MODELING PROPORTIONS TO ASSESS THE SOIL NEMATODE COMMUNITY STRUCTURE IN A TWO YEAR ALFALFA CROP

by

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Abstract

The southern root-knot nematode (SRKN) and the weedy perennials, yellow nutsedge (YNS) and purple nutsedge (PNS) are simultaneously occurring pests in the irrigated agricultural soils of southern New Mexico. Previous research has very well characterized SRKN, YNS and PNS as a mutually-beneficial pest complex and has revealed their enhanced population growth and survival when they occur together. The density of nutsedge in a field could be used as a predictor of SRKN juveniles in the soil. In addition to SRKN, which is the most harmful of the plant parasitic nematodes, in southern New Mexico, other species or categories of nematodes could be identified and counted. Some of them are not as damaging to the plant as SRKN, and some of them may be essential for soil health. The nematode species could be grouped into categories according to trophic level (what nematodes eat) and herbivore feeding behavior (how herbivore nematodes eat). Subsequently, three ratios of counts were calculated for trophic level and for feeding behavior level to investigate the soil nematode community structure. These proportions were modeled as functions of the weed hosts YNS and PNS by generalized linear regression models using the logit link function and three probability distributions: the Binomial, Zero Inflated Binomial (ZIB) and Binomial Hurdle (BH). The latter two were used to account for potential high proportions of zeros in the data. The SAS NLMIXED procedure was used to fit models for each of the six sampling dates (May, July and September) over the two years of the alfalfa study. General results showed that the Binomial pmf generally provided the best fit, indicating lower zero-inflation than expected. Importance of YNS and PNS predictors varied over time and the different ratios. Specific results illustrate the differences in estimated probabilities between Binomial, ZIB and BH distributions as YNS counts increase for two selected ratios.

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Chapter 1 - INTRODUCTION

Nematodes are usually microscopic worm-like organisms or roundworms, which can live in almost every habitat on earth. There are thousands (if not million) of nematode species, most of them are still not described by scientists. Many of them play critical ecological roles as decomposers and predators on microorganisms, but some are parasitic species, which affect humans directly or indirectly.

The most economically damaging genera of plant-parasitic nematodes on horticultural and field crops are the root-knot nematodes, *Meloidogyne* spp. These species live and feed within plant roots most of their lives. The southern root-knot nematode, *Meloidogyne incognita* (hereafter referred to as 'SRKN') is an example of that most damaging plant-parasitic nematode. The SRKN is widely distributed and - according to Entomology, Plant Pathology, and Weed Science Department of New Mexico State University - without proper management, can result in yield losses that exceed 40% in chile and 25% in cotton and many other annual New Mexico crops. The southern root-knot nematode and the weedy perennials, yellow nutsedge (*Cyperus esculentus*, hereafter referred to as 'YNS') and purple nutsedge (*Cyperus rotundus*, hereafter referred to as 'PNS') are simultaneously occurring pests in the irrigated agricultural soils of southern New Mexico. Previous research (Schroeder et al. 1994, Thomas et al. 1997, Schroeder et al. 2004, Thomas et al. 2004, Schroeder et al. 2005) has very well characterized SRKN, YNS and PNS as a mutually-beneficial pest complex and has revealed their enhanced population growth and survival when they occur together. Therefore the effectiveness of management practices that target the nematodes or nutsedge weeds alone, has been substantially reduced due to these beneficial interactions.

Previous research (Fiore 2004, Ou et al. 2008, Murray et al. 2012, Trojan et al. 2009) was focused on developing an economically integrated management strategy able to stifle those three pests. Crop rotation with a nondormant, SRKN-resistant alfalfa (*Medicago sativa* cultivar 'Mecca II'), which has aggressive growth and successfully can compete with nutsedge for light and other resources, can provide simultaneous suppression of those pests (Fiore 2004). It was also shown, that by monitoring the locations of pest population suppression and resurgence of

each pest, the density of nutsedge in a field could be used as a predictor of SRKN juveniles in the soil (Ou et al. 2008, Murray et al. 2012).

In addition to SRKN, other species or categories of nematodes could be identified (Trojan et al. 2009). Some of them are not as damaging to the plant as SRKN, and some of them may be essential for soil health. Therefore, I will use count of SRKN as well as counts of other species or categories of nematodes to examine the soil nematode community structure.

Chapter 2 - MATERIALS AND METHODS

Description of Field Experiment

A 2-yr alfalfa field experiment was initiated in September 2004 at the Leyendecker Plant Science Research Center, New Mexico State University, near Las Cruces, NM, in the soil infested with the SRKN/YNS/PNS pest complex. For complete information on the conduct of the management of the field experiment, see Fiore (2004), Ou et al. (2008) and Murray et al. (2012).

For the field experiment researchers chose a 55x100 m rectangular section of the 1 ha alfalfa field with the similar irrigation properties. Further, this section was split into a grid with a total of 1,375 plots of size 2 x 2 m and was sampled six times in:

- 2005, Sample 1 (May 19), Sample 2 (July 8), Sample 3 (September 16)
- 2006, Sample 1 (May 2), Sample 2 (July 25), Sample 3 (September 28).

Because of logistical constraints on personnel and time, eighty 2 x 2 m plots were randomly chosen out of the 1,375 plots on each sample date. There were no plots sampled twice a year. Each sample was obtained from a 0.25 x 1 m quadrat put in the middle of a chosen 2 x 2 m plot. Visual counts of YNS and PNS shoots and counts of twelve categories or species of nematodes recovered from the soil were gathered at each sample date. In order to get counts of nematode populations, ten 50-cm^3 soil cores were collected near nutsedge plants, if nutsedge plants were present in selected quadrat, or at random within the quadrat, if no nutsedge plans were detected. Nematodes were extracted from the 500 cm^3 of soil by elutriation and processed using centrifugal flotation (Jenkins, 1964).

This work is based on nematode count data from the above field experiment near Las Cruces, New Mexico (hereafter referred to as ‘Nematode data’).

Characterizing the Soil Nematode Community

There were 12 categories or species of nematode identified in Nematode data. Unfortunately, in the first and second sample of 2005, some species of nematodes were not identified separately, but were listed together as “other”. Therefore we could observe counts of nematodes in the following categories or species (Table 2.1).

Table 2.1 Identified categories and species of nematodes in Nematode data

Nematode categories[1]		May05 & July05	Sep05, May06, July06 & Sep06
1	*Meloidogyne incognita*	√	√
2	*Trichodorus* spp.	√	√
3	*Tylenchorhynchus* spp.	√	√
4	*Pratylenchus* spp.	√	√
5	*Mesocriconema* spp.	√	√
6	Bacteriovores		√
7	Aphelenchoid		√
8	Dorylaimoid		√
9	*Hemicycliophora* spp.		√
10	Entomopathogenic		√
11	*Tylenchus* spp.		√
12	Monochoid		√

[1] Nematode categories not identified separately in May05 & July05 were pooled into "Other" category

The nematode categories or species from Table 2.1 could be grouped into categories according to trophic level (what nematodes eat) and herbivore feeding behavior (how herbivore nematodes eat).

Trophic categories for nematodes in Nematode data are defined as follows (S. H. Thomas, personal communication):

- **Fungivore**: nematode species that feed exclusively on fungi present in the soil. These nematodes play an important role in soil health by taking nutrients extracted from organic matter by soil fungi and excreting them into the water in the soil pore spaces where such nutrients are available to plants and other organisms. Aphelenchoid is the unique type of esophagus found in most fungivore nematodes.
- **Bacteriovore**: nematode species that feed exclusively on bacteria present in the soil. These are also important in soil health for the same reason as fungivores, except these nematodes excrete compounds extracted from organic matter by bacteria.
- **Herbivore**: nematode species that feed on higher plants; any plant-parasitic nematode is a herbivore. Herbivores include the following species: *Meloidogyne, Trichodorus, Tylenchorhynchus, Pratylenchus, Mesocriconema* and *Hemicycliophora*.

- **Other**: this was a general category that New Mexico scientists used to lump all nematodes that are not Herbivores ("other" = fungivore + bacteriovore + omnivore + predator = Bacterial Feeders + Aphelenchoid + Dorylaimoid + Entomopathogenic + *Tylenchus* + Monochoid).

Feeding behaviors of interest within the herbivore group in nematodes are (S. H. Thomas, personal communication):

A) Endoparasites (endos) – nematodes that live inside of the host plant. They can be:

- **Sedentary Endoparasites** – nematodes that feed as stationary parasites inside the plant root. They invade root tissues after hatching and then set up a permanent feeding location. They must transform root tissue of the host plant to support theirs sedentary lifestyle, which is the most damaging to the plant. *Meloidogyne incognita* = root-knot nematode is typical sedentary endoparasite.
- **Migratory Endoparasites** - lesion nematodes that feed while migrating around inside the root. They do not transform any root tissue, but kill the cells they feed on and cause wound channels in the roots. They are considered intermediate in the amount of damage a nematode causes on the plant. *Pratylenchus* is an example of migratory endoparasite.

B) Ectoparasites (ectos) – nematodes that live on the surface of the host plant. They never enter a root, and only stick their stylet (a type of feeding tube) into the root from outside in the soil. Typically they are the least damaging to the host, because only the stylet is inserted into the root. In Nematode data, ectos include the species: *Trichodorus, Tylenchorhynchus, Mesocriconem* and *Hemicycliophora.*

Based on above classification, we are interested in the soil nematode community ratios (Trojan et al., 2009) as defined in Table 2.2 and Table 2.3.

Table 2.2 Ratios and their interpretation – Trophic Level

Ratio Label	Ratio calculation[2]		Interpretation
	Numerator	Denominator	
BH = $\frac{B}{B+H}$	B = Bacteriovores	B + H = Bacteriovores + Herbivores where H = Herbivores = the sum of counts for following categories: 1. Meloidogyne, 2. Trichodorus, 3. Tylenchorhynchus, 4. Pratylenchus, 5. Mesocriconema, 9. Hemicycliophora	proportion of bacteriovores to plant-parasitic nematodes
FB = $\frac{F}{F+B}$	F = Fungivores = count of: 7. Aphelenchoid	F + B = Fungivores + Bacteriovores (as previously defined for BH)	what proportion of the nematodes important in nutrient cycling are feeding on fungi
HT = $\frac{H}{Total}$	H = Herbivores (as previously defined for BH)	Total = total count of 12 categories or species of nematodes	proportion of the total soil nematode community that are plant-parasitic or herbivores

[2] Label number of each nematode species/category as given in Table 2.1

Table 2.3 Ratios and their interpretation – Herbivore Feeding Behavior

Ratio Label	Ratio calculation[3]		Interpretation
	Numerator	Denominator	
SM = $\frac{S}{S+M}$	S = Sedentary Endoparasites = the count of: 1. Meloidogyne	S + M = Sedentary Endoparasites+ Migratory Endoparastites where M = Migratory Endoparasites = the count of: 4. Pratylenchus	the proportion of sedentary endoparasites (most damaging nematodes) among all the endoparasites in a sample
SE = $\frac{S}{S+E}$	S = Sedentary Endoparasites (as previously defined for SM)	S + E = Sedentary endoparasites + Ectoparasites where E = Ectoparasites = the sum of counts for following categories/species: 2. Trichodorus, 3. Tylenchorhynchus, 5. Mesocriconema, 9. Hemicycliophora	proportion of sedentary endoparasites to ectoparasites (least damaging) in a sample
ME = $\frac{M}{M+E}$	M = Migratory Endoparasites (as previously defined for SM)	M + E = Migratory Endoparastites + Ectoparasites (as previously defined for SM & SE)	the proportion of migratory (= interme-diate in damage) endoparasites to ectoparasites in a sample

[3] Label number of each nematode species/category refer to Table 2.1

Chapter 3 - STATISTICAL ANALYSIS

Previous research analyses were focused on modeling counts of the nematode plant parasite *Meloidogyne incognita* (SRKN) as predicted by YNS and PNS plant counts of the perennial weeds. Nematode counts are discrete non-negative integers, which often have a skewed frequency distribution and higher than expected zero-counts, under the assumption of a Poisson distribution. Therefore, these data were analyzed using the Poisson and the Poisson with scale parameter (Ou et al., 2008) and the Generalized Poisson, Zero Inflated Poisson and Poisson Hurdle distributions (Murray et al., 2012).

This current work is a continuation of research to assess the overall soil nematode community as measured by the three trophic-level proportions and three feeding behavior proportions. For these ratios, large number of zero counts in the ratio numerator may occur, meaning that the Binomial distribution may not fit well.

Therefore the objective of this work is statistical modeling of the six nematode community ratios using YNS and PNS counts as predictors and three probability distributions:

a) Binomial distribution
b) Zero Inflated Binomial distribution (hereafter referred to as 'ZIB distribution')
c) Binomial Hurdle distribution (hereafter referred to as 'BH distribution')

Probability distributions for dealing with "too many" zeros

Stroup (2012) provides general discussion for Zero Inflated and Hurdle distributions to deal with excessive zero counts. Generally, both types of distributions use a mixture of a binary, on-off process and a discrete counting distribution. Both are two-component distributions with zero counts component (zero inflated or hurdle component accordingly) and a discrete counting distribution component. The difference is that in Zero-Inflated distributions there are two sources of zeros. In Zero Inflated distributions, zeros occur in the "off" phase (zero inflated component – only zero counts with probability π_0 are possible in "off" phase) and also are possible in the "on" part of the process (counting component – with probability 1-π_0). However, in Hurdle distributions there is only one source of zeros, because zeros occur only in the "off" part of the process (with probability π_0) and not in the "on" phase, since when the system is "on" only

nonzero counts may be observed. The parameter π_0 is called the inflation probability because, when the system is "off", zero counts are "inflated" or more frequent compared to the discrete counting distribution (the "on" part).

Therefore, Zero Inflated distributions can be defined generically as follows (Stroup, 2012):

$$\Pr(Y=y) = \begin{cases} \pi_0 + (1-\pi_0)\, f(0) & for\ y = 0 \\ (1-\pi_0)\, f(y) & for\ y = 1,2,\dots,n \end{cases} \quad \text{(Eq. 1)}$$

where f(y) is the discrete probability distribution function (in this work Binomial distribution). Once again, the zero inflated distributions are two-component models with zero or nonzero count component when system is "on" and a zero-inflated component that models zero counts, when the system is "off".

The probability distribution for the Hurdle models can be described as:

$$\Pr(Y=y) = \begin{cases} \pi_0 & for\ y = 0 \\ (1-\pi_0)\ \frac{f(y)}{1-f(0)} & for\ y = 1,2,\dots,n \end{cases} \quad \text{(Eq. 2)}$$

As clearly seen, the Hurdle distributions are two-component models with truncated count component for only positive counts (system is "on") and hurdle component that models the zero counts, when the system is "off".

In this work I am interested in modeling ratios, so that the Binomial distribution will be used as the counting component to produce the ZIB and BH models. Therefore the probability mass function (pmf) f(y) in the Eq. 1 and Eq. 2 follows the Binomial distribution in this work.

I have used the general method of Stroup to obtain pmfs and have developed formulas for means and variances of ZIB and BH distributions (Table 3.1). Table 3.1. compares the probability mass functions and moments for Binomial, ZIB and BH distributions for Y=Z=H=0, 1, 2, …, n, where π_p is used to denote the Binomial probability and π_0 the zero counting probability.

