factor that might affect the relationship is the past experiences of people. If there has been a large gap between the standard and level of living for many years, a person may adjust their level of satisfaction at a point in time to alleviate some of the cognitive dissonance that the large gap has created. If the same large gap exists for two different people, a person who feels powerless to affect a change in that gap may have a lower satisfaction level with that gap than someone who has the skills, ability, or ambition to affect a change in the gap. How much experience a person has had with others who are not like themselves might also affect how a person evaluates a gap.

Both socioeconomic and socio-psychological variables have predicted satisfaction with the level of living. Homemakers who had higher incomes, were white, perceived their incomes as adequate, had husbands who were employed, had husbands who held white collar jobs, owned houses with seven or more rooms, and had not moved in the last five years were most satisfied with their level of living (Hafstrom & Dunsing, 1973; Hefferan, 1971). Hafstrom and Dunsing (1973), in addition, found high marital satisfaction to result in increased satisfaction with the level of living. Hahn (1972) discovered that a homemaker was more likely to want only material things if she was dissatisfied with her level of living.

However, no studies investigating the standard or level of living have included a variable that measures how much control the respondents felt they had over what happened to them. In the 1960s, Rotter introduced

and developed the "Internal-External Locus of Control" scale as a measure of a generalized belief that rewards are due to one's own behavior as opposed to the view that they are controlled by external forces. Since then a considerable amount of research has been done on the concept (Bugaighis & Schumm, 1983; Lefcourt, 1976; Rotter, 1966).

Rotter's measure is particularly important to use in this study because of the sample, farm women. Due to what has been happening in the agricultural economy in recent years, farm families have found it more and more difficult to support themselves on the land. Increasingly both farm men and women have been deciding to take an off-farm job as an option to selling the farm (Beale, 1980; Bokemeier, Sachs, & Keith, 1983; Brown & O'Leary, 1979; Coughenous & Swanson, 1983; Jones & Rosenfeld, 1981). But we do not know how what is happening in the agricultural economy and the market decisions that are made as a result affect their locus of control or their perceived gap between the standard and level of living or the satisfaction with the gap.

An earlier study (Danes, in press) investigated the relationships among locus of control, the gap between the standard and level of living, and the satisfaction with that gap with a sample of farm women. The findings from that study indicated that the more internal control the women experienced, the smaller the gap between the standard and level of living. The smaller the gap and the higher the internal control experienced, the higher was the satisfaction with the gap. There were also indirect effects mediated through locus of control in the path model being tested.

The hypothesis for this study was that the larger the internal control experienced by the respondents, the smaller the gap between the standard and level of living and, in turn, the higher the satisfaction with the gap. The household size, off-farm employment, income level, educational level, and age of the respondents were hypothesized as variables that would affect the three dependent variables in the path model, locus of control, the gap between the standard and level of living, and the satisfaction with the gap.

### The Sample

The same path model is tested on two samples in this study and then the findings are compared. The data for the initial sample (Sample 1) were collected in a Midwestern state in the Spring of 1988. The data were collected by mail questionnaire from a random sample of 513 farm women. There was a 42 percent return rate. The sample represented counties from the entire state. The data from the study were compared to U.S. and Midwest census data for farm populations. That comparison indicated that the demographic data from this study closely resembled those from the overall farm population.

The data for the sample of farm men and women under economic stress (Sample 2) were collected by mailed questionnaires in 1987 and 1988 to recently completed cases of Mandatory Farm Credit Mediation in 29 randomly selected counties of a Midwestern state. The sampling unit was a mediation case and each case had the potential of generating two respondents when there was an intact marriage. Respondents included 592 persons representing 329 mediation cases.

## The Variables

Dependent Variables

A locus of control index was created from eight questions that asked about the degree of control the respondents felt over various aspects of their lives. Seven of the questions for the index used for this study came from work done by Bugaighis and Schumm (1983) and Edwards and Booth (1976). An eighth question on control over finances was added to provide an additional dimension to the locus of control index.

The answers to each question ranged from strongly disagree to strongly agree on a five-point scale. The mean of the index for Sample 1 was 25; the alpha reliability of the index was .622. The mean of the index for Sample 2 was 22 and the alpha reliability of the index was .659. The higher the score of the index, the more internal control the respondents felt over their lives. It is logical that a sample under economic stress would have a lower mean on the locus of control index as compared to a random sample.

The gap between the standard and level of living was based upon Cantrils' (1965) self-anchoring striving scale. The respondent first read a statement that expressed that there sometimes is a gap between the current situation and what we would like the situation to be. Then, the respondent was asked to suppose 10 represented the very best situation she could think of for herself and 1 represented the very worst situation she could think of for herself. The respondents were given a brief definition of level of living. It was defined as what you consume as well as your working conditions, possessions, sense of well being and the balance between these things (Davis, 1945). These anchoring points represented what was desired.

Using this self-defined continuum, the respondent was then asked to circle the number that best reflected where she would put herself. This number represented the actual assessment by the respondent of her current level of living compared to what she considered to be the best situation for herself or the gap between her standard and level of living.

To further explain the scale, if 10 represented the best situation for the respondent and the respondent circled a 9, there would be a small gap between the standard and level of living. If the respondent circled a 2, there would be a large gap between the standard and

level of living. If the variable remained coded as it was thus presented to the respondent, a large number code would indicate a small gap. So that the coding of the variable reflected the conceptual nature of the variable and so that the coding reflected the logical thinking of most people in that a large code equated to a large gap and vice versa, the variable was recoded so that a 1 now represents a small gap between the standard and level of living and a 10 represents a large gap. The range of the variable was from 1 to 10. The mean was 4 for Sample 1 and 4.5 for Sample 2.

The satisfaction with the gap between the standard and level of living was based on a seven-point scale from extremely dissatisfied (1) to extremely satisfied (7). Level of living was again defined for the respondents as described in the gap question. The mean was 5 for Sample 1 and 4 for Sample 2. The seven-point scale of the satisfaction question meets the suggestion of Hafstrom and Dunsing (1973) that satisfaction with level of living questions have a finer breakdown of "satisfied" categories than was used in their study.

Independent Variables

The education variable was the number of years of school completed. The range was from 2 years to 19 years in Sample 1 and 2 to 21 years in Sample 2; the average respondent completed high school in both samples. The average age was 46 years in Sample 1 and 49 in Sample 2. The number of years married was part of an earlier model but it was dropped from the analytical model because of a high correlation with age. The average household size was 3.6 and the range was one to ten for Sample 1. For Sample 2, the average household size was 3.5 and the range was from one to nine.

Income was the adjusted gross income of the household; it was a continuous variable. The range of the income variable was -$92,722 to $325,000 for Sample 1 and the income range for Sample 2 was $-306,128 to $421,207. Since the income variable was adjusted gross income, that figure included the farm income plus any off-farm income that there may have been. The natural log transformation of income was utilized in this study in order to satisfy one of the assumptions of regression and that is that there be homogeneity of variances.

The off-farm job variable is a dummy variable where "0" represents those respondents who were not employed off the farm and "1" represents those who were employed off the farm. Fifty-four percent of the respondents were not employed off the farm and 46 percent of them were employed off the farm for Sample 1. Forty-four percent were not employed off the farm for Sample 2 and 56 percent were employed off the farm.

## The Analysis

Preliminary analyses for the study included frequencies, cross-tabulations, and correlations. The path analysis included three regression equations. In one, the

locus of control was the dependent variable. In another, the gap between the standard and level of living was the dependent variable. In the third equation, the satisfaction with the gap between the standard and level of living was the dependent variable. The regression analysis included those equations to determine the indirect effects among the variables as well as the direct effects.

A residual analysis was completed to check that the error terms were normally distributed and to check for outliers. For each of the equations, the error terms were normally distributed and there were no outliers. Pedhazer's (1982) rule of thumb was used in this residual analysis which was to consider standardized residuals greater than two as extreme.

## Results

### Path Analysis

The fully recursive path model is described. Figure 1 includes the standardized betas for the path model from Sample 1 and Figure 2 includes the ones for the path model from Sample 2. Since a detailed discussion for Sample 1 can be read in another source (Danes, in press), what will be emphasized in this study are the results of the path analysis from Sample 2 and the comparison of the findings from Sample 1 and Sample 2.



Figure 2. Path Analysis Diagram for Economically Stressed Men and Women Sample
$R^2 = .07$

* p<.05, ** p<.01, *** p<.001
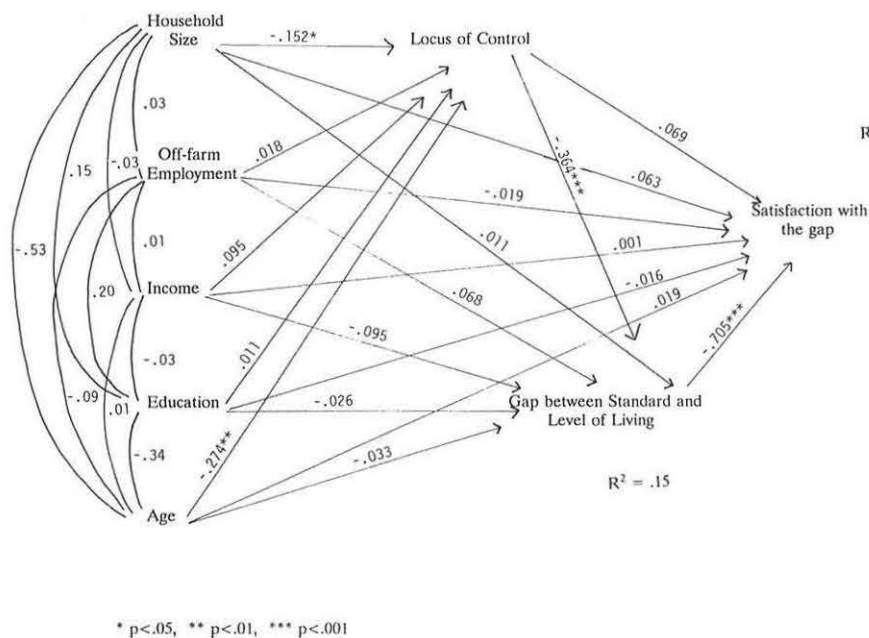
Two variables, household size and age, were statistically significant in predicting locus of control for a sample of farm men and women under economic stress (Figure 2). The higher the number of members in the household, the more the respondent felt their life was controlled by external forces. The older the respondent, the more the respondent felt their life was controlled by external forces. The $R^2$ for the equation was .066, which

meant that approximately seven percent of the variance in locus of control was explained by household size and age. The F-score for the model was 4.03 (p<.01).

The second regression equation in the path model was the regression analysis of the gap between the standard and level of living on household size, off-farm employment, income, education, age, and locus of control. Approximately 15 percent of the variance of the gap between the standard and level of living was explained by these variables. Locus of control was statistically significant at the .001 level and was the only variable that was statistically significant predictor of the gap between the standard and level of living. The more internal control the respondent felt over their life, the smaller the gap between the standard and level of living. The F-score for the equation was 8.28 (p<.001).

Approximately 54 percent of the variance in the satisfaction with the gap between the standard and level of living was explained by the variables in the model. The only statistically significant predictor of the satisfaction with the gap was the explicit measure of the gap. The smaller the gap between the standard and level of living, the higher was the satisfaction with the gap. The F-score for the equation was 46.86 (p<.001).

### Indirect Effects

Figure 2 indicates only the direct effects in the path analysis for Sample 2. Path analysis allows an investigation of indirect effects as well. Only those variables having indirect effects higher or equal to .05 with rounding will be discussed here. Household size had a total effect of .082 on the gap between the standard and level of living. It had a direct effect of .011. It also had an indirect effect of .071 on the gap between the standard and level of living through locus of control. The more persons in the household, the greater was the gap between the standard and level of living. There also was an indirect effect of age (.103) on the gap between the standard and level of living through locus of control. The older respondents experienced a larger gap between the standard and level of living.

Household size had an indirect effect of -.053 on satisfaction with the gap between the standard and level of living. The higher the household size the lower the level of satisfaction with the gap. There was also an indirect effect of age (-.087) on satisfaction; the older respondents were less satisfied with the gap.

There were indirect effects of off-farm employment (-.049), income (.067), and locus of control (.257) on

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satisfaction with the gap through the explicit gap between the standard and level of living. Those respondents who worked off the farm were less satisfied with the gap. Those respondents with higher incomes had higher levels of satisfaction with the gap between the standard and level of living. The respondents who experienced more internal control also experienced higher levels of satisfaction with the gap between the standard and level of living.

Comparison of the Two Samples

The path model was tested first with a random sample of farm women (Sample 1). Then it was tested with a sample of both farm men and women who were under economic stress (Sample 2). In regard to the hypothesized direct effects, the findings were consistent in direction and magnitude for both samples (Figure 1 and 2). The more internal control the respondents experienced the smaller the gap they experienced between their standard and level of living and the smaller the gap, the higher was the satisfaction level.

Figure 1. Path Analysis Diagram for Initial Sample of Women
$R^2 = .03$



* p<.05, ** p<.01, *** p<.001
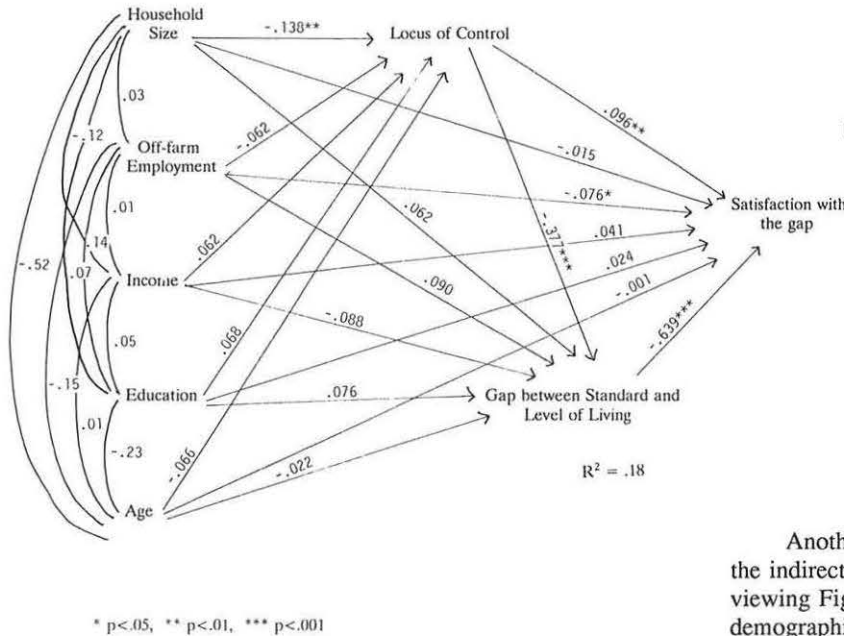
There were some other direct effects that differed between the two samples. Age was a significant predictor of locus of control in Sample 2 but not in Sample 1. Locus of control and the employment off the farm were significant predictors of satisfaction with the gap between the standard and level of living in Sample 1 but not in Sample 2.

The majority of the significant indirect effects of the path model were similar in direction and magnitude. However, there were a few differences in the comparison of the indirect effects between the two samples. Age had a significant indirect effect on the gap through locus of control in Sample 2 but not Sample 1. Age also had an

indirect effect on the satisfaction with the gap through locus of control in Sample 2 but not in Sample 1. Education had an indirect effect on satisfaction with the gap through the explicit measure of the gap in Sample 1 but not in Sample 2. Those respondents who had higher levels of education were less satisfied with the gap in Sample 1.

### Discussion and Conclusions

The purpose of the study was to replicate a path model that investigated the relationships among selected demographic variables, locus of control, the gap between the standard and level of living, and the satisfaction with the gap. Two points are clear from the comparison of the analyses from the two samples. The hypothesized direct effects between the dependent variables were consistent in direction and magnitude for both samples. The second point that becomes clear from the analysis is that it is crucial to investigate the indirect effects as well as the direct effects in the path analysis.

There were few statistically significant direct relationships between the various demographic variables and the dependent variables within the path analysis. However, there were quite a few indirect effects of the demographic variables through various dependent various to others in the model.