Table 3.1 Comparison of the probability mass functions and moments for the Binomial, ZIB and BH distributions

	Binomial	ZIB	BH
PMF and Parameter Space	Pr (Y=y) $= \binom{n}{y} (\pi_p)^y (1-\pi_p)^{n-y}$, y = 0, 1, 2, …, n	Pr(Z=z) $= \pi_0 + (1-\pi_0)\Pr(Y=0)$ $= \pi_0 + (1-\pi_0)(1-\pi_p)^n$ for z=y = 0 or $= (1-\pi_0)\Pr(Y=y)$ $= (1-\pi_0)\binom{n}{y}(\pi_p)^y(1-\pi_p)^{n-y}$ for z= y =1, 2, … , n	Pr(H=h) $= \pi_0$ for h= y = 0 or $= (1-\pi_0)\frac{\Pr(Y=y)}{1-\Pr(Y=0)}$ $= (1-\pi_0)\frac{\binom{n}{y}(\pi_p)^y(1-\pi_p)^{n-y}}{1-(1-\pi_p)^n}$ for h = y =1, 2, … , n
Mean	$E(Y) = n\pi_p$	$E(Z) = E(Y)(1-\pi_0)$ $= n\pi_p(1-\pi_0)$	$E(H) = E(Y)\frac{(1-\pi_0)}{1-(1-\pi_p)^n}$ $= (n\pi_p)\frac{(1-\pi_0)}{1-(1-\pi_p)^n}$
Variance	$V(Y) = n\pi_p(1-\pi_p)$	$V(Z) = E(Z^2) - [E(Z)]^2$ $=\{(1-\pi_0)[V(Y)+(E(Y))^2]\} - [E(Z)]^2$ $=\{(1-\pi_0)[n\pi_p(1-\pi_p)+(n\pi_p)^2]\}$ $-[n\pi_p(1-\pi_0)]^2$	$V(H) = E(H^2) - [E(H)]^2$ $=\{\frac{(1-\pi_0)}{1-(1-\pi_p)^n}[V(Y)+(E(Y))^2]\} - [E(H)]^2$ $=\{\frac{(1-\pi_0)}{1-(1-\pi_p)^n}[n\pi_p(1-\pi_p)+(n\pi_p)^2]\}$ $-[(n\pi_p)\frac{(1-\pi_0)}{1-(1-\pi_p)^n}]^2$
Reduce to Binomial	•	when $\pi_0 = 0$	when $\pi_0 = 0$

In order to compare the means and variances from Table 3.1 of all three distributions, it seems easier when I define following multipliers as:

- A = (1-π_0)
- B = $(\frac{1}{1-(1-\pi_p)^n})$

Thus, comparing the means of the three distributions it is clear that:

a) The mean of Binomial distribution E(Y) is always greater than the mean of ZIB distribution E(Z), since:

   E(Z) = A * E(Y)

   where multiplier A = (1-π_0) < 1

b) The Binomial mean E(Y) is generally greater than the BH mean E(H), but not always. Here:
   E(H) = A * B * E(Y) = B * E(Z)

   Generally, when the multiplier B is big enough to compensate for a small multiplier A, then the BH mean is smaller than the Binomial mean. Only in the case of small n (n=1 or n $\leq$ 3 in some cases) or when $\pi_0 = \pi_p$ = 0.50 for n=1, is the BH mean E(H) greater or equal to the Binomial mean E(Y).

To illustrate the above mean comparisons, I have calculated the means for Binomial, ZIB and BH distributions for 4 combinations of π_0 = 0.25 and 0.50 and π_p = 0.33 and 0.50 for n=1, 3, 5, 10 and 100 accordingly. Table 3.2. shows these calculated means comparisons.
In Table 3.3. I have calculated variances for Binomial, ZIB and BH distributions for the same 4 combinations of π_0, π_p and n as above.

Table 3.2 Comparison of mean for Binomial, ZIB and BH distributions

ZIB — $\pi_0 = 0.25$ & $\pi_p = 0.33$

π_0	0.25					
π_p	0.33	E(Y)	x multipA	= **E(Z)**		**E(Y)**
n	**1**	0.330	0.75	**0.2475**	<	0.330
n	**3**	0.990	0.75	**0.7425**	<	0.990
n	**5**	1.650	0.75	**1.2375**	<	1.650
n	**10**	3.300	0.75	**2.4750**	<	3.300
n	**100**	33.000	0.75	**24.7500**	<	33.000

BH — $\pi_0 = 0.25$ & $\pi_p = 0.33$

π_0	0.25						
π_p	0.33	E(Y)	x multipA	x multipB	= **E(H)**		**E(Y)**
n	**1**	0.330	0.75	3.03	**0.7500**	>	0.330
n	**3**	0.990	0.75	1.43	**1.0619**	>	0.990
n	**5**	1.650	0.75	1.16	**1.4307**	<	1.650
n	**10**	3.300	0.75	1.02	**2.5210**	<	3.300
n	**100**	33.000	0.75	1.00	**24.7500**	<	33.000

ZIB — $\pi_0 = 0.50$ & $\pi_p = 0.33$

π_0	0.50					
π_p	0.33	E(Y)	x multipA	= **E(Z)**		**E(Y)**
n	**1**	0.330	0.50	**0.1650**	<	0.330
n	**3**	0.990	0.50	**0.4950**	<	0.990
n	**5**	1.650	0.50	**0.8250**	<	1.650
n	**10**	3.300	0.50	**1.6500**	<	3.300
n	**100**	33.000	0.50	**16.5000**	<	33.000

BH — $\pi_0 = 0.50$ & $\pi_p = 0.33$

π_0	0.50						
π_p	0.33	E(Y)	x multipA	x multipB	= **E(H)**		**E(Y)**
n	**1**	0.330	0.50	3.03	**0.5000**	>	0.330
n	**3**	0.990	0.50	1.43	**0.7079**	<	0.990
n	**5**	1.650	0.50	1.16	**0.9538**	<	1.650
n	**10**	3.300	0.50	1.02	**1.6806**	<	3.300
n	**100**	33.000	0.50	1.00	**16.5000**	<	33.000

ZIB — $\pi_0 = 0.50$ & $\pi_p = 0.50$

π_0	0.50					
π_p	0.50	E(Y)	x multipA	= **E(Z)**		**E(Y)**
n	**1**	0.500	0.50	**0.2500**	<	0.500
n	**3**	1.500	0.50	**0.7500**	<	1.500
n	**5**	2.500	0.50	**1.2500**	<	2.500
n	**10**	5.000	0.50	**2.5000**	<	5.000
n	**100**	50.000	0.50	**25.0000**	<	50.000

BH — $\pi_0 = 0.50$ & $\pi_p = 0.50$

π_0	0.50						
π_p	0.50	E(Y)	x multipA	x multipB	= **E(H)**		**E(Y)**
n	**1**	0.500	0.50	2.00	**0.5000**	=	0.5000
n	**3**	1.500	0.50	1.14	**0.8571**	<	1.5000
n	**5**	2.500	0.50	1.03	**1.2903**	<	2.5000
n	**10**	5.000	0.50	1.00	**2.5024**	<	5.0000
n	**100**	50.000	0.50	1.00	**25.0000**	<	50.0000

ZIB — $\pi_0 = 0.25$ & $\pi_p = 0.50$

π_0	0.25					
π_p	0.50	E(Y)	x multipA	= **E(Z)**		**E(Y)**
n	**1**	0.500	0.75	**0.3750**	<	0.500
n	**3**	1.500	0.75	**1.1250**	<	1.500
n	**5**	2.500	0.75	**1.8750**	<	2.500
n	**10**	5.000	0.75	**3.7500**	<	5.000
n	**100**	50.000	0.75	**37.5000**	<	50.000

BH — $\pi_0 = 0.25$ & $\pi_p = 0.50$

π_0	0.25						
π_p	0.50	E(Y)	x multipA	x multipB	= **E(H)**		**E(Y)**
n	**1**	0.500	0.75	2.00	**0.7500**	>	0.5000
n	**3**	1.500	0.75	1.14	**1.2857**	<	1.5000
n	**5**	2.500	0.75	1.03	**1.9355**	<	2.5000
n	**10**	5.000	0.75	1.00	**3.7537**	<	5.0000
n	**100**	50.000	0.75	1.00	**37.5000**	<	50.0000

Table 3.3 Comparison of variances for Binomial, ZIB and BH distributions

ZIB — $\pi_0 = 0.25$ & $\pi_p = 0.33$

π_0	0.25							
π_p	0.33	{[V(Y)	+ $E(Y)^2$]	x multipA }	- $E(Z)^2$	= V(Z)		V(Y)
n	1	0.221	0.1089	0.75	0.0613	**0.1862**	<	0.2211
n	3	0.663	0.9801	0.75	0.5513	**0.6812**	>	0.6633
n	5	1.106	2.7225	0.75	1.5314	**1.3396**	>	1.1055
n	10	2.211	10.8900	0.75	6.1256	**3.7001**	>	2.2110
n	100	22.110	1089.000	0.75	612.5625	**220.7700**	>	22.1100

BH — $\pi_0 = 0.25$ & $\pi_p = 0.33$

π_0	0.25								
π_p	0.33	{[V(Y)	+ $E(Y)^2$]	x multipA	x multipB }	- $E(Z)^2$	= V(H)		V(Y)
n	1	0.221	0.1089	0.75	3.03	0.5625	**0.1875**	<	0.2211
n	3	0.663	0.9801	0.75	1.43	1.1276	**0.6351**	<	0.6633
n	5	1.106	2.7225	0.75	1.16	2.0468	**1.2723**	>	1.1055
n	10	2.211	10.8900	0.75	1.02	6.3552	**3.6530**	>	2.2110
n	100	22.110	1089.000	0.75	1.00	612.5625	**220.770**	>	22.1100

ZIB — $\pi_0 = 0.50$ & $\pi_p = 0.33$

π_0	0.50							
π_p	0.33	{[V(Y)	+ $E(Y)^2$]	x multipA }	- $E(Z)^2$	= V(Z)		V(Y)
n	1	0.221	0.1089	0.50	0.0272	**0.1378**	<	0.2211
n	3	0.663	0.9801	0.50	0.2450	**0.5767**	<	0.6633
n	5	1.106	2.7225	0.50	0.6806	**1.2334**	>	1.1055
n	10	2.211	10.8900	0.50	2.7225	**3.8280**	>	2.2110
n	100	22.110	1089.000	0.50	272.2500	**283.3050**	>	22.1100

BH — $\pi_0 = 0.50$ & $\pi_p = 0.33$

π_0	0.50								
π_p	0.33	{[V(Y)	+ $E(Y)^2$]	x multipA	x multipB }	- $E(Z)^2$	= V(H)		V(Y)
n	1	0.221	0.1089	0.50	3.03	0.2500	**0.2500**	>	0.2211
n	3	0.663	0.9801	0.50	1.43	0.5011	**0.6740**	>	0.6633
n	5	1.106	2.7225	0.50	1.16	0.9097	**1.3031**	>	1.1055
n	10	2.211	10.8900	0.50	1.02	2.8245	**3.8476**	>	2.2110
n	100	22.110	1089.000	0.50	1.00	272.2500	**283.305**	>	22.1100

ZIB — $\pi_0 = 0.50$ & $\pi_p = 0.50$

π_0	0.50							
π_p	0.50	{[V(Y)	+ $E(Y)^2$]	x multipA }	- $E(Z)^2$	= V(Z)		V(Y)
n	1	0.250	0.2500	0.50	0.0625	**0.1875**	<	0.2500
n	3	0.750	2.2500	0.50	0.5625	**0.9375**	>	0.7500
n	5	1.250	6.2500	0.50	1.5625	**2.1875**	>	1.2500
n	10	2.500	25.0000	0.50	6.2500	**7.5000**	>	2.5000
n	100	25.000	2500.000	0.50	625.0000	**637.5000**	>	25.0000

BH — $\pi_0 = 0.50$ & $\pi_p = 0.50$

π_0	0.50								
π_p	0.50	{[V(Y)	+ $E(Y)^2$]	x multipA	x multipB }	- $E(Z)^2$	= V(H)		V(Y)
n	1	0.250	0.2500	0.50	2.00	0.2500	**0.2500**	=	0.2500
n	3	0.750	2.2500	0.50	1.14	0.7347	**0.9796**	>	0.7500
n	5	1.250	6.2500	0.50	1.03	1.6649	**2.2060**	>	1.2500
n	10	2.500	25.0000	0.50	1.00	6.2622	**7.5012**	>	2.5000
n	100	25.000	2500.000	0.50	1.00	625.0000	**637.500**	>	25.0000

ZIB — $\pi_0 = 0.25$ & $\pi_p = 0.50$

π_0	0.25							
π_p	0.50	{[V(Y)	+ $E(Y)^2$]	x multipA }	- $E(Z)^2$	= V(Z)		V(Y)
n	1	0.250	0.2500	0.75	0.1406	**0.2344**	<	0.2500
n	3	0.750	2.2500	0.75	1.2656	**0.9844**	>	0.7500
n	5	1.250	6.2500	0.75	3.5156	**2.1094**	>	1.2500
n	10	2.500	25.0000	0.75	14.0625	**6.5625**	>	2.5000
n	100	25.000	2500.000	0.75	1406.250	**487.5000**	>	25.0000

BH — $\pi_0 = 0.25$ & $\pi_p = 0.50$

π_0	0.25								
π_p	0.50	{[V(Y)	+ $E(Y)^2$]	x multipA	x multipB }	- $E(Z)^2$	= V(H)		V(Y)
n	1	0.250	0.2500	0.75	2.00	0.5625	**0.1875**	<	0.2500
n	3	0.750	2.2500	0.75	1.14	1.6531	**0.9184**	>	0.7500
n	5	1.250	6.2500	0.75	1.03	3.7461	**2.0604**	>	1.2500
n	10	2.500	25.0000	0.75	1.00	14.0900	**6.5552**	>	2.5000
n	100	25.000	2500.000	0.75	1.00	1406.250	**487.500**	>	25.0000

Comparing the variances of the three distributions, we see, that variance of Binomial distribution V(Y) is smaller than variance of ZIB or BH distributions V(Z) for large n. This occurs because:

$V(Z) = E(Z^2) - [E(Z)]^2 = \{A^* [V(Y) + (E(Y))^2]\} - [E(Z)]^2$

and

$V(H) = E(Z^2) - [E(Z)]^2 = \{ A * B * [V(Y) + (E(Y))^2]\} - [E(Z)]^2$

where multiplier A = $(1-\pi_0)$ is always smaller than 1 and multiplier B = $\left(\frac{1}{1-(1-\pi_p)^n}\right)$ is smaller or greater than 1 and this depends on n and π_p.

Figure 3.1. gives a graph of the pmfs for Binomial, ZIB and BH models for the same 4 combinations of π_p (0.33 and 0.50) and π_0 (0.25 and 0.5) given in Tables 3.2 and 3.3 but only for n=5.

Computations of pmfs was done for the same 4 combinations of π_0 and π_p and n=5. In every case, the probability of zero counts is much greater for ZIB and BH pmfs compared to the Binomial pmf. For the Binomial pmf, probability '0' is never the highest, as it is generally for ZIB and BH models (except of BH model for π_0 = 0.25 and π_p = 0.33).

Generally we could say, that probability is shifted from the highest bars (never probability of zero counts) from Binomial distribution to significant increase of probability of zero counts in ZIB and BH distributions. Therefore probabilities of higher counts are decreasing in ZIB and BH pmfs compared to regular Binomial pmf.

Figure 3.1 Pmfs of Binomial, ZIB and BH models for 4 combinations of π_p and π_0 & n=5

Chapter 4 - RESULTS

Fitting the models

The six ratios of nematode counts described in Tables 2.2 and 2.3 were modeled as functions of the weed hosts YNS and PNS by generalized linear regression models using the logit link function and three probability distributions: the Binomial, ZIB and BH. As mentioned in the previous chapter, the ZIB and BH models were used to account for potential high proportions of zeros in the data. Because the ZIB and BH pmfs are not available in the SAS GENMOD and GLIMMIX procedures, the SAS (ver. 9.3) NLMIXED procedure was used to fit models based on maximum likelihood for each of the six sampling dates (May, July and September) over the two years of the alfalfa study.

The binomial probability π_p in the Binomial, ZIB and BH pmfs was modeled as a function of the weed hosts in four ways:

a) Intercept-only model (no YNS or PNS as predictors at all, parameter denoted as β_0),
b) YNS only model (with YNS count as predictor, parameters denoted as β_0, β_1),
c) PNS only model (with PNS count as predictor, parameters denoted as β_0, β_2),
d) Full model (with YNS, PNS, YNS^2, PNS^2 and YNS*PNS as predictors, parameters denoted as β_0, β_1, β_2, β_{11}, β_{22}, β_{12}).

The zero inflation probability π_0 was modeled only as an intercept-only model with parameter denoted as α_0.

Examples of the pmfs from Table 3.1 with the addition of a regression model are given in Table 4.1 for the case of YNS as predictor.

In total we have could have: 3 (distribution) x 4 (sets of different predictors) x 6 (ratios) x 6 (sample dates) = 432 model combinations, but as we mentioned previously, we did not have data information for 2 ratios for 2 sample dates in 2005 and we are missing 2 (sample date) x 2 (ratio) x 3 (distribution) x 4 (predictors) = 48 models. Therefore we have fitted 384 model combinations. Summary Tables for all 384 model combinations for all ratios over all sample dates are in Appendix B.

In following sections, we discuss results based on statistical model-fitting and not biological interpretations.

Table 4.1 The general formulas for calculating probabilities with predictor YNS for Binomial, ZIB and BH distributions

	Binomial	**ZIB**	**BH**
Regression parameters used	. β_0 β_1	α_0 β_0 β_1	α_0 β_0 β_1
Probabilities π_0 or/and π_p as functions to regression parameters	. $\pi_p = \frac{\exp(\beta_0+\beta_1 \mathrm{YNS})}{1+\exp(\beta_0+\beta_1 \mathrm{YNS})}$	$\pi_0 = \frac{\exp(\alpha_0)}{1+\exp(\alpha_0)}$ $\pi_p = \frac{\exp(\beta_0+\beta_1 \mathrm{YNS})}{1+\exp(\beta_0+\beta_1 \mathrm{YNS})}$	$\pi_0 = \frac{\exp(\alpha_0)}{1+\exp(\alpha_0)}$ $\pi_p = \frac{\exp(\beta_0+\beta_1 \mathrm{YNS})}{1+\exp(\beta_0+\beta_1 \mathrm{YNS})}$
Probability of zero count (y=0)	$(1-\pi_p)^n$	$\pi_0+(1-\pi_0)(1-\pi_p)^n$	π_0
Probability of non-zero count (y=1 to n)	$\binom{n}{y}(\pi_p)^y(1-\pi_p)^{n-y}$	$(1-\pi_0)\binom{n}{y}(\pi_p)^y(1-\pi_p)^{n-y}$	$(1-\pi_0)\frac{\binom{n}{y}(\pi_p)^y(1-\pi_p)^{n-y}}{1-(1-\pi_p)^n}$
Model Probability (y = 0, 1, 2,…, n)	$\binom{n}{y}*[\frac{\exp(\beta_0+\beta_1 YNS)}{1+\exp(\beta_0+\beta_1 YNS)}]^y *$ $[1-(\frac{\exp(\beta_0+\beta_1 YNS)}{1+\exp(\beta_0+\beta_1 YNS)})]^{n-y}$	$[1-(\frac{\exp(\alpha_0)}{1+\exp(\alpha_0)})]*\binom{n}{y}*[\frac{\exp(\beta_0+\beta_1 YNS)}{1+\exp(\beta_0+\beta_1 YNS)}]^y$ $*[1-(\frac{\exp(\beta_0+\beta_1 YNS)}{1+\exp(\beta_0+\beta_1 YNS)})]^{n-y}$	$[1-(\frac{\exp(\alpha_0)}{1+\exp(\alpha_0)})]*[\frac{\exp(\beta_0+\beta_1 YNS)}{1+\exp(\beta_0+\beta_1 YNS)}]^y *$ $[1-(\frac{\exp(\beta_0+\beta_1 YNS)}{1+\exp(\beta_0+\beta_1 YNS)})]^{n-y} *$ $\frac{\binom{n}{y}}{1-[1-(\frac{\exp(\beta_0+\beta_1 YNS)}{1+\exp(\beta_0+\beta_1 YNS)})]^n}$

General Results

After modeling all the above models for all sample dates, we checked the Akaike's Information Criterion (hereafter referred to as 'AIC') in order to find "the best" model. Table 4.2 lists the best combination of regression + pmf models with the smallest value of AIC, among all the fitted models across all sample dates.

General results based on Table 4.2 showed that the Binomial pmf provided the best fit for 20 sample dates out of 32, ZIB was the best 10 times while BH for only 2 sample dates. The dominant position of Binomial model may indicate lower zero-inflation than was expected. Distributions dealing with excessive zeros (ZIB and BH) were the best fits in 12 (10+2) sample dates out of 32. The importance of YNS and PNS predictors varied over time and the different ratios, since for 11 sample dates YNS was the best predictor, for 9 sample dates the Full model with both YNS and PNS was the best, in 8 cases the Intercept only model was the best, and in 4 cases PNS was the best predictor.

In following sections, we examine results more closely for two sample dates, September 2005 and 2006. September samples were chosen because at that time of the year the crop should be established with grown weeds, which as we know are supposed to be good predictors of nematode existence.

Best Regression + pmf model for September 2005 and 2006

Table 4.3 shows the smallest values of AIC (bolded) for the best combination of regression + pmf models for September (Sample 3) dates in the two analyzed years. We can compare how far from the best (in most cases) Binomial model are ZIB and BH models or in other words, how comparable are other models to the best fit model based on AIC. Burnham and Anderson (2010) suggest comparing AIC by calculating difference between AIC values for the best model (i.e. with smallest value of AIC) and $model_i$ we want to compare. This AIC difference is defined as $\Delta_i = AIC_i - AIC_{min}$. Further, if $\Delta_i \leq 2$, Burnham and Anderson suggest that level of empirical support of $model_i$ is substantial in comparison to the best model, meaning the two models have comparable support. When Δ_i is greater than 2 but less than 10, the $model_i$ being compared is considerably worse than the best model in explaining some substantial variation in the data. Models with Δ_i exceeding 10 have no support and might be omitted from further consideration.

Table 4.2 Combination of regression + pmf models with the smallest AIC (the best models) across all sample dates

B=Binomial, Z=ZIB & H=Hurdle Model, 1=Sample 1 (May), 2=Sample 2 (July), 3=Sample 3 (September)

	BH ratio				**FB ratio**				**HT ratio**						**SM ratio**						**SE ratio**						**ME ratio**					
	2005	2006			2005	2006			2005			2006			2005			2006			2005			2006			2005			2006		
	3	1	2	3	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Intercept										B						B	B				B			Z	B	Z		B				
YNS		B			Z	B			H			Z						Z	H	Z									B	Z		Z
PNS								B							B							B					B					
Full	B		B	B			B				B		B	B									Z								Z	

Table 4.3 Models with listed smallest AIC (the best models) for September Samples (Sample 3).
With bolded smallest AIC values

		BH ratio		**FB ratio**		**HT ratio**		**SM ratio**		**SE ratio**		**ME ratio**	
		2005	2006	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Intercept	B							**64.9**			143.6		
	ZIB							66.9			**122.9**		
	BH							141.7			123.4		
YNS	B			290.3					131			**83.1**	671.4
	ZIB			**287.2**					**99.4**			83.7	**523.9**
	BH			292.4					120.3			97.2	531.2
PNS	B				**236.6**								
	ZIB				238.2								
	BH				254.2								
Full	B	**367**	**668.1**			**371.7**	**691.3**			182.7			
	ZIB	369	670.1			373.7	693.3			**172.2**			
	BH	369	670			372.7	693.3			175.6			

Therefore it is easily seen in Table 4.3, that although Binomial distribution is the best with smallest AIC value in most cases, ZIB and BH are comparable models for the BH and HT ratio for both Samples 3 in 2005 and 2006 since the $\Delta_i \leq 2$. Also, for the FB ratio in 2006, ZIB is comparable to the best Binomial ($\Delta_i = 1.6$), while BH is much worse ($\Delta_i = 17.6$). Also for the SM ratio in 2005, ZIB is comparable to the best Binomial ($\Delta_i = 2$), while BH could be excluded ($\Delta_i = 76.8$). For the SE ratio in 2006, BH is comparable to the best ZIB ($\Delta_i = 0.5$), while Binomial is much worse ($\Delta_i = 20.7$). For the ME ratio in 2005, ZIB is comparable to the best Binomial ($\Delta_i = 0.6$), while BH could be omitted ($\Delta_i = 14.1$). For the FB ratio in 2005, where ZIB model was the best, $2 \leq \Delta_i < 10$, meaning that Binomial and BH models are considerably worse than ZIB in explaining some substantial variation in the data, but should not be excluded ($\Delta_i = 3.1$ and 5.2 accordingly). For the SM ratio in 2006, BH and Binomial models are very poorly approximating the data at hand compared to the best ZIB, because for all of them Δ_i is greater than 10.

Summarizing, in most cases Binomial models present the best fit, but also in many cases ZIB and BH are comparable models, so they are almost as good in fitting the data. This suggests that there is some zero-inflation in the Nematode data, but this influence of zero counts of nematodes was a little bit over-anticipated. Explanation for this could be that even if we have a lot of zeros in the data, in modeling ratios those zeros could be balanced out because the denominator or nominator in the ratio could be sum of counts of few nematode species.

Illustrating differences for estimated probabilities between Binomial, ZIB and BH distributions for two chosen ratios for September 2005 and 2006

In order to illustrate specific differences in the estimated probabilities between fitted pmfs, we have selected four examples for further investigation: the SM and ME ratios for September (Sample 3) in 2005 and 2006. Table 4.1 showed the relationships between the regression parameters and the Binomial parameter π_p and zero-inflation parameter π_0 for the three pmfs of interest. Estimated probabilities were calculated using the fitted regression coefficient estimates in Appendix B.

Figures 4.1 – 4.4 illustrate the differences in estimated probabilities between Binomial, ZIB and BH distributions as YNS counts increase for the selected examples. These figures present only the subset of possible probabilities assuming that the ratio denominator count is n=5, so that numerator count is 0 to 5, as in the ordinary Binomial. In reality, this ratio's denominator can obviously be different from 5, but this is difficult to show in a compact form.
The estimated probabilities in Figures 4.1 – 4.4 are, therefore, in general:

P (Numerator = y │ Denominator (n) = 5, YNS=k, distribution = d),

where y = 0, 1, 2,…, 5, k = 0, 2, 4, 8, and d = Binomial, ZIB, BH distributions.

Note that distributions graphed in Figure 3.1 in Chapter 3 are equivalent to case where the best model is an intercept-only model for the Binomial parameter π_p, that is, no predictor variables were significant for π_p. This case allows the effect of zero-inflation to be clearly seen. The case of significant predictors in the π_p model is represented in Figures 4.1 – 4.4, with YNS as the only predictor.

As specific example of estimated probabilities, we use the SM ratio (Table 2.3), which is calculated using the formula: SM ratio = Meloidogyne / (Meloidogyne + Pratylenchus).
Figure 4.1 presents estimated probabilities for SM ratio for September (Sample 3) 2005 with YNS as predictor. Actually for SM ratio in September 2005, the best model was the intercept-only model with AIC=64.9, but the second best was YNS model with AIC=65 (Summary Table for SM ratio in Appendix B). Because the difference between two best models was very small and we want to compare differences in predicted probabilities as the predictor increases, the results of the YNS regression model is illustrated here instead of the intercept-only regression model.

The estimated probabilities in Figure 4.1 were calculated using following estimated regression coefficients and other fixed information for YNS=0:
P [Meloidogyne=0 │ (Meloidogyne + Pratylenchus)=5, YNS=0, distribution = Binomial, $\widehat{\beta_0}$ = 1.4714, $\widehat{\beta_1}$ = - 0.297] = 0.00023
P [Meloidogyne=0 │ (Meloidogyne + Pratylenchus)=5, YNS=0, distribution = ZIB, $\widehat{\alpha_0}$ = - 19.3131, $\widehat{\beta_0}$ = 1.4714, $\widehat{\beta_1}$ = - 0.297] = 0.00023

P [Meloidogyne=0 | (Meloidogyne + Pratylenchus)=5, YNS=0, distribution = BH, $\widehat{\alpha_0}$ = 0.3023, $\widehat{\beta_0}$ = 1.4126, $\widehat{\beta_1}$= - 0.1536] = 0.57500

and for YNS=8:

P [Meloidogyne=3 | (Meloidogyne + Pratylenchus)=5, YNS=8, distribution = Binomial, $\widehat{\beta_0}$ = 1.4714, $\widehat{\beta_1}$ = - 0.297] = 0.12120

P [Meloidogyne=3 | (Meloidogyne + Pratylenchus)=5, YNS=8, distribution = ZIB, $\widehat{\alpha_0}$ = -19.3131, $\widehat{\beta_0}$ = 1.4714, $\widehat{\beta_1}$= - 0.297] = 0.12120

P [Meloidogyne=3 | (Meloidogyne + Pratylenchus)=5, YNS=8, distribution = BH, $\widehat{\alpha_0}$ = 0.3023, $\widehat{\beta_0}$ = 1.4126, $\widehat{\beta_1}$= - 0.1536] = 0.14537

Figure 4.1 Estimated probabilities for SM ratio, Sample 3, 2005, YNS as predictor and denominator count=5

Calculated using following estimated regression coefficients:

Binomial	ZIB	BH
$\widehat{\beta_0}$ = 1.4714	$\widehat{\alpha_0}$ = -19.3131	$\widehat{\alpha_0}$ =0.3023
$\widehat{\beta_1}$ = -0.297	$\widehat{\beta_0}$=1.4714	$\widehat{\beta_0}$=1.4126
	$\widehat{\beta_1}$=-0.297	$\widehat{\beta_1}$=-0.1536