For instance, household size had a significant direct effect on locus of control for both samples but not on the gap between the standard and level of living nor satisfaction with the gap. But, there were indirect effects of household size upon the gap through locus of control and on satisfaction with the gap through locus of control.

Another example of why it is important to analyze the indirect effects as well as the direct effects is that by viewing Figure 1 and 2, it appears as if of the demographic variables only off-farm employment in Sample 1 and none in Sample 2 have a direct effect upon satisfaction with the gap. When analyzing the indirect effect in Table 1 and 2, however, off-farm employment, income, and education have a significant indirect effect on satisfaction with the gap in Sample 1 and off-farm employment and income have a significant indirect effect on satisfaction with the gap in Sample 2.

A big difference between the path analyses from the two samples was the affect of age within the analysis from Sample 2, the one including both farm men and women and the sample that was experiencing economic stress. There was a direct negative effect of age upon locus of control. Those who were older experienced more control from external forces in their lives. The

respondents had all completed Mandatory Farm Credit Mediation and the older ones felt that they had less internal control because there is less time and other resources to recover from this experience. There were indirect effects of age on the explicit measure of the gap and satisfaction with the gap. Those respondents who were older perceived a larger gap between their standard and level of living and a lower level of satisfaction with the gap.

The locus of control measure in these studies was an influential variable because it not only had direct but indirect effects on the gap between the standard and level of living and the satisfaction with the gap. For those professionals doing financial management education or counseling, it is important to do things early in the process that provide internal control to the students or clients. For example, teaching them a simple method of keeping track of family income and expenses as they occur on a calendar allows the family to discuss alternatives based on their stated goals. It empowers families to make some decisions such as which bills to pay, what proportion of a bill to pay, or it provides concrete information with which to negotiate with creditors.

Some people do not know where they spend their money. Nor, as a result, can they think ahead to what might be coming in the near future for which they might need money. Having families keep track of the income/outgo on a calendar, provides them with more internal control, which in turn, begins to reduce their assessment of the gap between the standard and level of living somewhat, which increases their satisfaction with the gap. So even though their financial status may have been affected only slightly in the short run, their sense of internal control has increased, which is a stimulus to continue to keep track of the income/outgo flow. In reality, the process of increasing the level of internal control which, in turn, affects the assessment of the gap and satisfaction with the gap is a circular one rather than a linear one.

It is also important to teach families the income/outgo flow process and then let them do it themselves rather than having them bring in the bills and the financial educator/counselor doing so. Allowing them to do it empowers them with a greater degree of internal control. Helping them get the entire family involved in the process helps the whole family "own" the process. Once the family has kept track of the income/outgo flow for at least a month or two (instilling higher levels of internal control), then the financial educator/counselor can help the family compare their goals with the income/outgo patterns and investigate ways to decrease the discrepancy between expenditure patterns and previously identified goals. By this time, the levels of internal control may have increased enough so as to stimulate motivation to begin to take action to change behavior.

The data from the study have implications for theory and research. Past literature has not included a measure of the gap between the standard and level of living but rather only one or the other of the concepts. However, family management theory has long stipulated that one of the most important motivators to change in families is dissatisfaction due to the gap between the actual level of living and the desired standard of living. Because both samples have incorporated measures of both the gap between the standard and level of living and the satisfaction with the gap and because the relationships between the variables were statistically significant, some evidence has been provided that supports that theoretical proposition.

An internal-external locus of control measure is also vital in models investigating the family level of living. There were statistically significant direct effects of locus of control on both the gap between the standard and level of living and the satisfaction with the gap. However, there were many indirect effects that were mediated through the locus of control, as well. Locus of control is an important concept to include in models like the one in this study because the interaction among these variables can influence a persons motivation to change in even small increments that might impact the success of an educational or counseling effort to affect change.

This study contributes to the literature on level of living as Schlater (1970), Hafstrom and Dunsing (1973), and Michalos (1986) stated was needed. The model needs to be tested with other than farm family samples to analyze whether similar effects are found. Further study also needs to be accomplished where the effect of the gap between the standard and level of living and the satisfaction with that gap on the motivation for change in families is determined. Doing so would contribute to family management theory as well as to the literature on the family level of living.

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# The Illinois Child Support Guidelines Project

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The Illinois Department of Public Aid requested a study of the guidelines used by the various states and of the costs of raising children to provide information for proposed revision of the state's child support guidelines pursuant to the provisions of the Family Support Act of 1988. We prepared a report which contained discussions of the guidelines models, various treatments of key factors, such as income, child care, etc., and a review of the costs of raising children literature and its relationship to determining appropriate percentages of income for child support guidelines. We then made our recommendations in these areas.

## Costs of Raising Children

Costs of raising children studies provide important information for setting child support guidelines because they tell us how income is distributed within the family between the adults and the children. This information must be converted into a percentage of income for the purpose of setting guidelines, which may not always be straightforward.

Among the major studies of child costs examined were those of Espenshade (1984), Olson (1983), Turchi (1983), Lazear and Michael (1988), the new USDA study (Lino, 1990), and one conducted for HHS. Our major findings included: (1) costs of raising children estimates vary widely, from roughly 16-33 percent of income for one child; (2) those based upon the Engel method give the highest estimates and those based upon the Rothbarth method give the lowest estimates; (3) most states' guidelines percentages presently fall below the highest estimates based upon the Rothbarth methodology.

## Major Issues

The two major issues concerning the state involved the level of the award and the type of model to be used. Compared to awards in other states and based on research of the costs of raising children and on studies examining economic well-being of families before and after divorce, we found that awards are on the low side.

Currently, awards are based on a flat percentage of the noncustodial parent's income, often referred to as the percent of income model. Many states are adopting the income shares model, where the total income of both parents is used in calculating the award which, in turn, is prorated between the parents based upon their relative, or prorated, income shares.

The advantages of keeping the percent of income model are: simplicity in calculating, administering, and updating awards; predictability for the parties involved; and possibly better acknowledgment of nonmonetary contributions of the custodial parent.

The advantages of changing to an income shares model are: accountability for both parents' income in relation to relative shares of income; more equitable treatment of families with different husband-wife income combinations; symbolic value which reduces the resistance to pay by noncustodial parents; and greater flexibility in treating key variables.

Other related issues are: Should the award be a constant or varying percentage of income? What definition of income should be used? How are key variables, for example, support obligations for other dependents, treated?

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# An Evaluation of the Relationship Between the Percentage-Of-Income Standard and Family Expenditures for Children

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Since July 1, 1987, family court judges in Wisconsin have been required to follow guidelines in establishing child support awards. These guidelines, known as the percentage-of-income standard, establish the portion of gross income that noncustodial parents should pay for child support: 17 percent for one child; 25 percent for two; and 29, 31, and 34 percent for three, four, or five or more children.

Federal law requires all states to have child support guidelines which are presumptive, meaning that a judge may deviate from the guidelines only for specified reasons and only with written justification. Some states base their guidelines on child-rearing costs, without reference to the income of the noncustodial parent. Wisconsin is one of 23 states that base child support awards on a percentage-of-income standard. Thirteen of these, including Wisconsin, use a "flat" percentage standard, meaning that the proportion of income to be paid in child support does not decline as income rises.

Several questions have been raised about the equity of the Wisconsin percentage-of-income standard. First, do the guidelines require noncustodial parents to spend a greater portion of their income on their children than do parents who live with their children? Second, do upper-middle-income noncustodial parents bear an unfair burden because parents in intact families tend to spend decreasing proportions of their incomes on their children as their incomes increase? And is this effect exacerbated by the fact that the percentage-of-income standard uses gross(i.e., pretax) income, and the overall tax system is progressive?

## Data for the Study

The analysis of these questions used a merged file of the Consumer Expenditure Survey (CEX) of the U.S. Bureau of Labor Statistics for the years 1982-83 and 1984. This survey collected data on major items of expense, including taxes, as well as on demographics, income by source, employment of household members, and changes in household assets and liabilities. The U.S. Census Bureau determined how the sample families were chosen, so that the outcome would be representative of the urban U.S. civilian population. The specific sample used in this study contained families from the Midwest--Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin, and was restricted to married couples.

## Method

A commonly employed technique-- though one with its share of critics-- was used to estimate the cost of child rearing. It was assumed that equally well-off families spend the same percentage of their income for food. Therefore the cost of a child can be calculated as the amount that a family's income must be increased to keep the percentage spent on food the same, after a child is added to the family, as it was when the family was childless. The child-rearing costs are then compared for lower- and upper-middle-income groups. Lower-middle-income families are defined as those with yearly incomes below $29,000, the median for the sample. Families with incomes below the poverty line are excluded. Upper-middle-income families are those with incomes of more than $29,000. The study also examined how specific expenditures are influenced by changes in income and family size.

## Results

The most striking result of this study was that intact families spend more on child rearing than the percentages required from noncustodial parents by the Wisconsin standards. Upper-middle-income families in which the mother is a full-time homemaker spend 21 percent of their income on a single child (compared to 17 percent in the standard); they spend 30 percent for two children (compared to 25) and 35 percent for three children (compared to 29). Lower-middle-income families spend even more; 25 percent of income for one child, 40 percent for two, and 45 percent for three. These data show that lower-middle-income families do, in fact, spend a larger percentage of

their gross income on child rearing than do their upper-middle-income payers, because the standard requires them to pay less than they would have paid prior to divorce.

To examine the question of whether the standard might better be applied to net rather than gross income, average tax rates were analyzed. The percentage standard has been criticized on the grounds that it unfairly penalized higher-income payers because it is applied to gross rather than net income. According to this line of reasoning, in a progressive taxation system, higher-income families would pay a higher percentage of their income in taxes, leaving them with proportionately less to spend on children and other consumption. These critics of the standard argue that the percentage of income owed for a child support obligation should either be applied to net income or, if applied to gross income, be reduced for higher-income payers, to adjust for the decrease in disposable income that results from progressive taxation.

No significant differences were found between lower- and upper-middle-income families in terms of the average percentage of taxes paid. Although if the mother was employed full-time the year round in the paid labor force, lower-middle-income families reported slightly lower average tax rates than their upper-middle-income counterparts, no similar trend emerged when the mother was a full-time homemaker. Furthermore, the only taxes examined were income taxes (federal, state, and local) and property taxes. Excluded were the next largest (and most regressive) taxes: the sales tax and social security contributions. It is very likely that if one takes into account both these regressive taxes and federal tax reform--which reduced the maximum marginal tax brackets--lower-middle-income families will be found to be facing higher average tax rates than upper-middle-income families. Therefore, one can conclude that criticisms of the standard because it is applied to gross income are unfounded.

### Conclusion

On average, upper-middle-income parents spend a smaller percentage of their gross income on their children than their lower-middle-income counterparts. This does not mean, however, that the Wisconsin percentage-of-income standard is punitive to upper-middle-income noncustodial parents. Although upper-middle-income noncustodial parents pay a larger share of their child's rearing costs than do lower-middle-income noncustodial parents, they still pay less than their share would have been before divorce. Neither group is required to pay as much of their income in child support as would have been allocated to the child had the family remained intact. The use of gross income rather than net income in the standard is not found to be an unfair burden on upper-middle-income noncustodial parents.

# The Development and Implementation of State Child Support Guidelines: Progress and Issues in Ohio

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To examine adequacy of support, guideline amounts for two household income levels are compared with USDA estimates for cost of raising a child.

Ohio child support guidelines are based on an income shares model (Child support guidelines, 1988). The premise of this model is that a child should receive the same proportion of parental income that he or she would have received if the parents lived together.

Combined gross income is used as the basis for determining amount. Amounts paid for health insurance for child(ren) and previous child support obligation are subtracted from the payer's income. The non-custodial parent's share of child support is proportionate to his/her contribution to total income. For example, if the combined gross income is $60,000, and the non-custodial parent's income is $40,000 (less $400 for insurance), the non-custodial share of child support is 66% of the Ohio guideline amount for $60,000.

Guidelines provide dollar amounts for incomes greater than $500 per month and less than $10,000 per month. Cases outside those limits are decided on a case-by-case basis. Support orders are mandatory absent total inability to pay.

## Effects of Guidelines

Adoption of guidelines has not changed the probability of the court's ordering support, but fairness and predictability of child support amounts increased (Stafford, Jackson, & Seiling, 1990). This assessment is made due to increased average amount, increased correlation between income and amount, and decreased differences in amount by gender of payer. Per capita weekly child support (in constant dollars) increased 21% since adoption of the guidelines.

Children of parents with incomes at extremes of the income range seem to have benefitted the most from adoption of the guidelines. The minimum award as well as the spread of the distribution have increased.

## Implications for Family Budgets

To check for adequacy of child support, guideline amounts were compared with USDA estimates of costs to raise a child. Two case studies were used. The first case was a household with combined gross income of $62,000 and two children ages 10 and 7 (Seiling & Jackson, 1990). The husband's income was $40,000, less $600 for health insurance. His share of child support was 64%, or $8765 annually.

The husband's share of the USDA estimate for this case is $7144. Thus, the husband pays more than the USDA estimates in year 1. Child support falls below USDA estimates after three years, however, if inflation is considered (assume 7.4%--the average rate for the period 1977-1987). After 11 years, the husband underpays an average of $1335 per year.

The second case is a one-child family with combined income of $22,000, and $14,000 husband's income (Seiling, Jackson, & Stafford, 1990). The guidelines provide a support level of $3564. The husband's share of that amount is $2267, whereas the husband's share of the USDA estimate is $2593. The shortfall, $326 in year 1, increases over time with inflation. Further, the mother is likely to fall below the poverty level if child support payments are not regular and on time.

Issues raised by these findings include definitions of adequacy and need for adjustments in support to account for inflation and increased costs of older children.

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# Iowa Child Support Guidelines: Progress and Issues

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## New Guidelines

New child support guidelines were adopted by the Iowa Supreme Court, effective December 31, 1990. The guidelines are based on the income-shares model. The award is calculated as a percentage of the noncustodial parent's net income. The percentage declines as the net income of the custodial parent increases. Net income is defined as gross income less deductions for federal and state income taxes; social security; mandatory pension; union dues; dependent health insurance; actual medical, child and spousal support paid pursuant to court order; unreimbursed medical expenses not to exceed $25 a month; and actual child care expenses of the employed custodial parent, less any tax credit. In addition to a child support award, the court will order medical support which is not to be included in the monetary amount of child support.

## Comparing the Iowa Guidelines

Table 1 compares the new Iowa guidelines to several standards. Examples of awards are based on the Iowa guidelines at various levels of net income of the parents, for a custodial family with two children. Three different assumptions are made about the custodial parent's net income: it equals zero, it equals one-half of the noncustodial parent's income (approximately the national average), and it equals the noncustodial parent's income.

A comparison is made between the total expenditures for child-rearing that are implicit in the Iowa calculations and recently published USDA figures of actual expenditures on children residing in husband-wife families. At the very lowest custodial parent income levels, AFDC eligibility would increase actual income and thus the estimate of total expenditures is unrealistically low. At moderate and upper income levels there is a general correspondence between the Iowa assumed total expenditures and the USDA figures. Because the published USDA figures are calculated as means within broad ranges of gross family income, the USDA figures at the lowest income categories are likely to be high and at the highest income categories in our table are likely to be low.

A comparison with Wisconsin's guidelines, which are based solely on the noncustodial parent's income, shows close correspondence between the Iowa and Wisconsin guidelines when the custodial parent's income is zero.

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## Issues

New presumptive guidelines for monetary and medical support raise many emerging questions. What will be the impact of the medical support requirement? If noncustodial parents meet this requirement via additional expenditures that reduce their net income and, in turn, reduces monetary support--will children be better off? Some cost shifting of health care costs for children from the Title XIX Program to private carriers is expected. Will these children receive comparable care? How will this influence the custodial parent's control over health care for her child/ren?

Will increased award guidelines result in increased child support payments to Iowa children? If yes, how will this affect divorced mothers and their children? If not, why not? What role might the process of calculating net income play in manipulating the ultimate child support award?