Figure 4.2 Estimated probabilities for SM ratio, Sample 3, 2006, YNS as predictor and denominator count=5

Calculated using following estimated regression coefficients:

Binomial	ZIB	BH
$\widehat{\beta_0}$ = -2.7692	$\widehat{\alpha_0}$ = -0.1452	$\widehat{\alpha_0}$ =1.2205
$\widehat{\beta_1}$ = 0.9641	$\widehat{\beta_0}$=-1.0425	$\widehat{\beta_0}$=-1.1176
	$\widehat{\beta_1}$=0.6624	$\widehat{\beta_1}$=0.5063

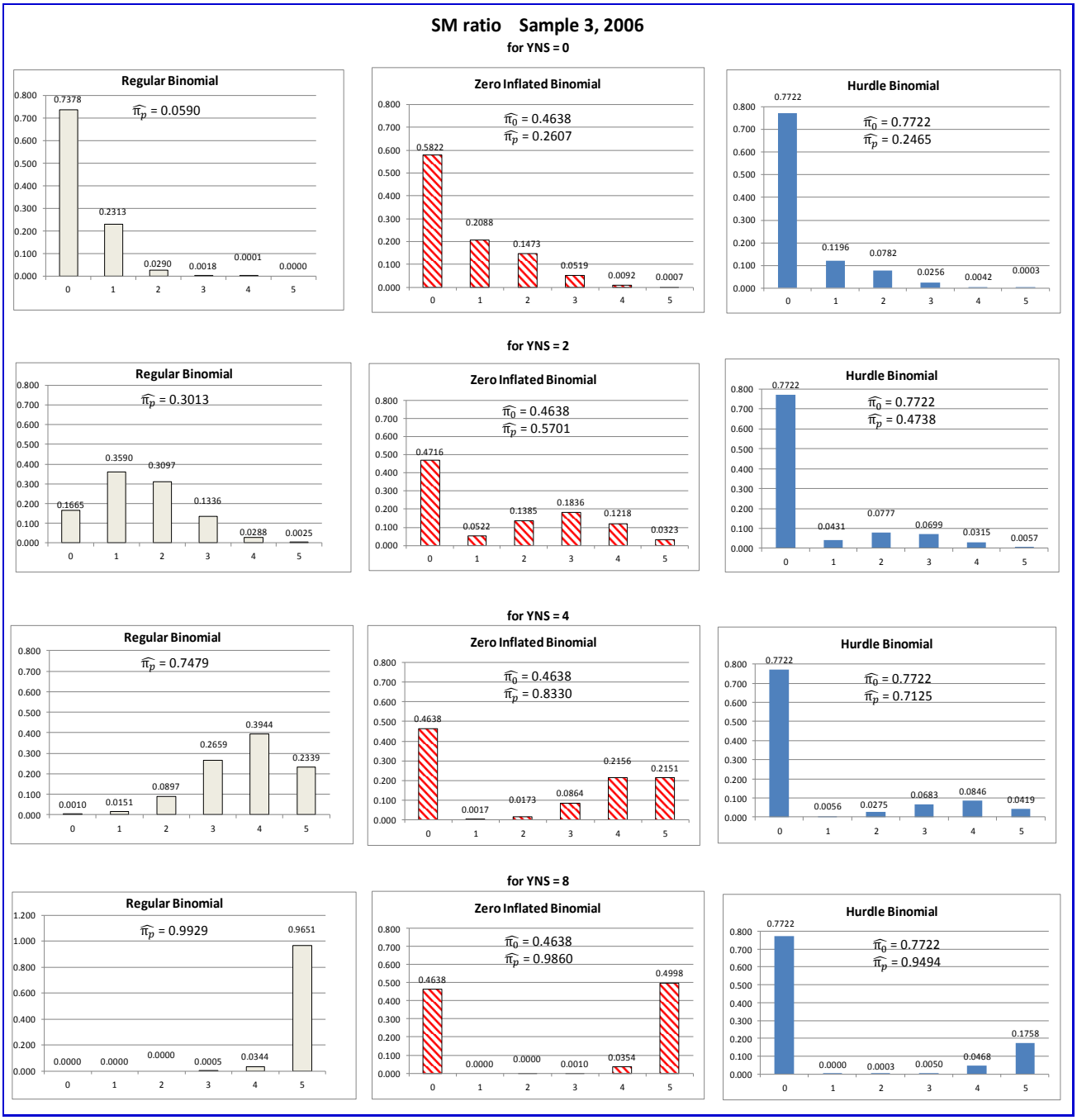

Figure 4.3 Estimated probabilities for ME ratio, Sample 3, 2005, YNS as predictor and denominator count=5

Calculated using following estimated regression coefficients:

Binomial	ZIB	BH
$\widehat{\beta_0}$ = -3.2173	$\widehat{\alpha_0}$ = -0.9145	$\widehat{\alpha_0}$ =1.4663
$\widehat{\beta_1}$ = 0.4415	$\widehat{\beta_0}$=-2.8900	$\widehat{\beta_0}$=-2.3000
	$\widehat{\beta_1}$=0.5171	$\widehat{\beta_1}$=-0.09429

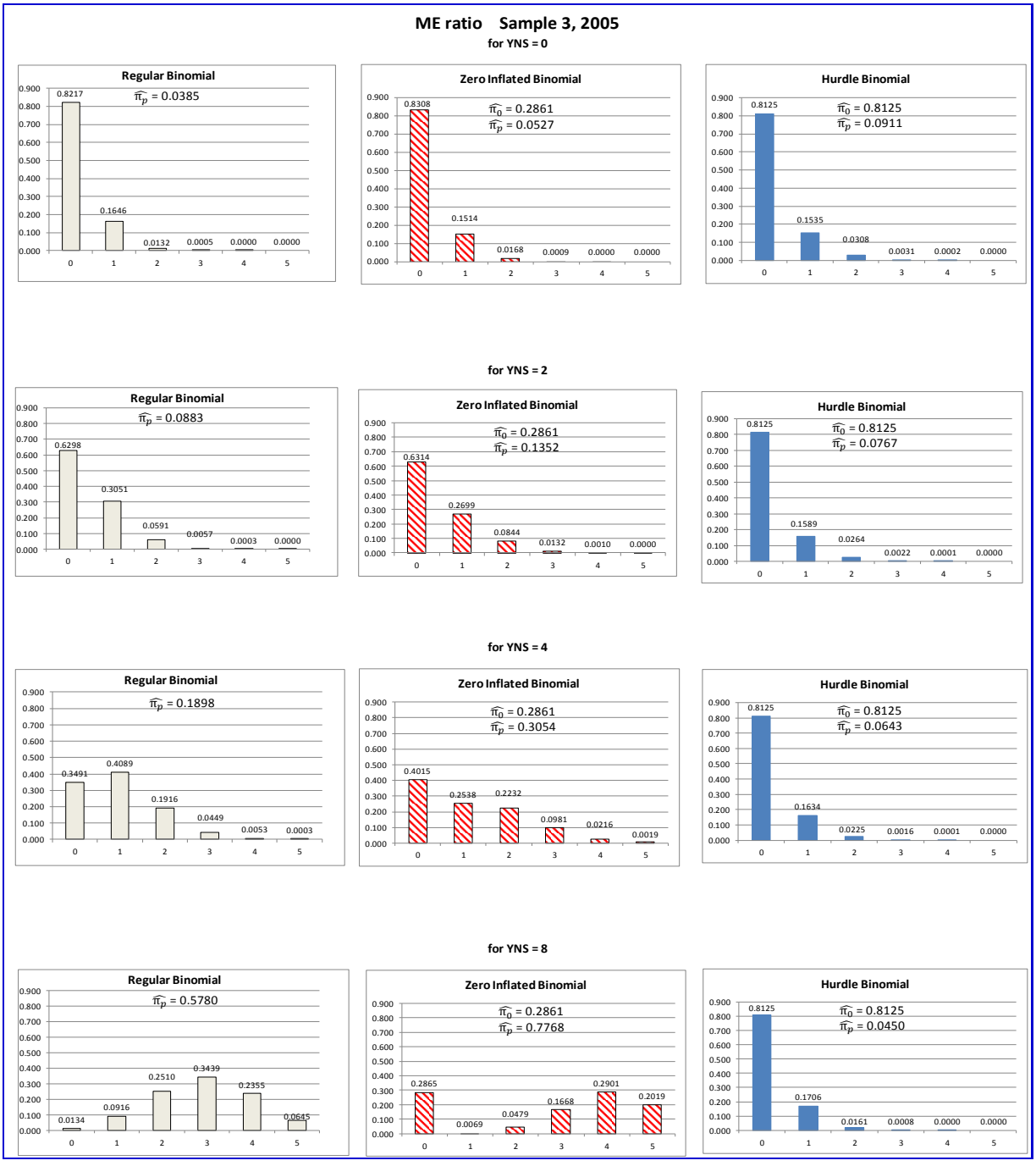

Figure 4.4 Estimated probabilities for ME ratio, Sample 3, 2006, YNS as predictor and denominator count=5

Calculated using following estimated regression coefficients:

Binomial	ZIB	BH
$\widehat{\beta_0}$ = -1.1520	$\widehat{\alpha_0}$ = -0.1571	$\widehat{\alpha_0}$ =0.1268
$\widehat{\beta_1}$ = -0.817	$\widehat{\beta_0}$=-0.6791	$\widehat{\beta_0}$=-0.6741
	$\widehat{\beta_1}$=-0.6675	$\widehat{\beta_1}$=-0.6255

Based on above graphs, we can generally say, that effect of zero-inflation was visible when estimated regression coefficient $\widehat{\alpha_0}$ was positive. For example for the SM ratio, Sample 3, 2005 (Figure 4.1), zero-inflation probability for ZIB model is not visible at all, because $\widehat{\alpha_0}$ = -19.31 makes the estimated zero-inflation probability $\widehat{\pi_0}$ as small as 4.0966E-9 and this does not change almost at all the ZIB estimated probabilities of zero count. Therefore for the SM ratio, Sample 3, 2005, the ZIB probabilities are almost mimicking the Binomial probabilities. When $\widehat{\alpha_0}$ was positive, then zero-inflation probability $\widehat{\pi_0}$ was greater than 0.5 and this would change both the probability of zero count and the probabilities of not-zero counts.

In the case of the BH models, where the probability of zero count is only equal to the zero-inflation probability $\widehat{\pi_0}$ and does not depend on the Binomial probability $\widehat{\pi_p}$, the probability of zero count is the same across all levels of predictor YNS. In other words, for the BH models, the value of probability of zero counts does depend only on value of estimated regression coefficient $\widehat{\alpha_0}$ and not on YNS level.

One interesting case is for the SM ratio, Sample 3, 2006 (Figure 4.2), where the estimated probabilities of zero counts were higher for Binomial distribution (0.7378) comparing to ZIB distribution (0.5822), when level of YNS count was 0. Generally we would anticipate that probability of zero count would be higher for ZIB than for Binomial distribution. And this is true when all the estimated regression coefficients are the same. But in this case the estimated regression coefficients for Binomial, ZIB and BH distributions are different, and therefore the estimated probabilities must differ. Because of that, it is very difficult to generally interpret those graphs, because too many things influence the estimated probabilities.

Based on the graphs, when the YNS count increases, the estimated probabilities of numerator zero-counts:

- increase for Binomial and ZIB (while constant for BH) for the SM ratio in 2005 and ME ratio in 2006 – this is what we would not expect based on the prior knowledge, that density of nutsedges in a field could be used as a predictor of SRKN nematodes.
- decrease for Binomial and ZIB (constant BH) for the SM ratio in 2006 and ME ratio in 2005 – this agrees with our prediction.

In comparison, when the YNS count increases, the estimated probabilities for higher numerator counts (i.e. count=4 or 5):

- decrease for all three distributions for the SM ratio in 2005 and ME ratio in 2006 – this is not expected,
- increase for all three distributions for the SM ratio in 2006 – expected pattern,
- slowly increase for Binomial and ZIB, while decrease for BH for the ME ratio in 2005.

Two ratios, SM in 2006 and ME in 2005, gave the results that agree with anticipated knowledge, that a higher density of YNS would attract higher number of nematodes due to mutual benefits and no or little zero counts would occur. In our data we sometimes see the departure from this prediction. The reason for that could be, that in this work we are using *ratios* of counts of many species of nematodes, not only SRKN, those of the most harmful for plants, whereas previous modeling looked at *count* of only SRKN. In addition, maybe other nematodes would not benefit as much from presence of nutsedge plants, as SRKN. So in some cases the YNS is good predictor of nematodes and in some cases is not. Also, it could be that YNS weeds exist in patches in the field and do not grow evenly.

Chapter 5 - SUMMARY

In summary, for the soil nematode community ratios, the Binomial pmf provided the best fit for 20 sample dates out of 32 (Table 4.2), ZIB was the best 10 cases while BH for only 2 cases. The dominant position of Binomial model may indicate lower zero-inflation than was anticipated based on previous research (Fiore 2004, Ou et al. 2008, Murray et al. 2012, Trojan et al. 2009). We showed that in many cases the ZIB and BH are as good as the Binomial, based on very small differences in AIC values, defined as $\Delta_i = AIC_i - AIC_{min.}$

The importance of YNS and PNS predictors varied over time and the different ratios, since for 11 sample dates YNS was the best predictor, for 9 sample dates the Full model with both YNS and PNS was the best, in 8 cases the intercept-only model was the best, and in 4 cases PNS was the best predictor.

And once again, it needs to be emphasized, that in this work *proportions* of nematode counts were fitted, not *counts* only, as was done in previous research (Fiore 2004, Ou et al. 2008, Murray et al. 2012, Trojan et al. 2009).

As mentioned earlier in this work, we discuss results based only on statistical model-fitting and not biological interpretations. Therefore the statistical results of this work should be interpreted by weed scientists and nematologists and probably they will be able to relate the above results to soil health and to examine the soil nematode community structure.

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Appendix A – SAS Code

Here is shown SAS code for only one ratio (HT ratio):

```
PROC IMPORT OUT= WORK.a
            DATAFILE= "E:\Research\Nematode.csv"
            DBMS=CSV REPLACE;
     GETNAMES=YES;
     DATAROW=2;
RUN;
data aa; set a;
Helicotylenchus = 0;          /* He herbivore, ectoparasite */
      if year = 2005 and sample = 1 or sample = 2 then Hemicycliophora = 0;
      run;

data aa; set aa ;
      yns2 = yns**2;
      pns2 = pns**2;
      ynspns = yns*pns;
      run;
data alla; set aa;
      H = sum
(Meloidogyne,Pratylenchus,Trichodorus,Tylenchorhynchus,Mesocriconema,Hemicycl
iophora,Helicotylenchus);
      if year = 2005 and sample = 1 or sample = 2 then O = Other;
      if year = 2005 and sample = 3 then O = sum
(Bacterial_Feeders,Aphelenchoid,Dorylaim,Entomopathogenic,Tylenchus,Monochoid
);
      if year = 2006 then O = sum
(Bacterial_Feeders,Aphelenchoid,Dorylaim,Entomopathogenic,Tylenchus,Monochoid
);
      E = sum
(Trichodorus,Tylenchorhynchus,Mesocriconema,Hemicycliophora,Helicotylenchus);

      FBdenom =  (Bacterial_Feeders + Aphelenchoid)/10 ;
      BHdenom =  (Bacterial_Feeders + H)/10;
      HTdenom =  (H + O)/10;
      SMdenom =  (Meloidogyne + Pratylenchus)/10;
      SEdenom =  (Meloidogyne + E)/10;
      MEdenom =  (Pratylenchus + E)/10;

      FBnum =  Aphelenchoid/10;
      BHnum =  Bacterial_Feeders/10;
      HTnum =  H/10;
      SMnum =  Meloidogyne/10;
      SEnum =  Meloidogyne/10;
      MEnum =  Pratylenchus/10;
      run;

data all; set alla;
if FBdenom = 0 then FBdenom=.;
if BHdenom = 0 then BHdenom=.;
if HTdenom = 0 then HTdenom=.;
if SMdenom = 0 then SMdenom=.;
if SEdenom = 0 then SEdenom=.;
```

```
if MEdenom = 0 then MEdenom=.;
run;

*********************************************;
*HT ratio                                    ;
* old name: OP ratio                         ;
*NLMIXED:                                    ;
*   Binomial distribution                    ;
*   LOG link                                 ;
*   Intercept only (b0)                      ;
*********************************************;
title 'Binomial - Intercept only Model - HT ratio';
proc nlmixed data=all;
by Year Sample;
      parms b0=0;
      * Ratio HT;
      num=HTnum;
      den=HTdenom;
      * Binomial;
      LinpredBin=b0;
      Pi_p = 1 / (1+ exp(-linpredBin));
      if num = 0 then
            ll = den*log(1-Pi_p);
            else ll =  num*log(Pi_P) + (den-num)*log(1-Pi_P) + lgamma(den+1)
- lgamma(num+1) - lgamma(den-num+1);
      model num ~ general(ll);
      run;

*********************************************;
*HT ratio                                    ;
*NLMIXED:                                    ;
*   Binomial distribution                    ;
*   LOG link                                 ;
*   YNS only (b0, b1)                        ;
*********************************************;
title 'Binomial - YNS only Model - HT ratio';
proc nlmixed data=all;
by Year Sample;
    *Set YNS;
      parms b0=0  b1=0;
      * Ratio HT;
      num=HTnum;
      den=HTdenom;
      * Binomial;
      LinpredBin=b0+b1*yns;
      Pi_p = 1 / (1+ exp(-linpredBin));
      if num = 0 then
            ll = den*log(1-Pi_p);
            else ll =  num*log(Pi_P) + (den-num)*log(1-Pi_P) + lgamma(den+1)
- lgamma(num+1) - lgamma(den-num+1);
      model num ~ general(ll);
      run;

*********************************************;
*HT ratio                                    ;
*NLMIXED:                                    ;
*   Binomial distribution                    ;
```

```
*   LOG link                                          ;
*   PNS only (b0, b2)                                 ;
*************************************************;
title 'Binomial - PNS only Model - HT ratio';
proc nlmixed data=all;
by Year Sample;
    *Set PNS;
      parms b0=0  b2=0;
      * Ratio HT;
      num=HTnum;
      den=HTdenom;
      * Binomial;
      LinpredBin=b0+b2*pns;
      Pi_p = 1 / (1+ exp(-linpredBin));
      if num = 0 then
            ll = den*log(1-Pi_p);
            else ll =  num*log(Pi_P) + (den-num)*log(1-Pi_P) + lgamma(den+1)
- lgamma(num+1) - lgamma(den-num+1);
      model num ~ general(ll);
      run;

*********************************************************;
*HT ratio                                                ;
*NLMIXED:                                                ;
*   Binomial distribution                                ;
*   LOG link                                             ;
*   Full model: YNS & PNS (b0, b1, b11, b2, b22, b12)    ;
*********************************************************;
title 'Binomial - Full Model - HT ratio';
proc nlmixed data=all;
by Year Sample;
    *Set FULL MODEL;
      parms b0=0   b1=0   b11=0
              b2=0   b22=0  b12=0;
      * Ratio HT;
      num=HTnum;
      den=HTdenom;
      * Binomial;
      LinpredBin=b0+b1*yns+b2*pns+b11*yns2+b22*pns2+b12*ynspns;
      Pi_p = 1 / (1+ exp(-linpredBin));
      if num = 0 then
            ll = den*log(1-Pi_p);
            else ll =  num*log(Pi_P) + (den-num)*log(1-Pi_P) + lgamma(den+1)
- lgamma(num+1) - lgamma(den-num+1);
      model num ~ general(ll);
      run;

*************************************************;
*HT RATIO                                         ;
*NLMIXED:                                         ;
*   ZIB distribution                              ;
*   LOG link                                      ;
*   Intercept only (a0, b0)                       ;
*************************************************;
title 'ZIB - Intercept only Model - HT ratio';
proc nlmixed data=all;
by Year Sample;
```

```
      parms a0 = 0
              b0 = 0;
      * Ratio HT;
      num=HTnum;
      den=HTdenom;
    * ZIB model: linear predictor for the inflation prob;
    LinpredZero=a0;
      Pi_0=1/(1+exp(-linpredZero));
      * Binomial;
      LinpredBin=b0;
      Pi_p = 1 / (1+ exp(-linpredBin));
      * Log-likelihood for ZIB;
      if num = 0 then
            ll = log(Pi_0 + (1-Pi_0)*((1-Pi_p)**den));
            else ll = log(1-Pi_0) + num*log(Pi_P) + (den-num)*log(1-Pi_P) +
lgamma(den+1) - lgamma(num+1) - lgamma(den-num+1);
      model num ~ general(ll);
      run;

*********************************************;
* HT ratio                                   ;
*NLMIXED:                                    ;
*   ZIB distribution                         ;
*   LOG link                                 ;
*   YNS only (a0, b0, b1)                    ;
*********************************************;
title 'ZIB - YNS only Model - HT ratio';
proc nlmixed data=all;
by Year Sample;
            parms a0 = 0
              b0 = 0  b1=0;
      * Ratio HT;
      num=HTnum;
      den=HTdenom;
    * ZIB model: linear predictor for the inflation prob;
    LinpredZero=a0;
      Pi_0=1/(1+exp(-linpredZero));
      * Binomial;
      LinpredBin=b0+b1*yns;
      Pi_p = 1 / (1+ exp(-linpredBin));
      * Log-likelihood for ZIB;
      if num = 0 then
            ll = log(Pi_0 + (1-Pi_0)*((1-Pi_p)**den));
            else ll = log(1-Pi_0) + num*log(Pi_P) + (den-num)*log(1-Pi_P) +
lgamma(den+1) - lgamma(num+1) - lgamma(den-num+1);
      model num ~ general(ll);
      run;

*********************************************;
*HT ratio                                   ;
* NLMIXED:                                  ;
*   ZIB distribution                         ;
*   LOG link                                 ;
*   PNS only  (a0, b0, b2)                   ;
*********************************************;
title 'ZIB - PNS only Model - HT ratio';
proc nlmixed data=all;
```

```
by Year Sample;
      parms a0 = 0
              b0 = 0  b2=0;
      * Ratio HT;
      num=HTnum;
      den=HTdenom;
    * ZIB model: linear predictor for the inflation prob;
    LinpredZero=a0;
      Pi_0=1/(1+exp(-linpredZero));
      * Binomial;
      LinpredBin=b0+b2*pns;
      Pi_p = 1 / (1+ exp(-linpredBin));
      * Log-likelihood for ZIB;
      if num = 0 then
            ll = log(Pi_0 + (1-Pi_0)*((1-Pi_p)**den));
            else ll = log(1-Pi_0) + num*log(Pi_P) + (den-num)*log(1-Pi_P) +
lgamma(den+1) - lgamma(num+1) - lgamma(den-num+1);
      model num ~ general(ll);
      run;

*************************************************************;
*HT ratio                                                   ;
* NLMIXED:                                                  ;
*   ZIB distribution                                        ;
*   LOG link                                                ;
*   Full model: YNS & PNS (a0, b0, b1, b11, b2, b22, b12)   ;
*************************************************************;
title 'ZIB - Full Model - HT ratio';
proc nlmixed data=all;
by Year Sample;
      parms a0=0
              b0=0   b1=0   b11=0
              b2=0   b22=0  b12=0;
      * Ratio HT;
      num=HTnum;
      den=HTdenom;
    * ZIB model: linear predictor for the inflation prob;
    LinpredZero=a0;
      Pi_0=1/(1+exp(-linpredZero));
      * Binomial;
      LinpredBin=b0+b1*yns+b2*pns+b11*yns2+b22*pns2+b12*ynspns;
      Pi_p = 1 / (1+ exp(-linpredBin));
      * Log-likelihood for ZIB;
      if num = 0 then
            ll = log(Pi_0 + (1-Pi_0)*((1-Pi_p)**den));
            else ll = log(1-Pi_0) + num*log(Pi_P) + (den-num)*log(1-Pi_P) +
lgamma(den+1) - lgamma(num+1) - lgamma(den-num+1);
      model num ~ general(ll);
      run;

*********************************************;
* HT ratio                                   ;
*NLMIXED:                                    ;
*   BH distribution                         ;
*   LOG link                                ;
*   Intercept only (a0, b0)                 ;
*********************************************;
```

```
title 'BH - Intercept only Model - HT ratio';
proc nlmixed data=all;
by Year Sample;
      parms a0 = 0
              b0 = 0;
      * Ratio HT;
      num=HTnum;
      den=HTdenom;
    * BH model: linear predictor for the inflation prob;
    LinpredZero=a0;
      Pi_0=1/(1+exp(-linpredZero));
      * Binomial;
      LinpredBin=b0;
      Pi_p = 1 / (1+ exp(-linpredBin));
      * Log-likelihood for Binomial Hurdle;
      if num = 0 then
            ll = log(Pi_0);
            else ll = log(1-Pi_0) + num*log(Pi_p) + (den-num)*log(1-Pi_p) +
lgamma(den+1)
                  - lgamma(num+1) - lgamma(den-num+1) - log(1-((1-
Pi_p)**den));
      model num ~ general(ll);
      run;

*********************************************;
*HT ratio                                    ;
*NLMIXED:                                    ;
*   BH distribution                          ;
*   LOG link                                 ;
*   YNS only (a0, b0, b1)                    ;
*********************************************;
title 'BH - YNS only Model - HT ratio';
proc nlmixed data=all;
by Year Sample;
      parms a0 = 0
              b0 = 0  b1=0;
      * Ratio HT;
      num=HTnum;
      den=HTdenom;
    * BH model: linear predictor for the inflation prob;
    LinpredZero=a0;
      Pi_0=1/(1+exp(-linpredZero));
      * Binomial;
      LinpredBin=b0+b1*yns;
      Pi_p = 1 / (1+ exp(-linpredBin));
      * Log-likelihood for Binomial Hurdle;
      if num = 0 then
            ll = log(Pi_0);
            else ll = log(1-Pi_0) + num*log(Pi_p) + (den-num)*log(1-Pi_p) +
lgamma(den+1)
                  - lgamma(num+1) - lgamma(den-num+1) - log(1-((1-
Pi_p)**den));
      model num ~ general(ll);
      run;

*********************************************;
*HT ratio                                    ;
```

```
*NLMIXED:                                          ;
*   BH distribution                                ;
*   LOG link                                       ;
*   PNS only (a0, b0, b2)                          ;
************************************************;
title 'BH - PNS only Model - HT ratio';
proc nlmixed data=all;
by Year Sample;
      parms a0 = 0
              b0 = 0  b2=0;
      * Ratio HT;
      num=HTnum;
      den=HTdenom;
    * BH model: linear predictor for the inflation prob;
    LinpredZero=a0;
      Pi_0=1/(1+exp(-linpredZero));
      * Binomial;
      LinpredBin=b0+b2*pns;
      Pi_p = 1 / (1+ exp(-linpredBin));
      * Log-likelihood for Binomial Hurdle;
      if num = 0 then
            ll = log(Pi_0);
            else ll = log(1-Pi_0) + num*log(Pi_p) + (den-num)*log(1-Pi_p) +
lgamma(den+1)
                  - lgamma(num+1) - lgamma(den-num+1) - log(1-((1-
Pi_p)**den));
      model num ~ general(ll);
      run;

************************************************************;
*HT ratio                                                  ;
*NLMIXED:                                                  ;
*   BH distribution                                        ;
*   LOG link                                               ;
*   Full model: YNS & PNS (a0, b0, b1, b11, b2, b22, b12)  ;
************************************************************;
title 'BH - Full Model - HT ratio';
proc nlmixed data=all;
by Year Sample;
      parms a0=0
              b0=0   b1=0   b11=0
              b2=0   b22=0  b12=0;
      * Ratio HT;
      num=HTnum;
      den=HTdenom;
    * BH model: linear predictor for the inflation prob;
    LinpredZero=a0;
      Pi_0=1/(1+exp(-linpredZero));
      * Binomial;
      LinpredBin=b0+b1*yns+b2*pns+b11*yns2+b22*pns2+b12*ynspns;
      Pi_p = 1 / (1+ exp(-linpredBin));
      * Log-likelihood for Binomial Hurdle;
      if num = 0 then
            ll = log(Pi_0);
            else ll = log(1-Pi_0) + num*log(Pi_p) + (den-num)*log(1-Pi_p) +
lgamma(den+1) - lgamma(num+1) - lgamma(den-num+1) - log(1-((1-Pi_p)**den));
      model num ~ general(ll);run;
```

Appendix B – Ratio summary tables for all samples

Appendix B contains all ratio summary tables for all available samples. Tables are listed according to trophic or herbivore feeding behavior in such order:

TROPHIC LEVEL RATIOS:

BH ratio – Sample 3, 2005
Sample 1, 2006
Sample 2, 2006
Sample 3, 2006

FB ratio – Sample 3, 2005
Sample 1, 2006
Sample 2, 2006
Sample 3, 2006

HT ratio – Sample 1, 2005
Sample 2, 2005
Sample 3, 2005
Sample 1, 2006
Sample 2, 2006
Sample 3, 2006

HERBIVORE FEEDING BEHAVIOR LEVEL RATIOS:

SM ratio – Sample 1, 2005
Sample 2, 2005
Sample 3, 2005
Sample 1, 2006
Sample 2, 2006
Sample 3, 2006

SE ratio – Sample 1, 2005
Sample 2, 2005
Sample 3, 2005
Sample 1, 2006
Sample 2, 2006
Sample 3, 2006

ME ratio – Sample 1, 2005
Sample 2, 2005
Sample 3, 2005
Sample 1, 2006
Sample 2, 2006
Sample 3, 2006