The research agenda for family economists and policy analysts resulting from this important policy reform is just beginning to take shape.

Table 1. Iowa Child Support Guidelines and Comparisons, 2 children

| Custodial Parent's Net Monthly Income | Noncustodial Parent's Net Monthly Income | | |
|---|---|---|---|
| | $1,000 | $2,000 | $3,000 |
| **Zero** | | | |
| Iowa Awards % | 37.1% | 37.2% | 37.2% |
| $ | $371 | $744 | $1116 |
| Assumed Total Expend.[1] | $371 | $744 | $1116 |
| USDA Expenditures[2] | | | |
| (2, 4) | $713 | $713 | $1014 |
| (8, 10) | $720 | $720 | $1018 |
| (14, 16) | $850 | $850 | $1164 |
| **One-Half Noncustodial Parent Income** | | | |
| Iowa Awards % | 34.3% | 30.7% | 30.0% |
| $ | $343 | $614 | $900 |
| Assumed Total Expend. | $515 | $921 | $1350 |
| USDA Expenditures | | | |
| (2, 4) | $713 | $1014 | $1445 |
| (8, 10) | $720 | $1018 | $1439 |
| (14, 16) | $850 | $1164 | $1608 |
| **Equal to Noncustodial Parent Income** | | | |
| Iowa Awards % | 31.7% | 30.0% | 30.0% |
| $ | $317 | $600 | $900 |
| Assumed Total Expend. | $634 | $1200 | $1800 |
| USDA Expenditures | | | |
| (2, 4) | $713 | $1014 | $1445 |
| (8, 10) | $720 | $1018 | $1439 |
| (14, 16) | $850 | $1164 | $1608 |
| Wisconsin Awards[3] | $375 | $750 | $1125 |

[1] Assumes custodial parent's expenditures on the children are proportional to net incomes.

[2] *Expenditures on a child by husband-wife families: 1990.* USDA. January 1991. Figures are total expenditures minus health care for two children ages 2 & 4, 8 & 10, or 14 & 16 years.

[3] Assumes Iowa noncustodial parent's net income is two-thirds of gross income (Wisconsin guide is 25% of gross income for 2 children).

# Rhode Island Consumers' Seafood Consumption
## and Perceptions of Seafood Quality

Joan Gray Anderson, University of Rhode Island[1]
Michael T. Morrissey, Oregon State University[2]

A random sample of 256 Rhode Island consumers was surveyed in the summer of 1990 to determine their seafood consumption patterns and their attitudes about seafood quality and safety issues.  Preliminary results are presented.

## Introduction

In the late 1980's, issues of seafood quality and safety received a great amount of media attention but little research has been done regarding consumers' perceptions of quality and safety.  A joint research project incorporating food science and consumer economics disciplines was designed and funded by Rhode Island Sea Grant.  In addition, a small grant was received from the Narragansett Bay Project (NBP) to help them  identify the kinds and amounts of seafood eaten by Rhode Island consumers which comes from Narragansett Bay.  In their eforts at risk assessment, NBP researchers realized that the one component of missing data for their work is what seafood consumers eat which comes from the Bay.  In Rhode Island, many consumers live near the ocean or Bay and have easy access to seafood.  Many residents fish themselves either recreationally or for a living or know someone who does.  Those who do not live on the coast are within an hour's drive; many vacation in coastal areas.  Understanding the seafood consumption patterns of these coastal consumers in addtion to their perceptions of seafood quality and safety was the purpose of this research.

## Methodology

In the summer of 1990, a telephone survey of Rhode Island households was conducted.  A sample of 256 was obtained which is believed to be representative of the Rhode Island population.  However, it should be noted for the reasons explained above,

areas may not be valid.  The researchers believe that this sample is probably more knowledgeable about and experienced with seafood than the average American.  Despite this limitation, the high level of knowledge and experience of this sample likely yeilded more useful data than may have been uncovered from a less informed sample.  The respondents surveyed had much to say about seafood and seemed to enjoy talking about it.

The survey was six pages long.  Depending on how much seafood a respondent consumes, it took between fifteen minutes and two hours to complete one interview.  The survey included the questions regarding specific species consumed, amount, where consumed, as well as preparation, portions consumed, differences in preferences within the family, consumption of selected (high risk) portions such as skin, fatty portions, dark portions of the flesh, liver/organs, and roe.  Hypothetical questions were posed to elicit consumer response to changes in seafood consumption which might result from changes in the marketplace (price, opening of a vendor of fresh seafood in the neighborhood, more information regarding seafood selection and preparation), regulatory policy (e.g. mandatory seafood inspection, seafood labeled with catch date) and environmental factors (closure of areas of the Bay, oil spill in the Bay).  Questions were also asked regarding how consumers define and assess quality.  Consumer perceptions regarding the overall safety of seafood were collected.  Open-ended answers were obtained regarding consumers' main safety concerns.  Demographic data was also gathered.  Selected highlights of the initial analysis will be presented in this paper.

## Results

### Seafood Consumption

Of the 256 respondents, 86 percent (235) eat seafood.  The most common reason given for not eating seafood is dislike (n=12).  Five respondents said they do not eat seafood because they feel it is unsafe.  Of the 235 respondents who do eat seafood, about 55 percent rated it as their most favorite food.  Another 25

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percent rated it quite highly. Yet, most respondents, 62 percent, feel that their knowledge level of seafood is about average. In an effort to ascertain what seafood R.I. consumers eat four specific questions about each of 13 species of finfish and 8 species of shellfish were asked. These questions were: Does your household eat (name of species)? If yes, how many times per year? Where do you usually eat it - home, restaurant or both? and If at home, do you buy it, get it as a gift or catch it yourself? The types of finfish eaten can be considered in two ways. First, the percent of respondents who eat a given species. Swordfish is most popular. Over 70% eat swordfish. Next most consumed are flounder and haddock at almost 70 percent. Salmon (49%), cod (41%), bluefish (36%), and tuna (32%) are next in descending order. However, when the number of times per year a species is eaten is charted (see Figure 1), cod is the most frequently consumed (almost 20 times per year), followed by haddock (17 times), flounder (16), salmon (13), scup (10) and swordfish (10).

Figure 1
How Often Does Your Household Eat Each type of Finfish.

Type of Fish



Avg Times/Year Consumed
Based on all respondents who
eat each type of finfish.
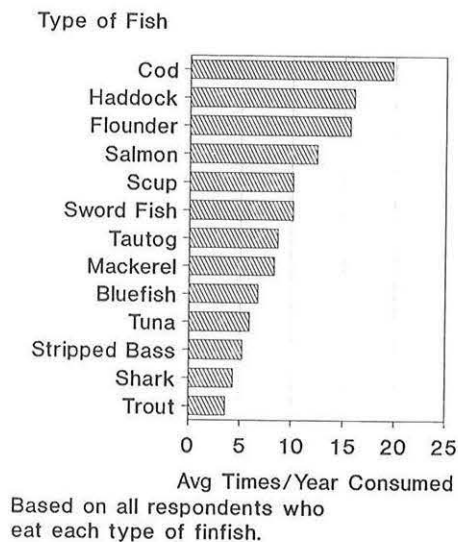
Almost ninety percent of respondents eat shrimp, followed by scallops (85%), lobster (80%0, clams (72%), and quahogs (61%). Oysters, mussels and squid are less popular with 32, 32, and 28 percent respectively. Shrimp is also the most frequently consumed (see Figure 2), about 15 times per year on average. Scallops and quahogs follow at 12 times per year each, followed by clams (10.5 times), lobster (9), squid (9), oysters (about 7) and mussels (about 6).

Figure 2
How Often Does Your Household Eat Each Type of Shellfish.

Type of Shellfish



Avg. Times/Year Consume
Based on respondents who
eat each type of shellfish.
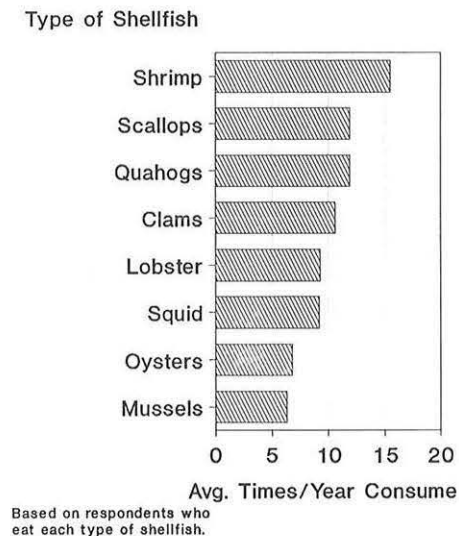
From a safety perspective, carcinogens and heavy metals tend to be stored in the skin, fat, dark flesh, organs and row. Therefore, respondents were asked whether they eat any of these. Nearly 38 percent eat the dark portions of the flesh. Next most commonly consumed are skin (15%), fat (12%), roe (11%) and organs (5%). About six (6) percent of respondents report that they sometimes consume finfish raw. Raw shellfish is often the subject of health advisories so it was important to learn which shellfish RI consumers actually eat raw. Littleneck clams are eaten raw by 61 percent of the 90 respondents who said they consume seafood raw. Oysters are a distant second (28%) followed closely by clams/quahogs (26%). Very few people eat shrimp, mussels, scallops or squid raw.

Since lobster is very popular in this state, and because roe and tamale pose a potential risk to humans, respondents were asked if they consume the tamale (liver) or roe (eggs) of the lobster. About four-fifths of those who eat lobster do not eat either of these parts.

Responding to concern about tracking seafood consumption for NBP, the research team included questions to ascertain if all household members consume the same seafood. Results reveal that 65 percent state that all members of their households consume the

same seafood. Future work will involve analysis of the other 35 percent of the respondents' households as well as the quantity prepared at a given meal for both finfish and shellfish.

Respondents were asked if their seafood consumption had changed over the past two years. While 52 percent said there had been no change, one-third (33%) stated that they have increased their seafood consumption, while only 15% have decreased their consumption. This indicates that the negative publicity generated over the past two years regarding seafood safety may not have had a negative impact on consumption as industry analysts had feared.

Reasons given for increasing seafood consumption included health, change in preference for seafood, change in location (moving to a coastal area made good quality seafood more available) and greater availability of seafood in general. Decreased consumption was attributed to perceptions of high risk by about 18 percent of the respondents who had changed their consumption. Many of these stated that change in lifestyle had affected consumption. Changes in family structure - marriage, divorce, new children, children leaving home, and similar factors - seemed to make seafood consumption more difficult for some and less difficult for others.

A series of hypothetical questions were asked to assess what might happen to seafood consumption under a variety of alternative scenarios. In response to the question regarding expected reaction to a 25% drop in the price of seafood, 25% stated that it would greatly increase consumption, 30% said it would increase consumption somewhat, and 42% stated it would have no effect. Respondents also would be positively impacted by mandatory seafood inspection, catch date labeling and selection and preparation information, with 10, 32, 58; 12, 38, 50; and 6, 36, 58 percent of the sample responding the change would greatly increase, somewhat increase and have no effect on their seafood consumption, respectively. Establishment of a new seafood vendor in the neighborhood would have a much smaller impact on consumption with 75% of those responding stating that it would have no impact on them. Only 4% stated that it would have a great effect while 21% said it would have a somewhat positive effect. As expected, closing of the Bay due to pollution or oil spill would have a negative impact on seafood consumption. Bay closing would cause 38% to decrease consumption somewhat, 19% to decrease consumption

greatly and would have no affect on 41%. If there were an oil spill in the Bay, 36% would decrease consumption somewhat, 28% would decrease greatly and for 36% there would be no impact on consumption.

## Consumer Perceptions of Seafood Quality

When respondents were asked if they ask questions when they buy seafood, 42 percent replied that they do. Fifty percent said that they never ask questions while another seven percent of those who eat seafood do not buy it. Of those who do ask questions, the most commonly asked questions can be seen in Figure 3.

Figure 3
What Questions Do You Ask When You Buy Seafood?



Percentage of Respondents

Based on 89 respondents who ask questions.
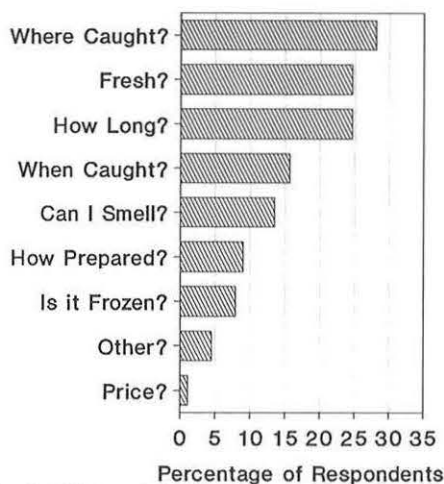
Of the 89 respondents who do ask questions, most (28%) ask where the fish was caught or where it is from. Another 25 percent ask if it is fresh, with the same percentage asking how long it has been at the store. When it was caught, a crucial but difficult to attain piece of information, is only asked by 16 percent of those who ask questions. No one mentioned asking the retail clerk what they recommend.

In answer to the open-ended question, What does high quality seafood mean to you, the majority (62%) answered fresh. This was followed by color (25%), smell (22%), high price (14%), trust the store(12%), and handling (10%). Other responses were given by less than ten percent of those responding.

## Consumer Perceptions of Seafood Safety

When asked how safe they believe seafood is in general, 19.6% stated that they believe it is very safe;

40.7% believe it is somewhat safe; and 33.5% think it is somewhat unsafe. About six percent have no opinion. (Refer to Figure 4.)

Figure 4
Consumer Perceptions of Seafood Safety

Percent of Respondents
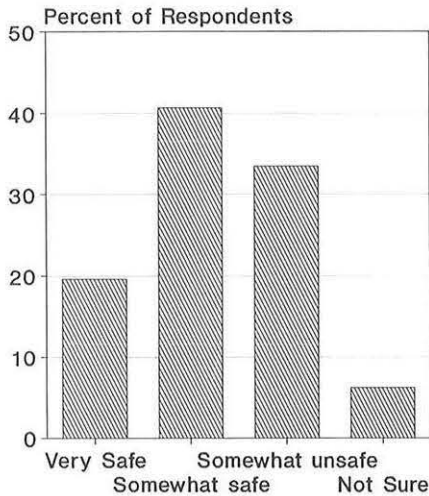


Based on 209 respondents.

In response to an open-ended questions asked only of the 151 respondents who expressed some degree of concern regarding the safety of the seafood supply, pollution was given most frequently. (See Figure 5.)

Figure 5
Consumers' Main Safety Concerns regarding Seafood

Type of Concern



Percent of Respondents
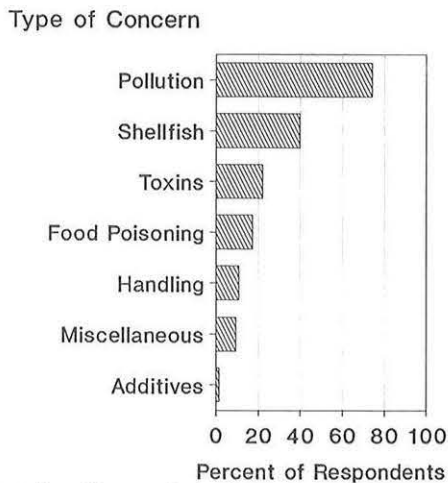
Based on 151 respondents who expressed concern for seafood safety. Respondents could cite more than one concern.

More than 70% of those responding to this question mentioned pollution. Forty percent mentioned the safety of shellfish as a major concern. Traditional concerns, toxins, food poisoning and additives, were mentioned by 22, 18, and 2 percent respectively. Ten percent mentioned that the way seafood is handled was a major concern to them indicating a high degree of understanding on the consumer's part of the perishable nature of seafood.

**Conclusions**

Consumers who reponded to this survey demonstrated a high degree of experience with seafood. Seafood consumption for this sample reflects their proximity to the coast and a supply of fresh seafood. Consumption data also revealed the wide variety of seafood consumed and the large amount that is obtained outside the conventional market channels. While safety concerns exist among this sample, there is little evidence that it has caused consumers to refrain from seafood consumption. On the contrary, consumption appears to be increasing. There appears to be modest, but not overwhelming, support for public policies which are aimed at assuring safety such as mandatory seafood inspection or at providing consumer information to facilitate the choice of quality seafood such as mandating catch date labeling.