BH ratio – Sample 3, 2005

September 2005 (Sample=3)									Observations Used: 80 Observations Not Used: 0	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	0.9236	.	.	.	.	.	402.1
		st.error	.	0.06032	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-18.1344	0.9236	.	.	.	.	.	404.1
		st.error	968.92	0.06032	.	.	.	.	.	
		P value	0.9851	<.0001	.	.	.	.	.	
	BH	estimate	-18.1376	0.9235	.	.	.	.	.	404.1
		st.error	970.45	0.06033	.	.	.	.	.	
		P value	0.9851	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	1.025	-0.1441	.	.	.	.	398.3
		st.error	.	0.07441	0.05931	.	.	.	.	
		P value	.	<.0001	0.0174	.	.	.	.	
	ZIB	estimate	-18.7736	1.0249	-0.1441	.	.	.	.	400.3
		st.error	1333.82	0.07441	0.05931	.	.	.	.	
		P value	0.9888	<.0001	0.0174	.	.	.	.	
	BH	estimate	-20.3676	1.0249	-0.144	.	.	.	.	400.3
		st.error	2959.51	0.07442	0.05933	.	.	.	.	
		P value	0.9945	<.0001	0.0175	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	1.3017	.	.	-0.1548	.	.	370.4
		st.error	.	0.09189	.	.	0.02659	.	.	
		P value	.	<.0001	.	.	<.0001	.	.	
	ZIB	estimate	-19.0648	1.3017	.	.	-0.1548	.	.	372.4
		st.error	1542.83	0.09189	.	.	0.02659	.	.	
		P value	0.9902	<.0001	.	.	<.0001	.	.	
	BH	estimate	-19.5751	1.3018	.	.	-0.1549	.	.	372.4
		st.error	1991.26	0.0919	.	.	0.0266	.	.	
		P value	0.9922	<.0001	.	.	<.0001	.	.	
Full model	Binomial (NLMIXED)	estimate	.	1.3535	-0.2834	0.003873	-0.03223	-0.02417	0.05902	367.0
		st.error	.	0.1357	0.1931	0.05566	0.09149	0.01271	0.02712	
		P value	.	<.0001	0.1461	0.9447	0.7256	0.0607	0.0325	
	ZIB	estimate	-19.3303	1.3535	-0.2833	0.003862	-0.03223	-0.02417	0.05902	369.0
		st.error	1761.87	0.1357	0.1931	0.05566	0.09149	0.01271	0.02712	
		P value	0.9913	<.0001	0.1461	0.9449	0.7255	0.0607	0.0325	
	BH	estimate	-19.433	1.3535	-0.2833	0.003849	-0.03226	-0.02419	0.05906	369.0
		st.error	1854.72	0.1357	0.1931	0.05567	0.0915	0.01271	0.02712	
		P value	0.9917	<.0001	0.1462	0.9451	0.7254	0.0607	0.0324	

BH ratio – Sample 1, 2006

May 2006 (Sample=1)

Observations Used: 79
Observations Not Used: 1

Model			a0 (α0) Zero-Inflation	b0 (β0) Intercept only	b1 (β1) YNS	b11 (β11) YNS_2	b2 (β2) PNS	b22 (β22) PNS_2	b12 (β12) YNS*PNS	AIC Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-0.3609	.	.	.	.	.	346.9
		st.error	.	0.08462	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-3.587	-0.334	.	.	.	.	.	348.4
		st.error	1.5926	0.09268	.	.	.	.	.	
		P value	0.0271	0.0005	.	.	.	.	.	
	BH	estimate	-1.5506	-0.3149	.	.	.	.	.	358.7
		st.error	0.2942	0.09142	.	.	.	.	.	
		P value	<.0001	0.0009	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-0.328	-0.2844	.	.	.	.	346.6
		st.error	.	0.08726	0.1947	.	.	.	.	
		P value	.	0.0003	0.1481	.	.	.	.	
	ZIB	estimate	-3.3638	-0.2919	-0.3035	.	.	.	.	347.8
		st.error	1.2918	0.096	0.1959	.	.	.	.	
		P value	0.011	0.0032	0.1253	.	.	.	.	
	BH	estimate	-1.5506	-0.2699	-0.3523	.	.	.	.	357.4
		st.error	0.2942	0.09447	0.2039	.	.	.	.	
		P value	<.0001	0.0054	0.0879	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-0.3481	.	.	-0.5682	.	.	347.9
		st.error	.	0.08557	.	.	0.5978	.	.	
		P value	.	0.0001	.	.	0.3447	.	.	
	ZIB	estimate	-3.4937	-0.3178	.	.	-0.5985	.	.	349.3
		st.error	1.4586	0.09386	.	.	0.599	.	.	
		P value	0.0190	0.0011	.	.	0.3208	.	.	
	BH	estimate	-1.5506	-0.2985	.	.	-0.6311	.	.	359.6
		st.error	0.2942	0.09256	.	.	0.6138	.	.	
		P value	<.0001	0.0018	.	.	0.307	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-0.3234	2.867	-1.6273	-0.2964	-0.2964	0	349.5
		st.error	.	0.08852	1.6909	0.8623	0.2991	0.2991	0	
		P value	.	0.0005	0.0939	0.0628	0.3246	0.3246	.	Covariance Mtrx
	ZIB	estimate	-3.332	-0.285	2.8093	-1.6081	-0.3157	-0.3157	0	350.7
		st.error	1.2559	0.09764	1.6921	0.8626	0.2998	0.2998	0	
		P value	0.0096	0.0046	0.1008	0.066	0.2956	0.2956	.	Covariance Mtrx
	BH	estimate	-1.5506	-0.2589	2.3274	-1.3796	-0.3354	-0.3354	0	361.6
		st.error	0.2942	0.09595	1.7629	0.8986	0.3072	0.3072	0	
		P value	<.0001	0.0085	0.1905	0.1287	0.2782	0.2782	.	Covariance Mtrx

BH ratio – Sample 2, 2006

July 2006 (Sample=2)

Observations Used: 79
Observations Not Used: 0

Model			a0 (α0) Zero-Inflation	b0 (β0) Intercept only	b1 (β1) YNS	b11 (β11) YNS_2	b2 (β2) PNS	b22 (β22) PNS_2	b12 (β12) YNS*PNS	AIC Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	0.4238	.	.	.	.	.	638.5
		st.error	.	0.0401	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-18.032	0.4238	.	.	.	.	.	640.5
		st.error	926.35	0.0401	.	.	.	.	.	
		P value	0.9845	<.0001	.	.	.	.	.	
	BH	estimate	-18.0265	0.4237	.	.	.	.	.	640.4
		st.error	923.81	0.0401	.	.	.	.	.	
		P value	0.9845	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	0.3311	0.06224	.	.	.	.	632.5
		st.error	.	0.05168	0.02227	.	.	.	.	
		P value	.	<.0001	0.0065	.	.	.	.	
	ZIB	estimate	-19.2315	0.3311	0.06225	.	.	.	.	634.5
		st.error	1687.53	0.05168	0.02227	.	.	.	.	
		P value	0.9909	<.0001	0.0065	.	.	.	.	
	BH	estimate	-19.2529	0.331	0.06226	.	.	.	.	634.4
		st.error	1705.71	0.05169	0.02227	.	.	.	.	
		P value	0.991	<.0001	0.0065	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	0.3907	.	.	0.03891	.	.	638.0
		st.error	.	0.04537	.	.	0.02534	.	.	
		P value	.	<.0001	.	.	0.1286	.	.	
	ZIB	estimate	-18.3279	0.3907	.	.	0.03891	.	.	640.0
		st.error	1074.11	0.04537	.	.	0.02534	.	.	
		P value	0.9864	<.0001	.	.	0.1286	.	.	
	BH	estimate	-20.2681	0.3907	.	.	0.03891	.	.	640.0
		st.error	2833.65	0.04538	.	.	0.02534	.	.	
		P value	0.9943	<.0001	.	.	0.1286	.	.	
Full model	Binomial (NLMIXED)	estimate	.	0.2199	0.268	-0.0365	-0.02213	-0.00126	0.01813	619.3
		st.error	.	0.06278	0.05285	0.008702	0.05448	0.007895	0.01581	
		P value	.	0.0008	<.0001	<.0001	0.6856	0.8733	0.2548	
	ZIB	estimate	-16.2425	0.2201	0.268	-0.03651	-0.02224	-0.00127	0.01817	621.3
		st.error	378.63	0.06278	0.05285	0.008702	0.05448	0.007894	0.01581	
		P value	0.9659	0.0008	<.0001	<.0001	0.6843	0.8723	0.2538	
	BH	estimate	-16.7425	0.2198	0.2681	-0.03652	-0.0222	-0.00127	0.01816	621.3
		st.error	486.14	0.06279	0.05287	0.008706	0.05452	0.007896	0.01582	
		P value	0.9726	0.0008	<.0001	<.0001	0.685	0.8725	0.2544	

BH ratio – Sample 3, 2006

Septmeber 2006 (Sample=3)									Observations Used: 79 Observations Not Used: 0	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-0.2663	.	.	.	.	.	675.5
		st.error	.	0.03771	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-17.975	-0.2663	.	.	.	.	.	677.5
		st.error	900.36	0.03771	.	.	.	.	.	
		P value	0.9841	<.0001	.	.	.	.	.	
	BH	estimate	-17.9716	-0.2664	.	.	.	.	.	677.4
		st.error	898.83	0.03772	.	.	.	.	.	
		P value	0.9841	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-0.3137	0.05221	.	.	.	.	675.9
		st.error	.	0.05311	0.0411	.	.	.	.	
		P value	.	<.0001	0.2077	.	.	.	.	
	ZIB	estimate	-16.8976	-0.3137	0.0522	.	.	.	.	677.9
		st.error	525.36	0.05311	0.0411	.	.	.	.	
		P value	0.9744	<.0001	0.2077	.	.	.	.	
	BH	estimate	-16.8835	-0.3139	0.05224	.	.	.	.	677.8
		st.error	521.66	0.05312	0.04111	.	.	.	.	
		P value	0.9743	<.0001	0.2075	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-0.2306	.	.	-0.03731	.	.	675.8
		st.error	.	0.04669	.	.	0.02889	.	.	
		P value	.	<.0001	.	.	0.2002	.	.	
	ZIB	estimate	-20.3239	-0.2305	.	.	-0.03733	.	.	677.8
		st.error	2913.88	0.04669	.	.	0.02889	.	.	
		P value	0.9945	<.0001	.	.	0.2000	.	.	
	BH	estimate	-17.5912	-0.2307	.	.	-0.0373	.	.	677.7
		st.error	743.14	0.0467	.	.	0.02889	.	.	
		P value	0.9812	<.0001	.	.	0.2004	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-0.307	0.3813	-0.1177	-0.2016	0.03308	-0.00387	668.1
		st.error	.	0.0665	0.1159	0.0383	0.06464	0.01872	0.03899	
		P value	.	<.0001	0.0015	0.0029	0.0025	0.081	0.9213	
	ZIB	estimate	-19.6658	-0.307	0.3813	-0.1177	-0.2016	0.03309	-0.00389	670.1
		st.error	2096.8	0.0665	0.1159	0.0383	0.06464	0.01872	0.03899	
		P value	0.9925	<.0001	0.0015	0.0029	0.0025	0.0809	0.9208	
	BH	estimate	-18.6668	-0.3073	0.3816	-0.1178	-0.2018	0.0331	-0.00381	670
		st.error	1272.42	0.06652	0.116	0.03832	0.06467	0.01873	0.03902	
		P value	0.9883	<.0001	0.0015	0.0029	0.0025	0.081	0.9224	

FB ratio – Sample 3, 2005

September 2005 (Sample=3)									Observations Used: 80 Observations Not Used: 0	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-1.7384	.	.	.	.	.	297.9
		st.error	.	0.08317	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-2.1597	-1.6051	.	.	.	.	.	292.0
		st.error	0.5131	0.09198	.	.	.	.	.	
		P value	<.0001	<.0001	.	.	.	.	.	
	BH	estimate	-1.3099	-1.6171	.	.	.	.	.	295.7
		st.error	0.2733	0.09501	.	.	.	.	.	
		P value	<.0001	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-1.9229	0.2429	.	.	.	.	290.3
		st.error	.	0.1055	0.07608	.	.	.	.	
		P value	.	<.0001	0.002	.	.	.	.	
	ZIB	estimate	-2.3549	-1.7872	0.2079	.	.	.	.	287.2
		st.error	0.6122	0.1194	0.07824	.	.	.	.	
		P value	0.0002	<.0001	0.0095	.	.	.	.	
	BH	estimate	-1.3099	-1.7801	0.1963	.	.	.	.	292.4
		st.error	0.2733	0.1229	0.08298	.	.	.	.	
		P value	<.0001	<.0001	0.0204	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-1.7981	.	.	0.02804	.	.	299.4
		st.error	.	0.1199	.	.	0.03984	.	.	
		P value	.	<.0001	.	.	0.4836	.	.	
	ZIB	estimate	-2.1521	-1.5916	.	.	-0.0057	.	.	294.0
		st.error	0.5121	0.1352	.	.	0.04203	.	.	
		P value	<.0001	<.0001	.	.	0.8924	.	.	
	BH	estimate	-1.3099	-1.5801	.	.	-0.01634	.	.	297.6
		st.error	0.2733	0.1388	.	.	0.04541	.	.	
		P value	<.0001	<.0001	.	.	0.7199	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-2.0124	0.1209	0.045	0.1213	-0.01568	-0.00836	296.8
		st.error	.	0.1788	0.2482	0.06639	0.1302	0.01935	0.03944	
		P value	.	<.0001	0.6275	0.4998	0.3545	0.4202	0.8327	
	ZIB	estimate	-2.3422	-1.8087	0.1345	0.02828	0.06791	-0.01194	-0.00553	294.5
		st.error	0.6139	0.2	0.2616	0.06954	0.1366	0.02004	0.04003	
		P value	0.0003	<.0001	0.6084	0.6854	0.6204	0.5528	0.8904	
	BH	estimate	-1.3099	-1.7935	0.1533	0.0183	0.07554	-0.01563	-0.0047	299.5
		st.error	0.2733	0.2112	0.2779	0.07342	0.1505	0.02262	0.0435	
		P value	<.0001	<.0001	0.5827	0.8038	0.617	0.4915	0.9142	

FB ratio – Sample 1, 2006

May 2006 (Sample=1)									Observations Used: 69 Observations Not Used: 11	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-2.0023	.	.	.	.	.	114.7
		st.error	.	0.1883	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-12.1146	-2.0022	.	.	.	.	.	116.7
		st.error	1363.62	0.1885	.	.	.	.	.	
		P value	0.9929	<.0001	.	.	.	.	.	
	BH	estimate	0.9076	-1.8814	.	.	.	.	.	134.9
		st.error	0.247	0.3282	.	.	.	.	.	
		P value	0.0004	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-1.9459	-16.4913	.	.	.	.	113.3
		st.error	.	0.189	4509.24	.	.	.	.	
		P value	.	<.0001	0.9971	.	.	.	.	
	ZIB	estimate	-20.718	-1.9459	-17.5	.	.	.	.	115.3
		st.error	37092	0.189	7466.78	.	.	.	.	
		P value	0.9996	<.0001	0.9981	.	.	.	.	
	BH	estimate	0.9076	-1.8814	0	.	.	.	.	136.9
		st.error	0.247	0.3282	0	.	.	.	.	
		P value	0.0004	<.0001	.	.	.	.	.	Covariance Mtrx
PNS only	Binomial (NLMIXED)	estimate	.	-2.0498	.	.	1.3567	.	.	114.8
		st.error	.	0.194	.	.	0.8875	.	.	
		P value	.	<.0001	.	.	0.1309	.	.	
	ZIB	estimate	-16.009	-2.0498	.	.	1.3567	.	.	116.8
		st.error	2546.14	0.194	.	.	0.8875	.	.	
		P value	0.995	<.0001	.	.	0.1309	.	.	
	BH	estimate	0.9076	-1.953	.	.	1.0625	.	.	136.2
		st.error	0.247	0.3473	.	.	1.1044	.	.	
		P value	0.0004	<.0001	.	.	0.3389	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-1.9924	-6.7277	-8.2331	0.6496	0.6496	0	119.5
		st.error	.	0.1946	1073.54	1073.54	0.4438	0.4438	0	
		P value	.	<.0001	0.995	0.9939	0.1479	0.1479	.	Covariance Mtrx
	ZIB	estimate	-17.0155	-1.9924	-6.0423	-8.0437	0.6496	0.6496	0	121.5
		st.error	3536.35	0.1946	693.24	693.24	0.4438	0.4438	0	
		P value	0.9962	<.0001	0.9931	0.9908	0.1478	0.1478	.	Covariance Mtrx
	BH	estimate	0.9076	-1.9531	0	0	0.5312	0.5312	0	144.2
		st.error	0.247	0.3473	0	0	0.5522	0.5522	0	
		P value	0.0004	<.0001	.	.	0.3389	0.3389	.	Covariance Mtrx