These results present only the very first stage of data analysis. The use of inferential statistics to determine relationships between the important consumption, attitude and demographic variables will enable greater understanding of consumer perceptions of seafood quality and safety.

## Seafood Safety and Quality Issues for the Consumer

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Potential safety problems in seafoods are related to the consumption of raw shellfish and a few species of finfish. Seafood quality assurance is changing from a traditional based buyer-seller relationship to one of dependence on inspection programs and consumer knowledge of seafood quality. As the seafood industry diversifies through the introduction of new species and final product forms, there will be a greater responsibility placed on the consumer to determine quality parameters for their seafood purchases.

### Background

The seafood industry including harvesting, production, and marketing is undergoing rapid changes. This is mainly due to the dramatic increase in seafood consumption in the U.S. in the last two decades and increased demand worldwide. Figure 1 shows that seafood consumption in the U.S. has increased to a level of 15.9 lbs per person in 1990 and is projected to increase to 20 lbs per person by the year 2000.

Figure 1
U.S. Seafood Consumption 1910-2000



lbs./person

Years

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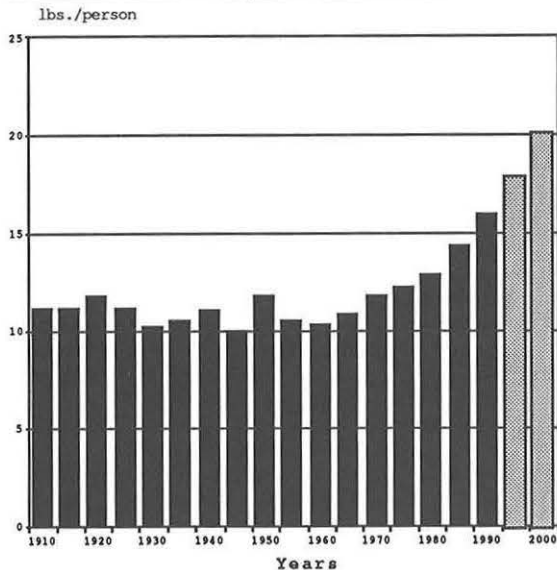
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The reasons for this increase are twofold; seafood is viewed as a highly nutritious source of animal protein and the variety it presents to the consumer has made seafood increasingly popular to restaurateurs and domestic cooks alike. In the 1988 Report on Nutrition and Health, the Surgeon General stated that seafood is one of the healthiest low fat proteins and is recommended for individuals who wish to reduce fat consumption (Young, 1989). Seafood products consumed in the U.S. are usually low in fat. The fat that is present has a high concentration of omega-3 fatty acids which has shown beneficial effects for prevention of certain heart diseases such as atherosclerosis and strokes (Kinsella, 1988; Nettleton, 1987).

Today, the American consumer is eating more seafood for a variety of other reasons such as economics, varying life-styles and changing demographics. Minorities are increasing in the U.S. and several ethnic groups, such as Southeast Asians, traditionally have high seafood consumption rates. There are more than 300 species of fish and shellfish that are currently sold in the U.S. This large variety of fishery products to choose from was once thought of as a point of confusion for the consumer but is now looked upon as a strong selling point for both retailers and restaurateurs. As more Americans become willing to enter into new gastronomic areas, the large number of choices seafood presents to the consumer has elevated, from the fish and chips mentality to one more akin to fine cuisine.

Approximately 60% of the seafood consumed in the U.S. is from foreign imports (USDOC, 1990). Of this amount, slightly more than one-half comes from developing countries. This will probably increase through the next decade as the U.S. appetite for shrimp and tropical fish increases. This large import of seafood from abroad has raised concern from several consumer groups as quality control standards in many of the exporting countries are not as stringent as in the U.S. Most of the seafood we consume is ocean caught. There is strong scientific evidence, as suggested by a number of fisheries

biologists, that the fishing industry is approaching the limits of harvest in the ocean. Although less than 10% of the fishery products consumed in the U.S. are from aquaculture sources, at present, it is felt that this percentage could reach more than 20% by the year 2000. As the demand for seafood products increases in the future, there will be increased imports and fishery products from aquaculture sources to satisfy the markets. There has been some justified concern that these changes may put the consumer at risk and compromise the beneficial effects of seafood consumption.

Several stories in the media over the last five years have focused on real and potential problems regarding safety and the consumption of seafood products. Concern exists about high mercury levels in swordfish, polychlorinated biphenyls (PCBs) in fatty fish such as blue fish and striped bass and contamination of heavy metals in shellfish harvested from polluted waters as well as outbreaks from emerging pathogenic microorganisms. In Prince Edward Island, Canada, a foodborne illness traced back to cultivated mussels caused the hospitalization of 135 persons and two deaths (Anonymous, 1988). Although the disease was related to a natural toxin, domoic acid from specific marine algae, the event resulted in a temporary shutdown of the regional industry and adverse impacts on consumer consumption of shellfish. In the summer of 1988, coastal pollution became a front page news story on the East coast of the U.S. Beaches were closed when hospital and sewage wastes were found. Cover stories in major newspapers and magazines reported the environmental contamination throughout the coastal regions. Reports of closed or contaminated fisheries in Texas, Louisiana, the Hudson River area by New York City, Boston's Quincy Bay, and the upper Narragansett Bay in Rhode Island were detailed. Official warnings about oysters, lobster, crabs, and English sole were published (Morgantheau, 1988). Regional consumers, unable to evaluate the safety of a given piece of seafood reacted by not purchasing seafood in these areas (Burros, 1988). The recent outbreak of cholera in Peru and its association with seafood harvested or washed in contaminated waters, has caused concern among federal agencies, fish importers and consumers in the U.S. (Brooke, 1991).

There has been a heightened concern about seafood in the media. Television programs such as 60 minutes and 20/20 have sensationalized specific incidents and have called into question the safety of all seafood. For example, a Sunday magazine article in a California newspaper on the hazards of Vibrio vulnificus was titled "Death on the Half Shell". This type of reporting has caused an outcry for strict legislation. Emergency regulations in California will require that by March 1991 retailers and restaurants that sell raw Gulf of Mexico oysters must post warnings about the threat of V. vulnificus (Anonymous, 1991). A waitress or waiter in California must say or hand the diner a card that reads, "eating raw oysters may cause severe illness and even death in persons who have liver disease, cancer or other chronic illnesses that weaken the immune system. If you eat raw oysters and become sick, you should seek immediate medical attention. If you are unsure whether or not you are at risk, you should consult your physician". Needless-to-say, this will have a negative impact on one's dining habits and put the unsuspecting consumer in an uncomfortable situation.

Much of the present concern with regard to quality and safety in seafood is due to the simple fact that there is no mandatory National Seafood Inspection Act as there are for other animal protein foods. Current seafood inspection systems include those that are mandated at the federal level, through the Food and Drug Administration (FDA) and those at the local level, as performed by state and health officials (Garrett, 1988). The U.S. Department of Commerce operates a voluntary seafood inspection program through the National Marine Fisheries Service (NMFS) on a fee-for-service basis that provides plant inspection and quality grading systems as well as laboratory services. The program has had mixed success and there is increasing pressure for a mandatory inspection system equivalent to that of meats. Currently there are two major bills in Congress; the Dingell bill in the House has the FDA as the regulatory agency, and the Mitchell bill in the Senate which sponsors the U.S. Department of Agriculture (USDA) as the main regulatory agency. It is assumed that a compromise will need to be worked out before a seafood inspection bill will be passed. There is recognition within the seafood industry itself that a seafood inspection act will, in the long run, be helpful to the industry and improve its relationship with seafood consumers. It is important that the final bill when passed be cost effective (there is a big question of who will pay for the inspection), be fairly implemented, and have real benefits to the consumer

(Vondruska, Otwell, and Martin, 1988).

## Seafood Safety

In spite of the negative press over the last few years, seafood is regarded in the food science and health communities as a safe and highly nutritious source of protein. It was recently noted by the National Academy of Sciences that although seafood consumption in the U.S. has increased by one-third over the last two decades there has not been a concomitant increase in reported seafood-borne illnesses. In studying the foodborne illness statistics, there is a need to separate finfish related illnesses from those related to the consumption of raw shellfish. Once this is done, it can be shown that the consumption of finfish products is as safe as consuming beef and poultry products (Young, 1989). In the hysteria of the late 1980's, statements such as "the consumer has a ten-fold risk of becoming sick from eating fishery products than beef or chicken" were not uncommon in the press. The basis for these statements was how the data was interpreted. Statistics from the Center for Disease Control (CDC) from 1973 to 1987 showed the following numbers of outbreaks and cases (Bean and Griffin, 1990).

Table 1
Number and Percentage of Foodborne Disease
Outbreaks and Cases 1973-87.

|  | Outbreaks | | Cases | |
|  | No. | % | No. | % |
|---|---|---|---|---|
| Beef | 327 | 9 | 15812 | 10 |
| Chicken | 120 | 3 | 5528 | 3 |
| Turkey | 133 | 4 | 10419 | 6 |
| Pork | 252 | 7 | 7924 | 5 |
| Finfish | 540 | 15 | 3357 | 2 |
| Shellfish | 213 | 6 | 4648 | 3 |

Bean and Griffin, 1990

An outbreak is considered a food illness event, while cases represent the number of individuals reported ill at the outbreak. A company picnic with salmonella-laden chicken salad that caused 100 people to get sick would be reported as 1 outbreak with 100 cases. At the other end of the spectrum, a person who is ill after eating baked mackerel with a high histamine content at a restaurant is reported as one outbreak and one case. It is easy to see, under these circumstances, how a more negative picture than necessary can be painted for seafood safety . In the left-hand column of Table 1, finfish are responsible for a much higher number of outbreaks than the other animal proteins. Consumption of finfish is much less than that of red meats or poultry products. Calculating the number of outbreaks per lbs of consumption by product categories will allow one to erroneously conclude that the risk of illness from finfish is several times greater than that of beef or chicken. However, this is not borne out by the right-hand column and the number of cases. In this column we can see that finfish related food illnesses drops to 2% of the cases reported. When consumption rates are factored in, the risk of food illness from finfish is no greater than that from red meats or poultry products.

A further breakdown to the identification of the classes of agents that cause seafood illnesses in fish and shellfish is shown in Table 2.

Table 2
Causes of Seafood Illness Outbreaks
1973-87

|  | Finfish | Shellfish |
|---|---|---|
| Bacterial | 54 | 36 |
| Viral | 1 | 11 |
| Parasitic | 6 | 0 |
| Chemical | 435 | 22 |
| Unknown | 44 | 144 |

Bean and Griffin, 1990

This table shows that the overwhelming majority of illnesses are caused by what the CDC classifies as chemical agents. These are not man-made chemicals and pollutants such as DDT and PCBs, but for the most part natural toxins that occur in the environment. This is illustrated in Table 3.

Table 3.
Chemical Causes of Seafood Illness
Outbreaks 1973-87

|  | Finfish | Shellfish |
|---|---|---|
| Ciguatoxin | 232 | – |
| Histamine | 199 | – |
| PSP | – | 21 |
| Other | 4 | 1 |

Bean and Griffin, 1990

Ciguatoxin poisonings are strongly linked with reef fish in tropical waters. Smaller reef fish eat specific types of algae that produce the toxin; these fish are in turn eaten by larger fish as the food chain is ascended, concentrating the toxin as this occurs. When larger fish are

harvested and served for human consumption, most often in a restaurant, the person becomes ill after ingestion of the toxin. Histamine poisoning or scombroid poisoning (named after a species of fish in which the toxicity commonly occurs) is a form of natural intoxification as well. In this scenario, certain species of fish with high concentrations of histidine (a common amino acid) are kept under warm conditions or non-refrigerated temperatures and there is a rapid growth of histamine forming bacteria. When ingested, the chemical causes histamine related symptoms similar to allergy-like food intoxifications (Taylor, 1988). PSP is an acronym for paralytic shellfish poisoning that is associated with natural algae blooms called "red tides" that occurs off all the coasts in the U.S. Shellfish are filter feeders, and as they feed on the algae and concentrate the toxin, they become toxic themselves. All states have monitoring systems and will close shellfish harvesting areas when there is a red tide event. However, there are a number of other algae related seafood toxins associated with shellfish and this is becoming an area that needs to be closely watched.

Although there is concern about seafood safety among the scientific community and regulatory agencies, the "current negative perception in consumers' minds (regarding fish safety) is not warranted when the health risks of seafood are compared with other food sources" (Young, 1989). The National Academy of Sciences Committee on Evaluation of the Safety of Fishery Products (Ahmed, 1991) has identified the major seafood consumption risks (in order of importance) as:

- raw or lightly cooked shellfish
- highly regionalized reef-associated fish in tropical areas
- species of fish closely associated with histamine production
- traditionally fermented foods
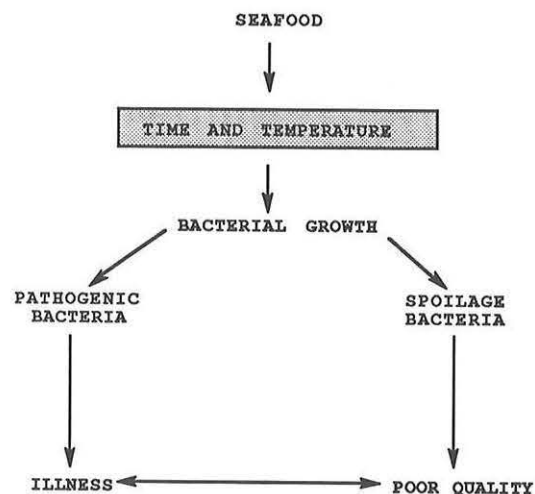- seafoods that may present foodborne disease hazards from errors in handling, storage or processing

The committee states simply that "most current health risks associated with seafood safety originate in the environment and should be dealt with by control of harvest at the point of capture." Their recommendations with regard to seafood inspection are ambivalent. They state that "Inspection at the processing level is important to maintain the safety of seafoods, but there is little evidence that increased inspection activities,

at this level, would effectively reduce the incidence of seafood-borne disease." The committee's main concern is not with seafood inspection but with improvement of the disease surveillance system. There is a need to better understand the nature of seafood hazards and obtain data to develop meaningful risk identification and risk assessment (Ahmed, 1991).

### Seafood Quality

Although there has been a strong focus toward seafood safety, quality issues are important to the consumer and are some of the major marketing issues in the seafood industry today. Quality and safety issues are inter-related. This is demonstrated in Figure 2.

Figure 2
Interrelationship between Seafood Quality and Safety

**SEAFOOD**

$\downarrow$

| TIME AND TEMPERATURE |

$\downarrow$

**BACTERIAL GROWTH**

PATHOGENIC BACTERIA          SPOILAGE BACTERIA

$\downarrow$                          $\downarrow$

ILLNESS $\longleftrightarrow$ POOR QUALITY

Although this figure is an oversimplification and represents only the microbiological events that can take place in seafood, it is obvious that abuse of temperature and time with sensitive seafood products will lead to exponential microbial growth and in short order poor quality. This may express itself in terms of fishy odors (which should steer the customer away from purchasing the fish) or poor texture (which may not be evident until consumption). Fish that are of poor quality will not necessarily make one ill, but will affect consumer purchases. Conversely, fish may be toxic (ciguatoxin) but have all other quality attributes of freshness and high quality. Nonetheless, there is a higher safety risk from eating seafood that is of poor quality, therefore, the consumer will benefit by choosing fishery products of higher quality not only in eating satisfaction but in reduced risk of illness.

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Seafood quality can be measured objectively (Gorga and Ronsivalli, 1988). There are chemical tests that quantify biochemical compounds that are products of microbial or endogenous enzymatic action. Some of these compounds such as oxidized fatty acids or trimethylamines have a direct relationship with rancid and fishy odors which reflect decomposition (Hutlin, McDonald and Kelleher, 1982; Hebard, Flick and Martin, 1982). There are physical testing instruments as well that measure texture and color. Also very important are standard microbiological tests. General microbial analyses will describe the total aerobic microbial count which increases in direct relationship to time and temperature of storage. More specifically, there are microbial tests for pathogenic bacteria and viruses if there is concern that the seafood may have been harvested or processed under questionable conditions (Ward and Hackney, 1990). These chemical, physical and microbiological analyses are, for the most part, laboratory tests and while they are valuable tools for the seafood researcher in understanding the processes by which fish deteriorates in quality, these tools are not readily available to the processor, retailer or consumer. Seafood quality, as judged in the industry, is still a subjective assessment of freshness, color, texture odor and ultimately edibility (Ronsivalli, 1982; Sawyer, 1987). Seafood quality is in many ways determined by what wholesalers and retailers think the consumer wants. Brought to a logical end point, seafood quality is in the eye of the consumer and they should be the final judges.

In several surveys concerning U.S. seafood consumption, the issue of quality is a recurrent theme in the consumer's decision making process. Vondruska (1984) has analyzed a number of consumer surveys undertaken in the U.S. and has listed the attitudinal factors as the most influential with regard to the purchase of seafood. These are:

- eating satisfaction
- product quality
- health and nutrition
- ease of preparation
- economy, budget and price
- availability

The determination of quality, however, is more difficult. Anderson and Anderson (1988) state that quality is a multi-dimensional attribute that includes nutritional value, taste, freshness, color, odor, texture, serving size, incidence of parasites, and presence of microorganisms as well as a host of other factors. Connell (1975) defines intrinsic quality as the "sum of attributes that are inherent in the raw material." Although there are quality parameters that are similar, there are many differences in quality factors as well as final organoleptic attributes among several species. How the consumer reacts to the introduction of new species and value-added products, information about the nutritional aspects of seafood, heightened awareness of issues regarding seafood safety and quality is of paramount interest to the seafood industry and regulatory agencies. In the past, a large portion of seafoods marketed in the U.S. were sold at small retail outlets or specialty stores. To a certain degree an element of trust was established between the seller and the buyer. The quality decision making process was left in the hands of the professional, the fish seller and the assumption was that the seafood sold was fresh and of high quality. With the increased demand for fishery products that we have seen in the last twenty years, there has been a shift of responsibility for judging quality to the consumer. Many larger supermarket chains are selling fresh seafood and are competing with each other as well as the smaller fish stores. Moreover, the variety of the seafood and the distance from point of capture to point of retail sales has increased significantly. Thirty years ago, in many middle-size New England towns, Friday afternoon shopping would include the local fish store and a choice between several species of fish all caught within New England waters. Today, consumers shop for seafood on any day of the week and have a choice of fish species from local waters as well as countries they would be hard pressed to locate on a world map. Moreover, the retailer may not know the country of origin or what waters the fish actually came from. Red snapper from the Yucatan peninsula will have passed through one or two wholesalers, several brokers as well as the main distribution center for a major supermarket chain before it arrives in the local store. With the changes that have taken place in the last decade, it is not uncommon for the retailer not to know, anymore than the consumer, how fresh the product is or what quality parameters it may have.

Consequently, the quality assurance programs in seafood are changing and this can be summarized in the following table.

Table 4
Quality Assurance in the Seafood
Industry

CONVENTIONAL ASSURANCES

Consumer's Trust in Retailer
Consumer's Knowledge of Seafood Quality

EMERGING ASSURANCE SYSTEMS

Grades and Standards
National Inspection Program
Consumer Education

As was mentioned previously, there has been an emphasis on consumer's trust in the retailer as well as their own knowledge of the seafood they were purchasing in the past. This trust and knowledge revolved around a few species that were locally caught and well understood. This has changed due to several factors that have been discussed in the paper. How the consumer will judge seafood quality in the future will be through a combination of emerging assurance systems and an expanding knowledge base. Grades and standards are established for several food products and are used by the consumer who insists on quality assurance at a certain level. These grades and standards are now being incorporated into the seafood industry through the voluntary inspection program with DOC and NMFS. More and more large supermarket chains are demanding that shore based processors have some form of seafood inspection program so that the supermarkets can pass this assurance on to the consumer. The National Seafood Inspection Act is expected to be passed by 1993, although there is no guarantee that this will occur. If passed, all seafood will undergo inspection similar to that which applies at present to beef and poultry. Because the majority of the seafood is imported, it is expected that Memorandums of Understanding between regulatory agencies in exporting countries and the seafood regulatory agency in the U.S. would need to be in place.

It needs to be pointed out that these inspection programs, however good they may be, will focus on seafood safety aspects, while assuring quality standards at acceptable levels. The main responsibility for quality assurance, that is quality at the higher levels, will fall on the retailer and the consumer. Because of the demands placed on the consumer, there is a present and future need for consumer education in the area of seafood quality as well as seafood safety. For the consumer to be effective in demanding quality, teaching programs as well as research that are directed toward increasing the consumer's knowledge of quality parameters and determination skills, benefit and risk trade-offs, decision-making inputs and outputs in purchasing seafood need to be implemented. There is little base-line data of what the consumer understands about the issues of quality and safety in seafood. The following papers in this section will shed some light on the consumer's perceptions of seafood safety and quality. With this beginning, it is hoped that adequate information can be gathered to formulate effective goals for consumer education in this area, and that consumer education programs can be developed to best fit their needs in the future.

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# Consumer Preferences for Seafood Quality Characteristics:
## Results of a Conjoint Analysis

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An experimental study was conducted to elicit factors which consumers use to evaluate quality of retail seafood products. Five characteristics were identified, each with two or three levels, and used to create 108 hypothetical products. Respondents were asked to rank and scale a subset of these products. Results indicate that consumers value age and odor as most important when evaluating seafood quality.

## Introduction

When a consumer is making a purchasing decision regarding fresh seafood, he/she is generally able to look into a fresh seafood counter at fillets and steaks of finfish, and fresh shellfish, either in the shell, or as with scallops, out of the shell. The information they have readily at hand is:

a. the type of store they are in (i.e. did they choose to purchase the seafood in a seafood specialty store or in the supermarket where they do the rest of their shopping?);
b. the prices of the items as displayed in the case;
c. the visual appearance of the seafood (texture, color, etc).

Other information they are able to obtain by asking the clerk behind the counter, included:

d. may they smell the fish? (to judge the odor, hence the quality);
e. how fresh is the fish? (i.e. how long has it been since it arrived at the store).

At issue for the latter two pieces of information is whether: 1) the consumer realizes that they are allowed to smell the fish; and, 2) the consumer believes the clerk is telling them the truth about the date of arrival of the fish (either the consumer believes that the clerk does not know, but will not admit it, or that the clerk may be lying to move the product).

Each of these pieces of information may be considered to be proxies for quality indicators. Therefore, with this information base, the consumer processes a 'quality' index for the particular seafood they are thinking about purchasing, and makes the decision whether or not to purchase. The interesting issues which follow from this are related to how a consumer judges quality. For example, does a higher price indicate higher quality? In particular, how do consumers trade off between the various indicators? What leads a consumer to choose a particular portion of seafood over another?

Answers to questions such as those posited above are important for a variety of reasons. First, those involved in the fresh seafood sector of the food industry are interested in the factors which influence consumers' demand for fresh seafood. Altering these factors in particular ways may increase consumer demand. In particular, consumer misconceptions about visual appearance and odor could be addressed through consumer education. Second, understanding the factors which determine seafood quality from a consumer's perspective may aid in the implementation of policies dealing with seafood inspection. These policies are being formulated in the current session of Congress with legislation proposed which would institute a mandatory seafood inspection program.

## Purpose

The purpose of this research was to determine the relative importance of various fresh finfish attributes that lead a consumer to be favorably inclined toward purchasing a piece of finfish; in other words, determining what types of attributes consumers use to judge quality seafood with available information.

## Methodology: Conjoint Analysis

To achieve this purpose, a market research technique called 'conjoint analysis' was used. Conjoint analysis

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as a methodology became frequently used in marketing research in the early 1970's. This technique is also gaining increasing acceptance by economists as a tool to disaggregate a product into a bundle of attributes. Environmental economists often use 'contingent ranking' techniques for environmental valuation studies, a technique which is similar to conjoint analysis.

Theoretical justification for this multi-attribute modeling of consumer preferences comes from the growing literature on consumer choice, including Lancaster (1971). The Lancaster characteristics approach to modeling demand assumes that each market good possesses a vector of characteristics (or qualities) that are objectively defined and measured by all producers and consumers and bear utility directly to the consumer. Consumers purchase and consume only certain combinations of goods and the level of utility is derived from the sum of characteristics belonging to these goods.

Green & Wind (1975) and Green & Srinivasan (1978) were among the first to propose the use of conjoint analysis as a marketing research methodology. Conjoint analysis incorporates the two assumptions of the Lancaster model, namely that each product is composed of various attributes while the utility the consumer derives from the product is a function of the product's attributes. In addition, conjoint analysis assumes that each attribute may have two or more levels. For example, price may be an attribute, while there may be more than one price (or level of price). This decompositional approach allows respondents to react to a set of hypothetical product descriptions, while the technique allows the analyst to separate the contribution of each attribute to the overall product value. The attributes that are chosen to represent the product are determined in part by the focus of the questions to be answered. More importantly, information on the consumer perceptions of the important attributes is attained directly from the consumer, either through focus groups or previous research.

The marginal contribution of a product characteristic to the average consumer's overall product preference is termed a 'part-worth'. There are a variety of statistical methods which can be used to estimate these values, including OLS, limited dependent variable techniques, and analysis of variance.

Conjoint techniques have been applied by agricultural and resource economists in assessing the importance of apple attributes (Manalo, 1990), determining willingness to pay for individual attributes of deer hunting trips (McKenzie, 1990), as well as by Anderson and Kusakabe (1989), Anderson and Brooks (1986) in analyses of the U.S. and Japanese salmon markets, and by Wirth, Halbrendt and Vaughn (1990) in an analysis of the striped bass market.

### Application

In this study, the conjoint analysis technique was applied to the problem of identifying the relative importance of characteristics which consumers use to select quality seafood. Fifty-five seafood consumers were surveyed in an experimental market setting at the Food Science laboratory on the University of Rhode Island campus (see Anderson & Morrissey (1991) for more detailed information on the survey endeavor).

Five attributes - age, odor, type of store, price, visual appearance - were chosen. These attributes were chosen for two reasons. First, as discussed above, these particular attributes are easily discerned by the average consumer in most market settings. Second, these factors were shown to influence the assessment of seafood quality by consumers who were interviewed in a telephone survey in Rhode Island.

The age attribute was deliberately left nebulous, and could be interpreted as either catch date or how long it had been in the store. The clerk is most likely to know only when the fish arrived. Handling before the fish arrives at the store, no matter what the length of time since caught, influences the quality, but is more difficult to determine and quantify. Therefore, it was left to the respondent to interpret the age attribute.

Because fresh seafood is very general, and fresh shellfish is more difficult to assign 'freshness' attributes to, the conjoint experiment focused on fresh finfish. In addition, because there are many species of finfish with a variety of characteristics, flounder was chosen to facilitate the ranking process. Flounder was chosen because a large number of respondents to the telephone survey indicated that flounder is frequently consumed.

Each attribute was assigned different levels. Table 1 shows the various attributes and the corresponding levels. The price levels corresponded roughly to current market conditions. Seafood versus grocery stores were identified as the two types of stores to determine if the consumer had greater confidence of finding higher quality products in a seafood specialty shop.

Table 1
Attributes and Levels of Flounder Fillets

- Flesh quality
  - soft
  - firm

- Age
  - 1 day
  - 3 days
  - 7 days

- Odor
  - none
  - mild
  - strong

- Type of Store
  - seafood
  - grocery

- Price
  - $2.50 / lb.
  - $4.50 / lb.
  - $6.50 / lb.

This combination of attributes and levels create a total of 108 total possible combinations of attributes, too many to reasonably expect each respondent to rank. Addelman (1962) developed a procedure in which an orthogonal array of a subset of the 108 can be found. This subset is composed of 18 products, shown in Table 2.

Table 2
Orthogonal Array of Flounder Fillet Attributes

| Product | Age | Odor | Price/lb. | Flesh Quality | Type of Store |
|---|---|---|---|---|---|
| 1 | 3 days | strong | $6.50 | firm | grocery |
| 2 | 3 days | none | $4.50 | firm | seafood |
| 3 | 3 days | mild | $2.50 | soft | grocery |
| 4 | 7 days | strong | $4.50 | soft | seafood |
| 5 | 7 days | none | $2.50 | firm | grocery |
| 6 | 7 days | mild | $6.50 | firm | grocery |
| 7 | 1 day | strong | $2.50 | firm | seafood |
| 8 | 1 day | none | $6.50 | soft | grocery |
| 9 | 1 day | mild | $4.50 | firm | grocery |
| 10 | 3 days | strong | $2.50 | soft | grocery |
| 11 | 3 days | none | $6.50 | firm | seafood |
| 12 | 3 days | mild | $4.50 | firm | grocery |
| 13 | 7 days | strong | $6.50 | firm | grocery |
| 14 | 7 days | none | $4.50 | soft | grocery |
| 15 | 7 days | mild | $2.50 | firm | seafood |
| 16 | 1 day | strong | $4.50 | firm | grocery |

## Survey Procedure

Each respondent was given a packet of index cards and told that each card represented a fillet of flounder with the characteristics found printed on the card. The respondent was then asked to rank the flounder fillets.

An orthogonal array of product attributes that simplifies to 18 products still creates a substantial number of products for a respondent to rank. The possibilities for confusion and mistakes are higher with such a large number of, in some cases, quite similar products. Therefore, the set of 18 products was further divided into subsets of 7 products each (6 products plus a 'control' card of product number 12 in each packet).

To obtain a complete ranking of all the products when further dividing the orthogonal array, it must be assumed that some respondents have identical preferences for the flounder attributes. For example, if three respondents are necessary to rank all 18 products, then those three respondents are assumed to have identical preferences for those product attributes. While this assumption is strong, it may not present serious problems because the attributes presented for the fish are quite broad. In addition, in weighing the bias which may result from confusion and mistakes on the part of the respondent from ranking 18 products, versus bias from dissimilar preferences between respondents ranking 7 products each, it was decided that the former could be larger than the latter.

The respondents were asked to rank the products from 1 to 7, with a rank of 1 equivalent to the product they would be most likely to purchase and 7 that which they would be least likely to purchase. The respondents were further asked to scale each product on a scale of 100 to 0. This scale is intended to represent the probability that a consumer would purchase the particular product in question if presented with the opportunity. For example, this gives the respondent the opportunity to indicate indifference between products. In addition, they may indicate that they would not be likely to purchase a product, even though they gave it a ranking of 1 because an attribute that they felt was important was not on the list.

## Results

Before the respondents were asked to rank the flounder fillets, they were given a card which listed the five attributes. On this card they were asked to indicate the importance of each attribute in their decision making process. Table 3 shows the results, and one can easily see that the most important attributes to the consumer

are the age of the fish and the odor. It is interesting that these are the two attributes for which the consumer does not know the levels because they either 1) did not know they could ask to smell the fillet, or 2) did not specifically ask the clerk the age of the fillet.

Table 3
Importance of Selected Seafood Attributes to Consumers

Degree of Importance

| Attribute | Very | Somewhat | Not |
|---|---|---|---|
| Flesh Quality | 76 | 20 | 4 |
| Type of Store | 35 | 36 | 29 |
| Age | 82 | 13 | 5 |
| Odor | 78 | 16 | 5 |
| Price | 38 | 49 | 13 |

Percentage of 55 respondents

The estimates of the part-worths of each attribute as derived from the regression estimates show the relative importance of each in the determination of overall quality for the seafood consumer. The regression estimates were obtained from an OLS equation in which product rank, $Y$, was regressed against indicator variables, $X_i$, of the presence or absence of each of the levels of attributes. For those attributes which had only two levels, type of store and flesh quality, the variable was defined as either negative one or one. Type of store was one if grocery, negative one if seafood, and flesh quality was one if firm, negative one if soft.