FB ratio – Sample 2, 2006

July 2006 (Sample=2)									Observations Used: 79 Observations Not Used: 0	
Model			a0 (α0) Zero-Inflation	b0 (β0) Intercept only	b1 (β1) YNS	b11 (β11) YNS_2	b2 (β2) PNS	b22 (β22) PNS_2	b12 (β12) YNS*PNS	AIC Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-2.129	.	.	.	.	.	309.7
		st.error	.	0.07735	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-2.5473	-2.0654	.	.	.	.	.	309.3
		st.error	0.7884	0.0857	.	.	.	.	.	
		P value	0.0018	<.0001	.	.	.	.	.	
	BH	estimate	-1.0818	-2.035	.	.	.	.	.	325.2
		st.error	0.2587	0.08509	.	.	.	.	.	
		P value	<.0001	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-2.286	0.08951	.	.	.	.	306.7
		st.error	.	0.1062	0.03867	.	.	.	.	
		P value	.	<.0001	0.0232	.	.	.	.	
	ZIB	estimate	-2.5108	-2.256	0.1097	.	.	.	.	305.8
		st.error	0.7376	0.1202	0.04791	.	.	.	.	
		P value	0.001	<.0001	0.0247	.	.	.	.	
	BH	estimate	-1.0818	-2.2565	0.1207	.	.	.	.	320.6
		st.error	0.2587	0.1257	0.04583	.	.	.	.	
		P value	<.0001	<.0001	0.0102	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-2.1357	.	.	0.00737	.	.	311.7
		st.error	.	0.08733	.	.	0.04394	.	.	
		P value	.	<.0001	.	.	0.8672	.	.	
	ZIB	estimate	-2.5349	-2.0588	.	.	-0.00616	.	.	311.3
		st.error	0.7835	0.09824	.	.	0.04565	.	.	
		P value	0.0018	<.0001	.	.	0.893	.	.	
	BH	estimate	-1.0818	-2.0005	.	.	-0.04023	.	.	326.7
		st.error	0.2587	0.09654	.	.	0.05636	.	.	
		P value	<.0001	<.0001	.	.	0.4775	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-2.4682	0.3287	-0.03192	0.01301	0.01935	-0.05966	305.6
		st.error	.	0.1422	0.1205	0.01991	0.1001	0.0157	0.03376	
		P value	.	<.0001	0.0078	0.1129	0.8969	0.2215	0.0811	
	ZIB	estimate	-3.062	-2.4224	0.3538	-0.03651	-0.01782	0.02254	-0.06163	305.8
		st.error	1.0551	0.1541	0.1286	0.02109	0.1029	0.01628	0.03519	
		P value	0.0048	<.0001	0.0073	0.0873	0.8629	0.1702	0.0838	
	BH	estimate	-1.0818	-2.3218	0.3067	-0.03072	-0.07309	0.01526	-0.03592	325.9
		st.error	0.2587	0.1663	0.15	0.02474	0.1221	0.02109	0.0508	
		P value	<.0001	<.0001	0.0442	0.218	0.5511	0.4714	0.4816	

FB ratio – Sample 3, 2006

Septmeber 2006 (Sample=3)									Observations Used: 79 Observations Not Used: 0	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-2.2266	.	.	.	.	.	236.9
		st.error	.	0.09093	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-3.4131	-2.191	.	.	.	.	.	238.4
		st.error	1.6122	0.1029	.	.	.	.	.	
		P value	0.0374	<.0001	.	.	.	.	.	
	BH	estimate	-0.952	-2.2002	.	.	.	.	.	254.6
		st.error	0.251	0.1087	.	.	.	.	.	
		P value	0.0003	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-2.1543	-0.08058	.	.	.	.	238.3
		st.error	.	0.1282	0.1037	.	.	.	.	
		P value	.	<.0001	0.4395	.	.	.	.	
	ZIB	estimate	-3.3863	-2.1148	-0.08351	.	.	.	.	239.8
		st.error	1.5577	0.1387	0.1046	.	.	.	.	
		P value	0.0327	<.0001	0.427	.	.	.	.	
	BH	estimate	-0.952	-2.1441	-0.06427	.	.	.	.	256.3
		st.error	0.251	0.1541	0.1286	.	.	.	.	
		P value	0.0003	<.0001	0.6186	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-2.3266	.	.	0.09824	.	.	236.6
		st.error	.	0.1132	.	.	0.06149	.	.	
		P value	.	<.0001	.	.	0.1141	.	.	
	ZIB	estimate	-3.5223	-2.2949	.	.	0.09835	.	.	238.2
		st.error	1.7878	0.1245	.	.	0.06301	.	.	
		P value	0.0523	<.0001	.	.	0.1225	.	.	
	BH	estimate	-0.952	-2.3208	.	.	0.1119	.	.	254.2
		st.error	0.251	0.1364	.	.	0.06854	.	.	
		P value	0.0003	<.0001	.	.	0.1065	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-2.3231	-0.3968	0.119	0.4504	-0.05811	-0.0302	236.9
		st.error	.	0.1656	0.2841	0.0942	0.1588	0.04345	0.08716	
		P value	.	<.0001	0.1665	0.2104	0.0058	0.1849	0.7299	
	ZIB	estimate	-3.5857	-2.3147	-0.3672	0.1088	0.4667	-0.05809	-0.03437	238.5
		st.error	1.751	0.1713	0.2918	0.09871	0.1648	0.0434	0.08751	
		P value	0.0439	<.0001	0.2119	0.2735	0.0059	0.1846	0.6956	
	BH	estimate	-0.952	-2.4606	-0.2965	0.09727	0.6069	-0.07994	-0.04511	253.9
		st.error	0.251	0.2166	0.3663	0.1419	0.2012	0.05224	0.1108	
		P value	0.0003	<.0001	0.4206	0.495	0.0034	0.1299	0.6851	

HT ratio – Sample 1, 2005

May 2005 (Sample=1)

Observations Used: 80
Observations Not Used: 0

Model			a0 (α0) Zero-Inflation	b0 (β0) Intercept only	b1 (β1) YNS	b11 (β11) YNS_2	b2 (β2) PNS	b22 (β22) PNS_2	b12 (β12) YNS*PNS	AIC Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-0.8823	.	.	.	.	.	339.7
		st.error	.	0.06947	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-3.121	-0.8279	.	.	.	.	.	335.8
		st.error	0.7133	0.07232	.	.	.	.	.	
		P value	<.0001	<.0001	.	.	.	.	.	
	BH	estimate	-2.3445	-0.8342	.	.	.	.	.	334.5
		st.error	0.3957	0.07321	.	.	.	.	.	
		P value	<.0001	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-0.8817	-0.00383	.	.	.	.	341.7
		st.error	.	0.07316	0.1599	.	.	.	.	
		P value	.	<.0001	0.981	.	.	.	.	
	ZIB	estimate	-3.042	-0.8657	0.3549	.	.	.	.	334.4
		st.error	0.6641	0.07537	0.1887	.	.	.	.	
		P value	<.0001	<.0001	0.0637	.	.	.	.	
	BH	estimate	-2.3445	-0.8836	0.3985	.	.	.	.	332.0
		st.error	0.3957	0.07747	0.1851	.	.	.	.	
		P value	<.0001	<.0001	0.0344	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-0.9221	.	.	0.1614	.	.	339.7
		st.error	.	0.07548	.	.	0.1143	.	.	
		P value	.	<.0001	.	.	0.1618	.	.	
	ZIB	estimate	-3.1735	-0.8619	.	.	0.126	.	.	336.6
		st.error	0.7434	0.0792	.	.	0.1152	.	.	
		P value	<.0001	<.0001	.	.	0.2777	.	.	
	BH	estimate	-2.3445	-0.867	.	.	0.1214	.	.	335.4
		st.error	0.3957	0.08018	.	.	0.1163	.	.	
		P value	<.0001	<.0001	.	.	0.2998	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-0.9284	1.4176	-1.0786	-0.4316	0.3019	0.8141	338.6
		st.error	.	0.0802	0.5593	0.4008	0.6863	0.3549	0.4648	
		P value	.	<.0001	0.0132	0.0087	0.5312	0.3975	0.0837	
	ZIB	estimate	-3.0063	-0.9059	0.5868	0.1051	-0.1506	0.1558	-0.602	338.9
		st.error	0.6364	0.08272	0.735	0.6744	0.6793	0.3512	0.7448	
		P value	<.0001	<.0001	0.427	0.8766	0.8251	0.6585	0.4213	
	BH	estimate	-2.3445	-0.9277	0.673	0.07868	-0.2721	0.2214	-0.597	335.7
		st.error	0.3957	0.08571	0.7448	0.6903	0.7208	0.3711	0.7612	
		P value	<.0001	<.0001	0.3689	0.9095	0.7068	0.5525	0.4352	

HT ratio – Sample 2, 2005

July 2005 (Sample=2)										Observations Used: 80 Observations Not Used: 0
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-1.6025	.	.	.	.	.	274.5
		st.error	.	0.08239	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-3.9688	-1.5852	.	.	.	.	.	276.4
		st.error	2.5361	0.09146	.	.	.	.	.	
		P value	0.1216	<.0001	.	.	.	.	.	
	BH	estimate	-1.1664	-1.5446	.	.	.	.	.	298.8
		st.error	0.2627	0.09177	.	.	.	.	.	
		P value	<.0001	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-1.7105	0.02165	.	.	.	.	274.9
		st.error	.	0.12	0.01694	.	.	.	.	
		P value	.	<.0001	0.2048	.	.	.	.	
	ZIB	estimate	-5.5165	-1.7047	0.02124	.	.	.	.	276.9
		st.error	11.4621	0.1365	0.01757	.	.	.	.	
		P value	0.6316	<.0001	0.2303	.	.	.	.	
	BH	estimate	-1.1664	-1.5588	0.002699	.	.	.	.	300.8
		st.error	0.2627	0.1354	0.01883	.	.	.	.	
		P value	<.0001	<.0001	0.8864	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-1.6337	.	.	0.01604	.	.	276.3
		st.error	.	0.1018	.	.	0.03023	.	.	
		P value	.	<.0001	.	.	0.5972	.	.	
	ZIB	estimate	-3.9195	-1.6171	.	.	0.01697	.	.	278.0
		st.error	2.3658	0.1081	.	.	0.0303	.	.	
		P value	0.1015	<.0001	.	.	0.5771	.	.	
	BH	estimate	-1.1664	-1.5606	.	.	0.008438	.	.	300.8
		st.error	0.2627	0.1117	.	.	0.03306	.	.	
		P value	<.0001	<.0001	.	.	0.7992	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-1.8135	0.08235	-0.00495	-0.01283	-0.00278	0.009476	279.8
		st.error	.	0.1964	0.05099	0.003287	0.08968	0.00713	0.008005	
		P value	.	<.0001	0.1103	0.1364	0.8866	0.6977	0.24	
	ZIB	estimate	-4.3804	-1.808	0.08296	-0.00505	-0.00442	-0.00351	0.009486	281.7
		st.error	3.4216	0.2006	0.05138	0.003311	0.09427	0.007526	0.008011	
		P value	0.2042	<.0001	0.1103	0.1314	0.9628	0.6426	0.2399	
	BH	estimate	-1.1664	-1.6529	0.06066	-0.00486	-0.00535	-0.0053	0.01113	306.0
		st.error	0.2627	0.228	0.0571	0.003642	0.1026	0.008108	0.009273	
		P value	<.0001	<.0001	0.2912	0.1857	0.9585	0.5154	0.2334	

HT ratio – Sample 3, 2005

September 2005 (Sample=3)									Observations Used: 80 Observations Not Used: 0	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-1.3397	.	.	.	.	.	414.1
		st.error	.	0.05733	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-17.9103	-1.3396	.	.	.	.	.	416.1
		st.error	1127.46	0.05733	.	.	.	.	.	
		P value	0.9874	<.0001	.	.	.	.	.	
	BH	estimate	-4.3694	-1.3464	.	.	.	.	.	415.7
		st.error	1.0063	0.05876	.	.	.	.	.	
		P value	<.0001	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-1.4134	0.1019	.	.	.	.	412.8
		st.error	.	0.0708	0.05502	.	.	.	.	
		P value	.	<.0001	0.0677	.	.	.	.	
	ZIB	estimate	-20.1687	-1.4134	0.1019	.	.	.	.	414.8
		st.error	3267.99	0.0708	0.05502	.	.	.	.	
		P value	0.9951	<.0001	0.0677	.	.	.	.	
	BH	estimate	-4.3694	-1.4195	0.09961	.	.	.	.	414.7
		st.error	1.0063	0.07292	0.05609	.	.	.	.	
		P value	<.0001	<.0001	0.0796	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-1.7425	.	.	0.1659	.	.	374.4
		st.error	.	0.08866	.	.	0.02541	.	.	
		P value	.	<.0001	.	.	<.0001	.	.	
	ZIB	estimate	-19.8703	-1.7425	.	.	0.1659	.	.	376.4
		st.error	2489.66	0.08866	.	.	0.02541	.	.	
		P value	0.9937	<.0001	.	.	<.0001	.	.	
	BH	estimate	-4.3694	-1.7694	.	.	0.1695	.	.	376.1
		st.error	1.0063	0.09329	.	.	0.02607	.	.	
		P value	<.0001	<.0001	.	.	<.0001	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-1.7148	0.2485	-0.01782	-0.00811	0.03018	-0.04569	371.7
		st.error	.	0.1304	0.1848	0.05162	0.08719	0.01199	0.02555	
		P value	.	<.0001	0.1825	0.7309	0.9261	0.0139	0.0775	
	ZIB	estimate	-18.6044	-1.7148	0.2485	-0.01783	-0.00811	0.03018	-0.0457	373.7
		st.error	1329.07	0.1304	0.1848	0.05162	0.08719	0.01199	0.02555	
		P value	0.9889	<.0001	0.1824	0.7306	0.9261	0.0139	0.0775	
	BH	estimate	-4.3694	-1.7325	0.2519	-0.01748	-0.01861	0.03222	-0.04652	372.7
		st.error	1.0063	0.1397	0.1924	0.05332	0.09065	0.01232	0.02603	
		P value	<.0001	<.0001	0.1942	0.7439	0.8378	0.0107	0.0777	