For those attributes with three levels, odor, age and price, two variables were specified for each. The variables were defined by some combination of  −1, 0, and 1. To illustrate, price was given three levels, $2.50, $4.50 and $6.50. The lowest level was defined as $(-1,-1)$, the next level as $(1,0)$ and the highest level as $(0,1)$. Define $X_1$ and $X_2$ as the variables for the price attribute, then $X_1$ is assigned a value of −1 and $X_2$ is also assigned −1 at the $2.50 level. Similarly, $X_1$ was 1 and $X_2$ was 0 for the level $4.50. Finally, for the last level, $6.50, $X_1$ was 0 and $X_2$ was 1.

Ordinary least squares was used as the estimation procedure. From the estimated parameters, part-worths are derived. To put the part-worths into a form in which the meanings are more intuitively clear, the part-worths are adjusted so that the least-desired part-worth level has a part-worth of zero, while the level with the highest part-worth has the largest adjusted part-worth. Thus, each of the levels which are the least desired for each attribute has a value of zero, which allows one to compare the estimates of the highest valued part-worth.

Table 4 shows the relative importance of the attributes, based on the values of the highest valued part-worth. Age is the most important attribute which the consumer uses to judge quality - assuming that they are able to obtain the information on age. Next is odor, again, assuming that they smell the fish. Visual appearance (flesh quality) is the third most important attribute, followed by price and, finally, type of store.

Table 4
Relative Importance of Attributes as Quality Indicators

| Attribute | Relative Importance |
|---|---|
| Age | 3.06 |
| Odor | 2.17 |
| Flesh Quality | 0.65 |
| Price | 0.33 |
| Type of Store | 0.13 |

**Analysis and Conclusions**

Of the five attributes identified as important by respondents of a telephone survey, the age of the fillet, which is the most difficult information attribute to reliably obtain, has been determined to be the most important quality indicator. This has serious implications for seafood quality. To assure the consumer that the fish is of the highest quality, and hence increase demand for fresh seafood, the retailer must provide the consumer with easy access to information on the freshness of seafood. This can be done in a variety of ways, the most commonly occurring being information conveyed by the clerk. The other way is through labeling. Fish labeled with its catch date provides an indicator of freshness.

**Further research**

There are limitations to this research project. In particular,

generalization to seafood cannot be made without making the statement conditional on the results from the ranking of flounder fillets. In addition, results from other surveys conducted on the same respondents at the same time (Anderson, 1991) indicate that the color of flounder fillets as well as texture should have been included as an appearance indicator.

Future research will include alternative specifications of the ranking equation. Limited dependent variable models have higher predictive validity than OLS models. However, OLS models provide easy interpretation of the part-worth results. In addition, models such as logit models allow one to incorporate the information gathered from the scaling information of the products by each respondent.

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# Consumer Perceptions of Finfish Quality

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The accuracy of consumer perceptions of finfish quality, defined as freshness, was measured against a panel of experts and objective laboratory analyses. Fillets of cod, salmon and flounder were purchased from a retail outlet and stored for 0, 5 and 10 days to simulate quality changes. Rankings of consumers and experts were statistically similar in most cases. This indicates that consumers are able to judge fillet quality when evaluating fish in a systematic manner.

## Introduction

Consumers today are selecting foods which are healthier and more nutritious. Inclusion of more seafood, especially finfish, would contribute a low calorie, low fat, high protein alternative to red meat or pork. Despite these advantages, seafood consumption is much lower than other flesh foods (Kinsella, 1988, Martin, 1988) and comprises only 4 percent of main meal choices (NMFS, 1981).

Lack of, or variable, quality has been identified as a main reason for infrequent consumption among consumers (Kinsella, 1988, N.O.A.A.,1988). Consumer perceptions of seafood quality are not well known. Their understanding of quality may be quite different from those of experts or retailers (Bisogni, Ryan & Regenstein, 1987). Seafood is currently the only flesh food not under mandatory inspection. This places more responsibility on the consumer to ascertain quality (Bisogni et al., 1987, Hadlett & Raab, 1990).

Seafood deteriorates much more rapidly than other flesh foods (Vondruska, Otwell, Martin, 1988). For this reason, freshness is considered to be the criterion by which quality is measured. Quality is often expressed as a function of storage time (Learson, 1969). Quality was defined as freshness in our study and quality changes were simulated by storing

samples for different periods of time.

Martin (1988) defines freshness as the degree to which deterioration or spoilage has taken place. These changes are microbial or chemical in nature which lead to changes in texture, color, odor and flavor (Gorga, 1988). Siang and Tsukuda (1989) state that the methods for assessing quality can be broadly categorized into three areas, sensory (odor, color, texture etc.), microbiological and chemical. Laboratory analyses assess the latter two categories, consumers and experts measured the first. Data from all three categories must be weighed.

The objective of this study is to determine the accuracy of both consumer and expert perceptions of seafood quality as considered against the objective standards of quality which result from laboratory testing. Although much has recently been written about how consumers perceive and evaluate seafood quality and safety, research to explore the relationship between consumers' perceptions and laboratory results has been minimal. This study combines theory and methodology from a variety of fields- economics, food science, consumer behavior- to explore the similarities and differences between three different sets of seafood evaluations: 1) those of food scientists, 2) those of consumers, 3) objective laboratory tests.

## Materials and Methods

As part of a larger Sea Grant project on consumer perceptions of seafood quality, 55 Rhode Island consumers and 5 experts in seafood were invited to the University of Rhode Island Food Science and Nutrition Center to evaluate actual samples of three species of finfish which had been aged under controlled conditions to effect quality changes.

Fillets of cod, flounder, and salmon were purchased from a retail market with a high quality reputation and stored for 0, 5 and 10 days. Storage conditions were designed to resemble those of the retailer. Care was taken to ask the retailer for the

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freshest fillets possible. Consumers and experts ranked the samples on a score of 1-4 for general appearance, color, odor, and texture. Microbial and chemical analyses were being conducted concurrently.

Four different laboratory tests were performed on the seafood specimens. The TBA (Thiobarbituric Acid) test, which measures the oxidative deterioration of lipids, was conducted only for salmon, as it is a test for fish with a high fat content and measures chemicals associated with rancidity (Tarladgis,1960).

The TVB (Total Volatile Base) test measures the level of protein deterioration. This is an excellent quality indicator as fish is comprised mainly of protein. The emergence of these bases correlates well with ammonia content, a main contributor to "fishy" odor and flavor. As quality declines, TVB scores increase.

The TMA (Trimethyl Amine) test assesses the deterioration of TMA-oxide to TMA, a compound which contributes to off odors (Dyer, W.J., 1945). It is considered an excellent quality indicator for spoilage of white-fleshed fish, especially cod. If levels of TMA are over 10-20 mg/100 g fish, it is regarded undesirable.

The aerobic plate count is a good overall indicator of the degree of spoilage and approximates the numbers of live bacterial cells per gram of fish. Upon storage, the microbial numbers increase exponentially. Generally, up to 10,000,000 colony forming units (CFUs) per gram are acceptable for consumption. Above this level, the flesh is considered spoiled.

## Results and Discussion

All laboratory procedures were performed in triplicate. The mean values are represented in Table 1 and Figures 1, 2 and 3. Laboratory analyses (TMA, TVB, APC) indicated that the samples of cod and flounder were representative of fish kept 0, 5, and 10 days in storage (Figs 1, 2 and Table 1). An increase in the chemical values measured (TMA, TVB, TBA) corresponds to a decrease in freshness, or quality. Our results for cod and flounder showed that the level of spoilage increased almost linearly with days in storage. However, there were no differences in the chemical or microbial tests for the 0 and 5 day salmon. It appears that the sample picked up 5 days prior was slightly fresher than the sample obtained on the day of the evaluation.

The TBA test, performed only for this species, indicated that the 0 day sample had a slightly higher level of fat decomposition. A possible explanation would be poor handling (temperature/time abuse, physical mishandling) of the 0 day salmon probably at the level of the wholesaler, and/or the retailer.

Figure 1
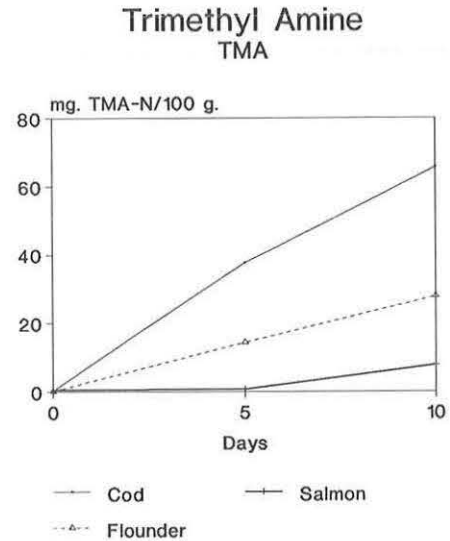Trimethyl Amine Levels of Three Samples of Three Species

Trimethyl Amine
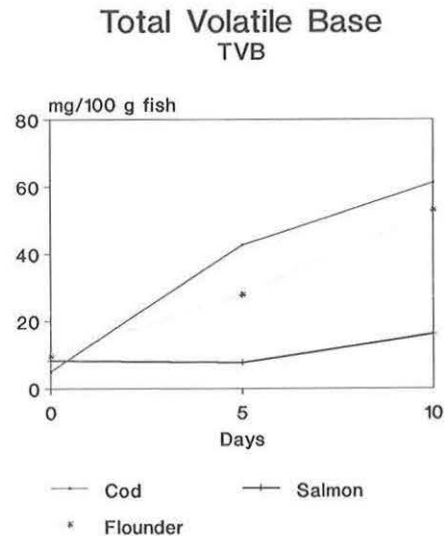TMA



Figure 2
Total Volatile Base for Three Samples of Three Species

Total Volatile Base
TVB



44

Figure 3
Thiobarbituric Acid Levels of 0, 5 and
10 Day Old Salmon

## Thiobarbituric Acid
Salmon Only

micro moles/kg fish



Days

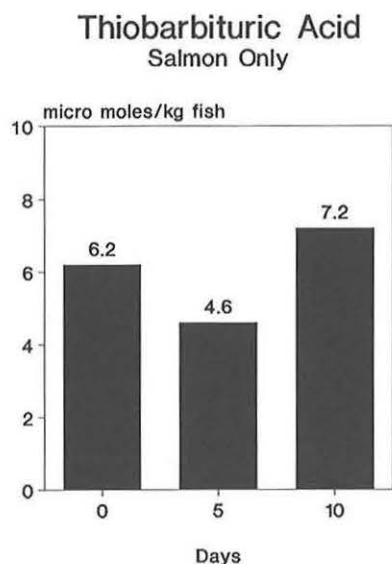Table 1
Aerobic Plate Count (in thousands) for
Three Samples of Three Species

## Microbiology
Aerobic plate count in thousands

| Species | Day 0 | Day 5 | Day 10 |
|---------|--------|-------|---------|
| Cod | 548.75 | 4,325 | 26,205 |
| Salmon | 777.6 | 990 | 309,920 |
| Flounder | 965.5 | 2,317 | 31,920 |

The microbiological analysis
showed similar results for cod and
flounder. There were no differences in
the 0 and 5 day salmon. According to
Table 1, the 10 day samples of all
three species exceeded the recommended
limits for consumption.

The means of the scores for both
the consumer and expert groups were
calculated. A series of t-tests were
performed to see if there were any
significant differences in the way the
two groups evaluated the samples.
Means were tested for significant
differences at the 0.1, 0.05 and 0.01
levels.

For the cod samples, both the
consumer and expert groups rated the 0
day old sample very high. There were

no significant differences between the
means of the scores; however, the
experts rated each attribute higher.
For the 5 day sample, there was a
significant difference at 0.05
confidence level for the texture score
only. Due to improper handling at the
processing level, the fillets purchased
that day had very poor texture and
uniformity. This flaw in appearance
seemed to influence the other scores,
which were also quite low. There were
no significant differences in the way
the two groups rated the 10 day sample,
although the experts assessed the odor
lower. These scores were slightly
higher than the 5 day sample, although
the laboratory analyses clearly show
the 10 day sample in a more advanced
state of decomposition.

Evaluation of the salmon resulted
in more differences between the two
groups. The experts rated the overall
appearance and texture slightly higher
on the 0 day sample, but the same
trends were observed. The experts
rated the 5 day sample higher at the
0,05 significance level for all
attributes and gave odor a perfect
score of 4.0. The only category with
a significantly different rating
between the two groups for the 10 day
sample was odor, which the expert group
recognized as poor and scored
accordingly.

The 0 day flounder was measured
quite high by both groups. Again, the
experts' mean scores were significantly
higher in all categories except
texture. The 5 day sample was
evaluated low in general, and scores of
the expert group were the lowest. The
color was off, appearing greyer in this
sample than the other two ages of the
same species. The 10 day specimen of
flounder was judged approximately equal
to the 5 day. Again, poor appearance,
especially in regard to color, seemed
to influence the groups perception of
quality.

### Conclusions

Although both consumer and expert
groups exhibited the same trends when
scoring the samples, the experts scores
were more extreme, the fresh higher and
older fish lower. This may indicate
that the experts were more confident in
scoring. The experts observed more
subtle differences, primarily in odor.
Both groups accurately identified the
very fresh samples, but were mislead as
the fish got older.

The salmon scores had the most
variation among the two groups and cod
had the least. Both groups were
influenced by appearance. Consumers
seem to put more emphasis on physical

attributes such as color and texture. The expert group used odor as the main indicator of freshness, or quality, and the scores were closely correlated to the laboratory results. Overall, the consumer groups' scores had the same inclination as the experts, signifying that they were indeed competent when judging quality. Fresh seafood is readily available in Rhode Island and the participants of this survey presumably consume more seafood than typical. Although this was a valid sample, it may contain more knowledgeable and experienced seafood consumers who are not representative of the average U.S. consumer. Results of this study may indicate that consumers who are experienced with seafood are quite skilled at identifying quality levels. Thus, it might be expected that as consumption increases, consumers will become increasingly able to judge quality attributes.

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# Consumer Perceptions of Seafood Safety:
## A Case Study of the Northeast Market for Blue Mussels

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Two consumer surveys were conducted in the northeastern United States in 1990 to examine consumer perceptions of seafood safety and the impact of those perceptions on demand for seafood. Using blue mussels as a case study, preliminary results indicate that consumers perceive some risk in consuming seafood and that this risk is particularly high for consuming mussels. Mandatory seafood inspection could help reduce consumers' perceived risk from eating seafood, while consumer education could help eliminate consumer misconceptions about seafood safety.

## Introduction

Currently in the United States there is no federally coordinated mandatory seafood inspection program similar to that in place for the inspection of red meats and poultry. Those seafood inspection procedures in place include a variety of programs mandated at the federal level through the Food and Drug Administration (FDA) and those at the local level performed by state health and marine resource agencies, all of which engage in a variety of services from water monitoring to plant inspection to the testing of imported seafood. The U.S. Department of Commerce operates a voluntary, fee-based seafood inspection program through the National Marine Fisheries Service (NMFS) that provides plant inspection, quality grading and laboratory services. The uncoordinated manner in which seafood is inspected and monitored in the U.S. has led the National Academy of Sciences Institute of Medicine, in its preliminary assessment of seafood safety in the United States, to conclude that "the present federal monitoring and inspection system is too limited in frequency and direction to ensure seafood safety" (Committee on the Evaluation of the Safety of Fishery Products, p.16, 1991).

Recently there has been a deluge of media publicity regarding the public health consequences of no mandatory seafood inspection and mounting public pressure for a seafood inspection system. In 1990, no less than seven bills were proposed before Congress to establish a mandatory federal seafood inspection program, and seafood inspection is on the 1991 Congressional agenda.

In the call for seafood inspection, the governmental and public focus has been and still is the maintenance of a clean and wholesome seafood supply to protect the public health. Another benefit to mandatory seafood inspection which is often overlooked by legislators will be an increase in consumer confidence in seafood and therefore an increase in demand for seafood.

This paper focuses on consumer perceptions and attitudes regarding seafood safety and how these perceptions might currently impact seafood demand. The blue mussel (Mytilus edulis) industry has been one sector of the seafood industry which has been particularly hard hit by media publicity of recent incidents of shellfish poisoning and an eroding consumer confidence in and demand for the product. Using blue mussels as a case study, two consumer surveys were conducted in the northeastern U.S. in 1990 to probe consumer perceptions of seafood safety, how these perceptions impact consumer demand, and what consumer would be willing to pay to reduce the health risk from eating mussels and other seafood.

First, a brief background of the U.S. blue mussel industry will be presented along with a discussion of some of the recent seafood contamination incidents which have affected the mussel market. Next, preliminary results pertaining to consumer perceptions of seafood safety will be presented. Finally, the potential impacts of consumer perceptions on seafood demand will be discussed, as well as the implications of consumer perceptions for mandatory seafood inspection.

## The U.S Blue Mussel Industry

The U.S. blue mussel industry has experienced rapid and significant changes in the past decade. Once considered a bait fish and targeted primarily for ethnic markets, blue mussels have begun to attain gourmet

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status and are now found in white tablecloth restaurants, gourmet shops and supermarkets throughout the U.S. Landings of blue mussels in the U.S., concentrated mainly in the Northeast where they are harvested both in the wild and increasingly through aquaculture, have increased dramatically from 17.8 million pounds in 1980 to 55.5 million pounds in 1989, a 212% increase in nine years (USDC 1991). The ex-vessel value of mussels was approximately $3.4 million in 1989, up 250% since 1980 (USDC 1991).

U.S. production and consumption of mussels are meager when compared to that of many European countries. For example, France produced 111.8 million pounds in 1988, the Netherlands 170.7 million pounds and Spain 459.5 million pounds (FAO 1990). Per capita consumption of mussels is estimated to be approximately 4.6 pounds per year in France, 4.8 pounds per year in the Netherlands and 10.3 pounds per year in Spain (De Franssu 1990). In contrast, estimated U.S. per capita consumption is less than a quarter pound per year. Indeed, compared to many European countries where aquaculture of mussels has existed for centuries and consumption is substantial, the U.S. market appears to be barely tapped.

Despite the expansion of the U.S. market, there has been a downward trend in wholesale prices, suggesting that supply is growing faster than demand. Real wholesale prices have declined approximately 20 percent over the period 1984 to 1990 (Urner Barry Publications, Inc. 1984-1990).

Further development of this relatively young industry is threatened by:

> (1) a lack of market research on consumer preferences and attitudes toward eating mussels with which to effectively promote and position the product; and

> (2) a perceived risk from eating mussels prompted by recent incidents of shellfish poisoning and adverse publicity about seafood safety.

Without such information, mussel producers and dealers may not be able to effectively market their products and stimulate further demand.

### Recent Incidents of Shellfish Poisoning

Recent incidents of shellfish poisoning and a flurry of publicity surrounding seafood safety contribute to the sluggishness of demand and pose a threat to further industry development. In the Northeast region a foodborne illness causing the hospitalization of 135 persons and three deaths occurred form eating cultivated mussels from Prince Edward Island, Canada (Committee on the Evaluation of the Safety of Fishery Products 1991). These mussels were tainted with an unusually high concentration of a natural algal toxin, domoic acid. The disease outbreak resulted in a temporary shutdown of the regional industry and substantial, though temporary, declines in consumption in both Canada and the U.S. (Seafood Business 1988).

Mussel producers and retailers also reported temporary declines in demand due to medical waste washing onto Mid-Atlantic and New England shores in the summer of 1988. In addition, a series of news broadcasts entitled "Killer Fish," which aired in New York, Boston and Philadelphia in 1988 deploring the safety of seafood contributed to a decline in demand (Blue Gold Mussel Farms 1989). More recently, the nationally broadcast television news program "20/20" aired a story in February 1990 which told of the threats of disease from eating raw shellfish, including oysters, clams and mussels. Some shellfish wholesalers and retailers, fearful of a negative impact on demand for shellfish and the resulting losses due to inventory spoilage, did not carry live shellfish for several weeks during and after the broadcast. The latest case of negative publicity directly related to mussels, occurred in June of 1990 when "20/20" aired a story about the 1987 Prince Edward Island mussel incident. These adverse consumer reactions result from a perceived health risk from eating mussels which stems not only from actual incidents of health problems, but perhaps more from media attention and consumer ignorance.

Incidents of health problems only underscore a widespread fear of eating shellfish. Shellfish, particularly filter feeding mollusks such as mussels, clams and oysters, have long been associated with the transmission of such health problems as paralytic shellfish poisoning (PSP) caused by a marine algae commonly known as red tide, and hepatitis due to pollution of the shellfish beds. In fact, the National Academy of Sciences Institute of Medicine found shellfish to be the cause of 57.5 percent of seafood related illness cases from 1978 to 1987 (Committee on the Evaluation of the Safety of Fishery Products 1991). However, during the period 1973 to 1987, shellfish and finfish only accounted for approximately five percent of all reported cases of

foodborne illness with a known cause (Bean and Griffith 1990). Dairy products were the major cause of foodborne illness with 13% of all cases of foodborne illness (with a known cause) reported from 1973-1987, followed by beef with 10 percent and turkey with six percent (Bean and Griffith 1990).

Although these incidents of seafood related illness are cause for national concern for the protection of public health, they are also a cause for concern regarding the livelihood of the U.S. seafood industry, as these incidents and the barrage of media publicity have undermined consumer confidence in the seafood supply. As in the case of mussels, this lack of confidence in the seafood supply, particularly shellfish, poses a threat to the seafood industry in terms of reduced or stagnant demand for seafood. The seafood industry needs to know the extent of the consumer perceptions of seafood safety so that they can educate consumers and help them make more informed decisions in the market place.

This research examines consumer perceptions of seafood safety and suggests how those perceptions may impact demand using mussels as a case study. The question to be answered is: Do consumers perceive health risks associated with eating blue mussels, and are these perceived risks significantly higher for mussels than for some other seafoods? Finally, does the consumer's risk perception have a significant impact on the demand for mussels?

## The Consumer Surveys

### The Supermarket Survey

In order to investigate retail demand for mussels, an extensive in-person survey was conducted in conjunction with Great Eastern Mussel Farms of Maine who were engaged in a supermarket demonstration program. Approximately 500 consumers were interviewed in supermarkets located from New Jersey to Maine during late 1989 and early 1990. The demonstration program and cooperation from Great Eastern Mussel Farms allowed us the unusual opportunity of surveying consumers in a supermarket setting as they were offered free samples of freshly steamed mussels and were faced with a real purchase decision.

In designing the survey to gather information on mussel demand, demand was hypothesized to be a function of the retail price, price of substitutes such as clams, risk perceptions, seafood consumption, demographics and other variables. To this end, consumers were interviewed regarding their willingness to pay for mussels, prior mussel consumption experience, attitudes toward mussels and various value-added mussel products, seafood consumption habits, risk perceptions related to eating mussels and other seafood, and demographics. The willingness of Great Eastern Mussel Farms to allow interviews of potential customers about the sensitive issue of seafood safety only underscores Great Eastern's concerns about consumer risk perceptions and the impact on demand for mussels.

In an effort to avoid an emphasis on seafood safety problems in the sensitive setting of a supermarket, questions regarding seafood safety perceptions were limited to gather information on media exposure to seafood related issues, fears of eating mussels and risk perceptions of eating various foods. The following questions were asked at different stages of the interview:
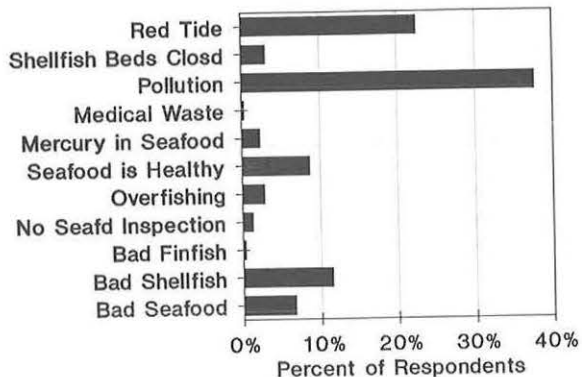
(1) What have you seen or heard about seafood in the media lately?

(2) Why don't you eat mussels or eat them more often?

(3) Why are you afraid to eat mussels? (If the respondent said that he or she did not eat mussels because they were afraid.)

(4) What do you think your risk of getting sick is from eating cod, clams, bluefish, mussels, salmon, lobster, chicken and beef?

Preliminary analysis of the data gathered from these questions indicates that consumers do perceive a risk from eating mussels and that this risk is significantly higher than the perceived risk from eating some other seafoods. Furthermore, perceived risk of eating mussels is higher among those consumers who have never eaten mussels and those consumers who say that they would never purchase mussels.

When asked about what they had seen or heard in the media regarding seafood, an overwhelming number of responses concerned some negative aspect of seafood (Figure 1). The most prevalent issue was pollution and the contamination of seafood mentioned by 37.6 percent of the respondents. This response was followed by red tide which was mentioned by 22.5 percent of respondents. The red tide response is not surprising in the Northeast where shellfish beds are routinely closed in the summer due to blooms of the red

tide algae. There was frequent mention of contaminated seafood, particularly shellfish. Only 8.7 percent of the respondents mentioned the positive health aspects of seafood.

When asked why they do not eat mussels or eat them more often, the responses varied, but 8.6 percent of the respondents claimed that they were afraid to eat mussels. These consumers were then asked what they were afraid of; 31 percent said that they were afraid that the mussels were contaminated by pollution, while another 27.6 percent said that they were afraid of the mussels being tainted with red tide (Figure 2). Fourteen percent of the respondents were wary of where mussels come from, many having seen mussels exposed on the beach at low tide or clinging to docks and pilings. Another 14 percent of the respondents who were afraid of mussels could not pinpoint a specific reason.

Figure 2
Why Are You Afraid to Eat Mussels?



Percent of Consumers Afraid to Eat Mussels
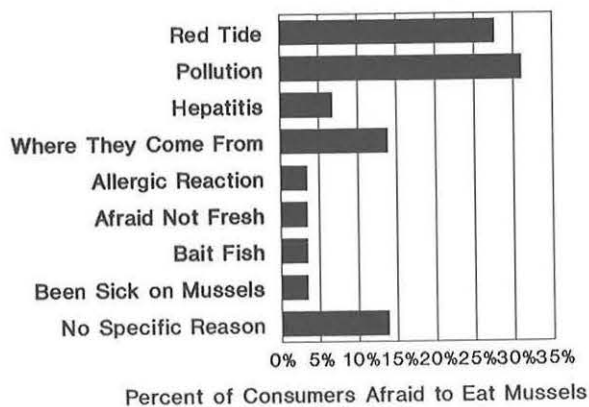
The final question regarding risk perceptions was more direct. Consumers were asked what they perceived their chances of getting sick are from eating the following foods: cod, clams, mussels, bluefish, lobster, salmon, chicken and beef. They were then asked to rate their chances on a scale of 0 to 100, where 0 was no chance at all and 100 was a certain or 100 percent chance. This question was left purposefully open-ended regarding the definition of "sick" so as to elicit the consumer's overall perceived risk. It is important to note that the relative perceived risk of eating mussels compared to other seafood is the key issue here, rather than the absolute level of risk perception, since the 0 to 100 scale is not appropriate for eliciting realistic risk estimations.

Results from the risk rating question are presented in Figures 3, 4 and 5 and are particularly revealing regarding consumer perceptions of risk from eating mussels relative to the risk perceived for other foods. Figure 3 illustrates the mean risk ratings of the total sample for all eight foods. Clams and mussels scored a significantly higher risk rating than the other foods, with average risk ratings of 26.9 and 23.7, respectively. Furthermore, mussels were rated as having a significantly greater health risk (at the 99 percent significance level) than all other seafoods except for clams. Mussels also scored a higher risk rating than chicken or beef, at the 95 and 99 percent significance levels, respectively. It is interesting to note that shellfish (clams, mussels and lobster) had the highest risk perceptions, followed by chicken and beef, with the finfish (cod, bluefish and salmon) scoring the lowest risk perceptions. Chicken has been the subject of much publicity recently as the public has been alerted to the widespread risk of salmonella.

Figure 3
Mean Perceived Risk Ratings for the
Total Sample.
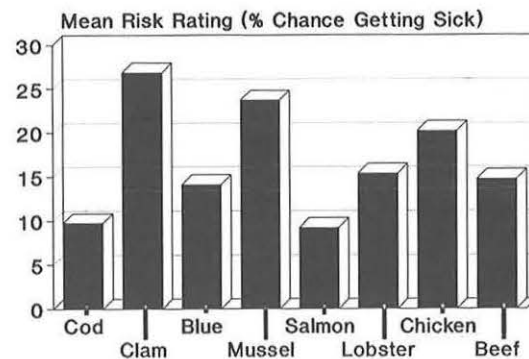
The sample was then divided among those respondents who had eaten mussels before (75 percent of the total sample) and those who had not (25 percent of the total sample). Again note that, not surprisingly, respondents who had never eaten mussels before had a significantly greater (at the 95 percent significance level) mean risk rating for mussels than those respondents who had eaten mussels (Figure 4). This result suggests that there are potential mussel consumers who are too afraid to even sample the product. Every food was perceived to carry a higher risk by the non-eaters of mussels than by respondents who had eaten mussels. This difference was significant for bluefish, salmon and lobster at the 95 percent significance level.

Figure 4
Mean Perceived Risk Ratings of the Sample Split by Whether or Not the Respondent Has Eaten Mussels.



Mean Risk Rating (% Chance Getting Sick)

■ Has Eaten    ▨ Has Not Eaten
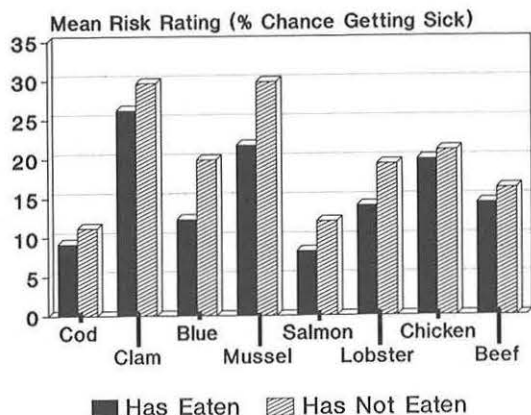
Finally, the sample was split between those consumers who said that they would buy mussels (75 percent of the total sample) and those who said that they would never buy mussels (25 percent of the total sample). Again, consumers who would not buy mussels had significantly higher (at the 99 percent significance level) risk perceptions for mussels (Figure 5). Risk perceptions for all other foods except chicken and cod were significantly greater (at the 90 percent or better significance level) for non-buyers of mussels than for buyers of mussels.

The evidence of higher risk perceptions among non-consumers of mussels and non-buyers of mussels is made even more clear when one examines the ratio of the risk rating of mussels to the average risk rating of all eight foods combined.[2] A relative risk rating greater than 1 indicates that

Figure 5
Mean Perceived Risk Ratings of Sample Split by Whether or Not the Respondent Would Buy Mussels.



Mean Risk Rating (% Chance Getting Sick)

■ Would Buy    ▨ Wouldn't Buy
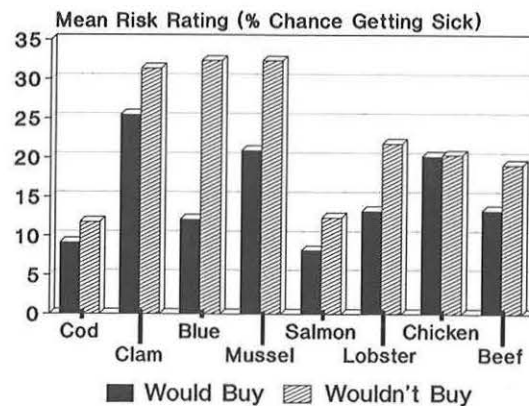
consumers perceive mussels to have a higher risk of getting sick than all of the foods averaged together. The mean relative risk rating of mussels of 1.58 by non-buyers of mussels is significantly greater at the 99 percent significance level than the mean relative risk rating of 1.27 by buyers of mussels (Figure 6). In addition, the mean relative risk rating of mussels of 1.45 by consumers who have never eaten mussels is greater than the mean relative risk rating of 1.31 by consumers who have eaten mussels, although this difference is only significant at the 75 percent significance level.

Figure 6
Mean Relative Perceived Risk of Eating Mussels.



Mean Relative Risk

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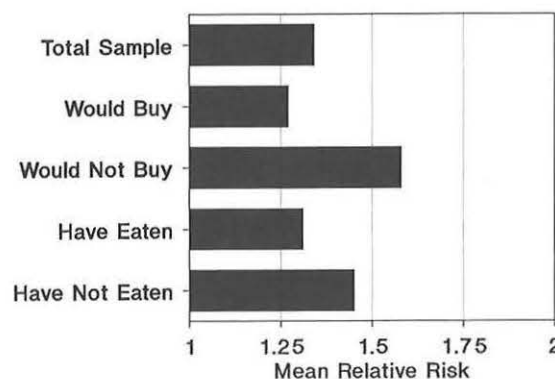
[2]RELRISK = Risk Rating (Mussels)/ Average(Risk Rating (Cod) + Risk Rating (Clams) + Risk Rating (Mussels) + Risk Rating (Bluefish) + Risk Rating (Lobster) + Risk Rating (Salmon) + Risk Rating (Chicken) + Risk Rating (Beef)).

Clearly there appears to be significant consumer risk perceptions associated with the consumption of mussels. Future research will focus on incorporating this risk perception into a demand model for mussels and testing for the impact of risk perceptions on demand.

The Pilot Study

Given the strong evidence of risk perceptions associated with the consumption of mussels, a pilot study was conducted in October 1990 which focused specifically upon consumer risk perceptions and willingness to pay for seafood safety. The pilot study was conducted in conjunction with a Sea Grant study of consumer perspectives on seafood quality and safety and consisted of interviewing 55 consumers from Rhode Island.[3]

The survey focused solely on seafood safety perceptions and the consumer's willingness to pay for a reduction in the risk from eating seafood. Risk perceptions were elicited for a variety of illnesses including mild gastrointestinal (GI) disorder, moderate GI disorder, severe GI disorder, non-lethal hepatitis, permanent disability, cancer, allergic reactions, paralytic shellfish poisoning and death. Consumers were asked to estimate their risk of contracting the above illnesses from eating flounder, clams and mussels using a logarithmic scale. Consumers rated each illness as having a risk of 1, 1 in 2, 1 in 10, 1 in 100, 1 in 1000, 1 in 100,000, 1 in 1 million or 0. Risk estimates for each illness and each seafood were elicited. Flounder was chosen as a "control" species since there was thought to be little perceived risk associated with eating this marine finfish.

Preliminary analysis of the risk estimates indicate not only a substantial level of risk perceived in eating all three seafoods, but a higher risk associated with eating mussels compared to clams and flounder. Figure 7 illustrates results for the illnesses which elicited relatively high risk estimates including, all three GI disorders, nonlethal hepatitis, allergic reactions and PSP. The difference between the mean risk ratings of mussels and the mean risk ratings of clams and flounder were found to be significant at the 80 percent or higher significance level

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[3] For more information on the pilot study see J.G. Anderson and M.T. Morissey (1991).

for mild and moderate GI disorders, non-lethal hepatitis, PSP, and allergic reactions.

Figure 7
Mean Risk Estimates of Experiencing Various Illness From Eating Mussels, Clams and Flounder.
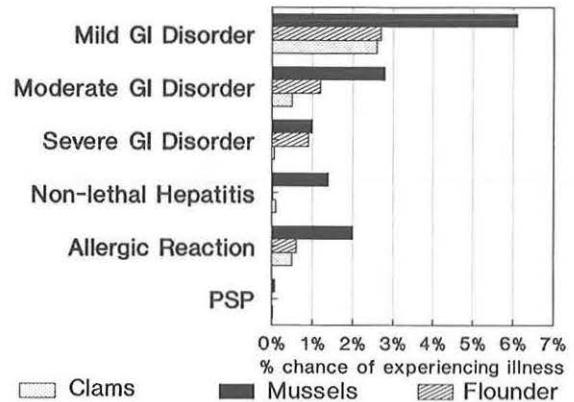


In contrast to the above illnesses, consumers did not perceive as high a risk of a permanent disability, cancer or death, although the average risk estimates of these illnesses ranged from less than a 0.0001 percent chance of dying from eating flounder to a 0.004 percent chance of experiencing a permanent disability from eating mussels.

In terms of evaluating the absolute levels of these risk estimates, it is difficult to find comparable objective estimates of the risks associated with consuming these seafoods and contracting these illnesses. The consumer risk estimates for the GI disorders, non-lethal hepatitis, allergic reaction and PSP are likely to be higher than the true risk.

This information along with other survey data will be incorporated into a model estimating a consumer's willingness to pay for seafood safety.

Conclusion

Preliminary results from two surveys of consumers indicate that consumers perceive some risk in consuming seafood and that this risk is particularly high for consuming mussels. Since a consumer's perception of product attributes such as safety are incorporated into his or her purchase decisions, risk perceptions may have a significant impact on seafood demand. In the case of blue mussels, evidence suggests that

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consumers have a significantly higher risk perception associated with consuming mussels than with other seafood. One would expect this perception of risk to have a negative impact on the demand for mussels.

If consumer's risk perceptions are higher than the true risk, consumers are making purchase decisions with incorrect information. Mandatory seafood inspection could help reduce consumers' perceived risk from eating seafood, while consumer education could help eliminate consumer misconceptions about seafood safety. The result would be more informed purchase decisions and greater benefits to the consumer.

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# Overview of an Expert Systems Laboratory

Sherman Hanna[1], The Ohio State University

The Family Resource Management Department at the Ohio State University received a grant from the Selective Excellence Program of the Ohio Board of Regents to establish an Expert Systems Laboratory for Family Resource Management. The laboratory has a fulltime programmer analyst and two graduate assistants, as well as undergraduate student programmers, working with faculty to develop computer software to help consumers and families.

Expert systems can be a superior tool for resource allocation decisions compared to printed materials, which can provide professionals and consumers with the information needed to make decisions but have limited potential for assisting in the actual process of decision making. In addition, the user of printed materials must be fairly literate and numerate, as well as motivated, in order to make appropriate use of the materials. The price of powerful microcomputers will continue to decrease in real terms. Within a few years, hardware available to consumers in their homes, in libraries, and in Cooperative Extension offices will have the potential of helping consumers with help with complex decisions, and in an understandable way. This potential is unlikely to be reached, as not very much development of sophisticated software to help consumers has taken place.

Useful expert systems are very expensive to develop. A typical human expert knows at least 50,000 rules. It may take a year or more to develop an expert system to duplicate part of a human expert's knowledge, and more time to implement and evaluate the system. While commercial development of software will fill some needs, it is unlikely to suffice in meeting personal, educational and research needs. As commercial software, by definition , must be purchased, it is likely to be developed for a higher income group -- for example, programs designed to assist in the management of stock portfolios. In addition, commercial programs are unlikely to be research based or to offer the possibility of modification as a result of research findings, nor will there likely be adequate scrutiny of the models, data, etc. used. There is thus a need for academic researchers to develop and evaluate expert systems software for consumers, and to increase funding for such research. It is possible for some types of expert systems and other computer software development to be consistent with academic reward structures (Hanna, 1991).

The **Family Resource Management Expert Systems Laboratory** will focus on software development which has one or more of the following characteristics:

A.  The application fits into the academic programs of the department, such as family financial management, and can be used by students in the department.

B.  There is a significant research component in the software development and testing, with theoretical models, empirical analysis for a database used in the program, and/or sophisticated statistical analysis for evaluation of the effectiveness of the software.

C.  The software can be used by government and nonprofit agencies, such as the Cooperative Extension Service and credit counseling agencies.

The first major project of the Family Resource Management Expert Systems Laboratory is the "Life Cycle Savings Program." It is designed to help consumers plan for long range savings goals such as retirement. It has been tested with more than 100 undergraduate students.

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# Research Opportunities in Expert Systems Development

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Development of expert systems or computer software programs to aid consumers in decision making can provide numerous opportunities for research. Research should be an integral part of the design and development plan of an expert systems development laboratory.

Good expert systems programs meet several constraints. They must be theory based, use accurate data for rule and constraint development, and take into account the decision making processes of users. In addition, users must perceive the outcome of the program to be correct or they will not accept or follow the advice.

If expert systems are to be theory based, developers must carefully survey previous literature and test new theories relevant to the domain or subject matter of the program. This research must be conducted prior to the development of the program. For example, a program attempting to aid retired consumers in allocating their investment portfolios might incorporate an asset allocation model. Because the asset allocation model was designed for corporate use and families do not have profit maximization as a goal, the model would need to be adapted for consumers. Individuals tend to be more risk averse than corporations, making perceptions of risk very important in the development of such an expert system. The economic, cognitive psychology and finance literature can provide a foundation for the research leading up to expert systems development for this application, but many of the theories and models would need to be adapted for use by individuals and families.

A second requirement for an expert system is to use correct and valid data and equations upon which calculations are based. Any assumptions entered as rules and constraints, or as the knowledge base on which the programs operate also need to be valid. For example, an expert system for retirement portfolio allocation would contain rules concerning the life expectancy of the retiree, because investment return rates would be lower given shorter time periods.

A third requirement for an expert system is to check user input for validity or at least plausibility. For instance, if the user if required to input inflation rates, incorrect estimates might lead to errors. One useful type of research related to expert systems is to analyze user assumptions about important parameters for input. In the design of expert systems, allowing for user input errors through use of reasonable default values or through consistency checking can lead to more valid output.

A fourth requirement of a good expert system is for the program to take into account the perceptions and cognitive processes of the users. This may be a promising area of research. There are no previous studies concerning the level of belief or trust users have in the decisions made by expert systems. Expert systems are used in many arenas by professionals for diagnostic and prescriptive decisions. These systems create two levels of "users" -- the professional and the end consumer. For example, if an expert system is used by a doctor to diagnose diseases, the doctor must believe that diagnosis, and the patient must believe the doctor. However, it is unlikely that the patient knows that a computer is doing the diagnosis.

A fifth requirement of a good expert system is that it must take into account the decision making process of the user. For applications with true human experts, study of the decision making process of an expert will help in expert system development. The expert's knowledge base and inference mechanisms can be shared by thousands of consumers or paraprofessionals. Research could be conducted based on observation of expert decision making, and also comparing the decision making processes of experts and ordinary consumers.

Developing expert systems provides opportunities for researchers to consider new ways to apply theories, lead to new interdisciplinary approaches, and gain more understanding of consumer decision making processes. Thus, research related to expert systems may contribute to theory development and also help consumers.

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# Challenges in Computer Program Development

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Establishing a framework for computer program development provides structure and organization by furnishing a set of steps that are consistently followed in each project. The steps involved are; the proposal, approval, team formation, pre-program documentation, program model, program code development, program testing, documentation, and support and training.

Initially someone has an idea or problem, and says, "Couldn't we use the computer to....". They begin by writing a proposal of how the problem could be addressed, including a statement of the problem, the objective and scope of the problem, the intended users and how the problem affects them. Reviewing past attempts at dealing with this problem can provide additional insights.

Determining what type of computer program is needed to address the problem is part of this component. Not all problems can be answered by computers, no matter now much we would like to believe they can. A spreadsheet template may handle the situation or a memory-resident program may be able to do a task. Software may already exist that gives a solution to the problem.

After having defined the problem and examined possible tools for solving it, there will have to be a decision on whether the problem is "worth fixing". At some point, it is not worth spending the time, energy and money needed to fix every problem. When deciding whether to approve a project, consideration will need to be given to the resources available both to the developer and the end-user or intended audience.

Team formation will occur after the project is approved. Some combination of the following team members will be needed; a subject matter specialist or expert, a project manager or knowledge engineer, a programmer, reviewers (two people from the intended audience), and an editor. The relationship between the team members will vary from one project to the next.

The overall design of the program is planned on paper before actual construction of the program begins. Pre-program documentation entails identifying each major component, its overall purpose, and the logical relationships among the components. This can be done using both textual information and in the form of a flow chart.

Next the programmer creates a program model with sample screens demonstrating all major options. Discussion of screen responses and data output enables the team to evaluate the appearance and functionality of the program. After review by the development team, actual programming can begin.

There are three components to program development. The first component is to construct the program itself, the inputs, variables, and formulas. Next, provide the environment within which the program runs. Of major importance is designing how the program interacts with the user, between 80 to 95 percent of programming time can be spent on this component. Each of these areas can be written and tested separately and then incorporated into the total program.

Documentation in the form of a user's guide and technical documentation are crucial for proper software development. This should be an on-going part of the project and not a last minute addition to it. Testing and evaluation of the program is also critical in software development. It is important to let many different people use the program during its development to find problems with "readability" or understanding what to input.

The job is not finished after developing and releasing a computer program. There is a need to train users in operating the program and for support of users. There will be questions concerning the operation of the program. Some of the questions will prompt changes to be incorporated into updated versions; other questions will need to be answered to clarify what is needed to run the program.

Software development can be a frantic experience or have a rhythmic flow. Establishing a routine for development will give the best results. By following the prescribed steps it can be achieved with the desired results.

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# Reflections on Testing and Evaluation of Expert Systems Software

Sharon A. DeVaney, The Ohio State University[1]

Evaluation and testing of Expert Systems software should be a continuous process beginning with a feasibility study, continuing through prototype development and documentation review, and culminating in a pilot study. A research project could be designed to measure the effects of the program itself, compare the use of computer software to other methods or to analyze psychological effects of the computer program.

Although there are many approaches to a feasibility study, broadly contrasting types include an issue-oriented study and a weighted category study. The issue-oriented study (Walters and Nielsen, 1988) analyzes economic, cultural, and technical issues. Economic issues include an estimation of benefits, costs, and risks. Should the development group be a pioneer? The risk of producing a knowledge-based system is higher than the risk associated with an algorithm-based application. Cultural issues include time and expense constraints and the users' wants and needs. Technical issues include suitability of the problem, the existence of expertise, and available technology. If an algorithmic solution to the problem already exists, then there may be no reason to develop an Expert Systems program.

Beckman (1991) defined specific categories and awarded points to each category as follows: task (25), payoff (20), customer management (20), system designer (15), domain expert (10), and user (10). To be considered an application must score 50 percent overall and task and payoff should each score over 50 percent. A reasonable time frame in which to accomplish a feasibility study would be 1 to 4 weeks. Management, expert, developers, and prospective users should form a team to prepare the feasibility study.

During prototype development, content testing and user testing, deserve equal consideration (Pedersen, 1989). Content testing involves the

developer, the expert, and the user. Since small units can be programmed, each should be tested as it is developed. The program content must be correct and designated cases must be solvable. A data base of common cases should be developed that can be tested against each module of the program.

User testing is just as essential and should be started as soon as possible. It is important to capture the real-world cases the final user sees as important. Users will quickly find erroneous recommendations. The program requirements and the users' skill level must match. A readability check on program statements may indicate that active verbs and short direct statements are needed.

Two instruments which could be used to evaluate documentation are a cloze test and a usability test. In a cloze test, every 5th or 7th word is eliminated from a 300 word passage and users are asked to provide the missing words. During a usability test, volunteers are given a portion of the User Guide such as the installation or operation and asked to proceed with no assistance.

Primary and secondary test groups could be colleagues, students or clients. Attitude surveys could help determine comprehension and positive affect of the program. An External Advisory Committee consisting of experts from related career fields could help identify factors not considered by the development team. A maintenance plan should be developed so that users will not be involved with outdated software. As the prototype stage is drawing to a close, a pilot study should be designed to measure the program's effectiveness.

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