HT ratio – Sample 1, 2006

May 2006 (Sample=1)									Observations Used: 79 Observations Not Used: 1	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-0.2847	.	.	.	.	.	382.4
		st.error	.	0.07179	.	.	.	.	.	
		P value	.	0.0002	.	.	.	.	.	
	ZIB	estimate	-2.6707	-0.2303	.	.	.	.	.	380.2
		st.error	0.6721	0.07603	.	.	.	.	.	
		P value	0.0002	0.0033	.	.	.	.	.	
	BH	estimate	-1.5506	-0.1929	.	.	.	.	.	398.7
		st.error	0.2942	0.07501	.	.	.	.	.	
		P value	<.0001	0.012	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-0.3339	0.5062	.	.	.	.	375.9
		st.error	.	0.07399	0.1795	.	.	.	.	
		P value	.	<.0001	0.0061	.	.	.	.	
	ZIB	estimate	-2.6912	-0.2805	0.5000	.	.	.	.	374.2
		st.error	0.6926	0.07843	0.1835	.	.	.	.	
		P value	0.0002	0.0006	0.0079	.	.	.	.	
	BH	estimate	-1.5506	-0.244	0.5104	.	.	.	.	392.5
		st.error	0.2942	0.07739	0.1848	.	.	.	.	
		P value	<.0001	0.0023	0.0071	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-0.2967	.	.	0.5199	.	.	383.2
		st.error	.	0.07268	.	.	0.4799	.	.	
		P value	.	0.0001	.	.	0.2819	.	.	
	ZIB	estimate	-2.6933	-0.2424	.	.	0.4655	.	.	381.2
		st.error	0.6856	0.07711	.	.	0.4806	.	.	
		P value	0.0002	0.0024	.	.	0.3357	.	.	
	BH	estimate	-1.5506	-0.2037	.	.	0.4268	.	.	399.9
		st.error	0.2942	0.07603	.	.	0.4804	.	.	
		P value	<.0001	0.009	.	.	0.377	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-0.3398	-2.4336	1.5206	0.2814	0.2814	0	378.4
		st.error	.	0.07504	1.6185	0.8244	0.2401	0.2401	0	
		P value	.	<.0001	0.1367	0.0689	0.2447	0.2447	.	Covariance Mtrx
	ZIB	estimate	-2.8622	-0.2913	-2.4083	1.4958	0.2572	0.2572	0	377.5
		st.error	0.7768	0.0798	1.6535	0.8417	0.2405	0.2405	0	
		P value	0.0004	0.0005	0.1492	0.0794	0.2881	0.2881	.	Covariance Mtrx
	BH	estimate	-1.5506	-0.2525	-1.8401	1.202	0.2378	0.2378	0	397.9
		st.error	0.2942	0.07858	2.1084	1.0658	0.2404	0.2404	0	
		P value	<.0001	0.0019	0.3854	0.2628	0.3255	0.3255	.	Covariance Mtrx

HT ratio – Sample 2, 2006

July 2006 (Sample=2)

Observations Used: 79
Observations Not Used: 0

Model			a0 (α0) Zero-Inflation	b0 (β0) Intercept only	b1 (β1) YNS	b11 (β11) YNS_2	b2 (β2) PNS	b22 (β22) PNS_2	b12 (β12) YNS*PNS	AIC Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-0.9296	.	.	.	.	.	645.1
		st.error	.	0.03682	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-20.5603	-0.9295	.	.	.	.	.	647.1
		st.error	3279.44	0.03682	.	.	.	.	.	
		P value	0.995	<.0001	.	.	.	.	.	
	BH	estimate	-18.3279	-0.9304	.	.	.	.	.	646.8
		st.error	1074.1	0.03687	.	.	.	.	.	
		P value	0.9864	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-0.8045	-0.08244	.	.	.	.	630.9
		st.error	.	0.04788	0.02101	.	.	.	.	
		P value	.	<.0001	0.0002	.	.	.	.	
	ZIB	estimate	-18.1257	-0.8045	-0.08244	.	.	.	.	632.9
		st.error	970.83	0.04788	0.02101	.	.	.	.	
		P value	0.9852	<.0001	0.0002	.	.	.	.	
	BH	estimate	-18.6707	-0.8051	-0.08254	.	.	.	.	632.6
		st.error	1274.89	0.04794	0.02106	.	.	.	.	
		P value	0.9884	<.0001	0.0002	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-0.8883	.	.	-0.04806	.	.	642.9
		st.error	.	0.04194	.	.	0.02415	.	.	
		P value	.	<.0001	.	.	0.0500	.	.	
	ZIB	estimate	-19.6886	-0.8883	.	.	-0.04807	.	.	644.9
		st.error	2120.86	0.04194	.	.	0.02415	.	.	
		P value	0.9926	<.0001	.	.	0.0500	.	.	
	BH	estimate	-18.4863	-0.8888	.	.	-0.04858	.	.	644.6
		st.error	1162.61	0.04201	.	.	0.02435	.	.	
		P value	0.9874	<.0001	.	.	0.0495	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-0.6698	-0.2904	0.0366	-0.02845	0.005007	-0.01238	612.3
		st.error	.	0.05739	0.04765	0.007854	0.04972	0.007347	0.01406	
		P value	.	<.0001	<.0001	<.0001	0.5688	0.4975	0.3813	
	ZIB	estimate	-17.3632	-0.6698	-0.2904	0.0366	-0.02844	0.005009	-0.01238	614.3
		st.error	663.08	0.05739	0.04765	0.007854	0.04972	0.007347	0.01406	
		P value	0.9792	<.0001	<.0001	<.0001	0.569	0.4974	0.3811	
	BH	estimate	-16.9908	-0.6701	-0.2914	0.03678	-0.02841	0.004999	-0.01255	613.8
		st.error	550.4	0.05744	0.04773	0.007869	0.05007	0.007426	0.01409	
		P value	0.9755	<.0001	<.0001	<.0001	0.5721	0.5028	0.3754	

HT ratio – Sample 3, 2006

Septmeber 2006 (Sample=3)

Observations Used: 79
Observations Not Used: 0

Model			a0 (α0) Zero-Inflation	b0 (β0) Intercept only	b1 (β1) YNS	b11 (β11) YNS_2	b2 (β2) PNS	b22 (β22) PNS_2	b12 (β12) YNS*PNS	AIC Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-0.2319	.	.	.	.	.	692.7
		st.error	.	0.03326	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-18.3229	-0.2319	.	.	.	.	.	694.7
		st.error	1071.43	0.03326	.	.	.	.	.	
		P value	0.9864	<.0001	.	.	.	.	.	
	BH	estimate	-18.3235	-0.2319	.	.	.	.	.	694.7
		st.error	1071.73	0.03326	.	.	.	.	.	
		P value	0.9864	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-0.1762	-0.06107	.	.	.	.	691.9
		st.error	.	0.04679	0.03625	.	.	.	.	
		P value	.	0.0003	0.096	.	.	.	.	
	ZIB	estimate	-17.2931	-0.1762	-0.06114	.	.	.	.	693.9
		st.error	640.24	0.04679	0.03625	.	.	.	.	
		P value	0.9785	0.0003	0.0956	.	.	.	.	
	BH	estimate	-17.3104	-0.1762	-0.06114	.	.	.	.	693.9
		st.error	645.79	0.04679	0.03625	.	.	.	.	
		P value	0.9787	0.0003	0.0956	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-0.2187	.	.	-0.01318	.	.	694.4
		st.error	.	0.0414	.	.	0.02465	.	.	
		P value	.	<.0001	.	.	0.5943	.	.	
	ZIB	estimate	-16.5863	-0.2186	.	.	-0.01318	.	.	696.4
		st.error	449.63	0.0414	.	.	0.02465	.	.	
		P value	0.9707	<.0001	.	.	0.5942	.	.	
	BH	estimate	-16.6788	-0.2187	.	.	-0.01318	.	.	696.4
		st.error	470.9	0.04141	.	.	0.02465	.	.	
		P value	0.9718	<.0001	.	.	0.5944	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-0.1439	-0.3078	0.08617	0.09595	-0.0322	0.03268	691.3
		st.error	.	0.05898	0.1023	0.03355	0.05598	0.01646	0.03369	
		P value	.	0.0169	0.0035	0.0121	0.0904	0.054	0.335	
	ZIB	estimate	-19.9003	-0.1439	-0.3078	0.08617	0.09595	-0.0322	0.03269	693.3
		st.error	2357.69	0.05898	0.1023	0.03355	0.05598	0.01646	0.03369	
		P value	0.9933	0.0169	0.0035	0.0121	0.0904	0.054	0.3349	
	BH	estimate	-16.5607	-0.144	-0.3079	0.08617	0.09599	-0.0322	0.03268	693.3
		st.error	443.92	0.05898	0.1023	0.03355	0.05598	0.01646	0.0337	
		P value	0.9703	0.0169	0.0035	0.0121	0.0903	0.054	0.3351	

SM ratio – Sample 1, 2005

May 2005 (Sample=1)									Observations Used: 62 Observations Not Used: 18	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	2.0857	.	.	.	.	.	95.6
		st.error	.	0.2371	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-18.9772	2.0856	.	.	.	.	.	97.6
		st.error	2237.31	0.2371	.	.	.	.	.	
		P value	0.9933	<.0001	.	.	.	.	.	
	BH	estimate	-1.033	2.1268	.	.	.	.	.	172.5
		st.error	0.2541	0.2594	.	.	.	.	.	
		P value	0.0001	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	2.1366	-0.3063	.	.	.	.	97.3
		st.error	.	0.2548	0.4878	.	.	.	.	
		P value	.	<.0001	0.5324	.	.	.	.	
	ZIB	estimate	-17.9101	2.1367	-0.3064	.	.	.	.	99.3
		st.error	1336.78	0.2548	0.4878	.	.	.	.	
		P value	0.9894	<.0001	0.5322	.	.	.	.	
	BH	estimate	-1.033	2.1999	-0.3862	.	.	.	.	174.0
		st.error	0.2541	0.2819	0.4928	.	.	.	.	
		P value	0.0001	<.0001	0.4355	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	1.9112	.	.	1.2628	.	.	93.5
		st.error	.	0.2439	.	.	0.8736	.	.	
		P value	.	<.0001	.	.	0.1534	.	.	
	ZIB	estimate	-18.9002	1.9111	.	.	1.2629	.	.	95.5
		st.error	2042.48	0.2439	.	.	0.8736	.	.	
		P value	0.9926	<.0001	.	.	0.1533	.	.	
	BH	estimate	-1.033	1.9364	.	.	1.2104	.	.	170.9
		st.error	0.2541	0.2685	.	.	0.8691	.	.	
		P value	0.0001	<.0001	.	.	0.1676	.	.	
Full model	Binomial (NLMIXED)	estimate	.	2.0715	-6.428	5.3678	-4.1001	4.1069	13.0215	97.4
		st.error	.	0	0	0	0	0	0	
		P value	.	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	Covariance Mtrx
	ZIB	estimate	-33.1949	2.0713	-6.4129	5.3531	-4.5421	4.5512	13.0349	99.4
		st.error	2722288	0	0	0	0	0	0	
		P value	1	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	Covariance Mtrx
	BH	estimate	-1.0327	2.1439	-6.9627	5.7849	-4.6592	4.5425	12.7477	174.5
		st.error	0.2541	0	0	0	0	0	0	
		P value	0.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	Covariance Mtrx

SM ratio – Sample 2, 2005

July 2005 (Sample=2)

Observations Used: 43
Observations Not Used: 37

Model			a0 (α0) Zero-Inflation	b0 (β0) Intercept only	b1 (β1) YNS	b11 (β11) YNS_2	b2 (β2) PNS	b22 (β22) PNS_2	b12 (β12) YNS*PNS	AIC Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	2.1212	.	.	.	.	.	45.2
		st.error	.	0.3567	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-19.418	2.1212	.	.	.	.	.	47.2
		st.error	3129.4	0.3567	.	.	.	.	.	
		P value	0.9951	<.0001	.	.	.	.	.	
	BH	estimate	-0.05001	1.9968	.	.	.	.	.	145.2
		st.error	0.2237	0.4107	.	.	.	.	.	
		P value	0.8237	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	2.2979	-0.02948	.	.	.	.	47.1
		st.error	.	0.6034	0.07814	.	.	.	.	
		P value	.	0.0004	0.7078	.	.	.	.	
	ZIB	estimate	-21.1993	2.298	-0.02951	.	.	.	.	49.1
		st.error	7679.32	0.6034	0.07814	.	.	.	.	
		P value	0.9978	0.0004	0.7075	.	.	.	.	
	BH	estimate	-0.05001	2.1017	-0.016	.	.	.	.	147.2
		st.error	0.2237	0.735	0.0915	.	.	.	.	
		P value	0.8237	0.0054	0.8616	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	1.9647	.	.	0.07549	.	.	46.9
		st.error	.	0.4314	.	.	0.1324	.	.	
		P value	.	<.0001	.	.	0.5714	.	.	
	ZIB	estimate	-22.0615	1.9647	.	.	0.07548	.	.	48.9
		st.error	11482	0.4314	.	.	0.1324	.	.	
		P value	0.9985	<.0001	.	.	0.5715	.	.	
	BH	estimate	-0.05001	1.831	.	.	0.07064	.	.	146.9
		st.error	0.2237	0.4992	.	.	0.1348	.	.	
		P value	0.8237	0.0004	.	.	0.6016	.	.	
Full model	Binomial (NLMIXED)	estimate	.	2.7976	-0.2527	0.01321	-0.09374	0.004201	0.02505	54.2
		st.error	.	1.2076	0.3146	0.01811	0.455	0.04601	0.05875	
		P value	.	0.0254	0.4262	0.4695	0.8377	0.9277	0.6719	
	ZIB	estimate	-21.4216	2.7976	-0.2527	0.01321	-0.09371	0.004202	0.02504	56.2
		st.error	0	1.2076	0.3146	0.01811	0.455	0.04601	0.05875	
		P value	<.0001	0.0254	0.4262	0.4695	0.8378	0.9276	0.672	Covariance Mtrx
	BH	estimate	-0.05001	2.3793	-0.1367	0.006227	-0.1501	0.006705	0.02972	154.6
		st.error	0.2237	1.4171	0.3757	0.02075	0.5079	0.05152	0.06273	
		P value	0.8237	0.097	0.717	0.7648	0.7683	0.8968	0.6369	

SM ratio – Sample 3, 2005

September 2005 (Sample=3)									Observations Used: 42 Observations Not Used: 38	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	1.1499	.	.	.	.	.	64.9
		st.error	.	0.2632	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-18.6751	1.1499	.	.	.	.	.	66.9
		st.error	3842.11	0.2632	.	.	.	.	.	
		P value	0.9961	<.0001	.	.	.	.	.	
	BH	estimate	0.3023	1.2295	.	.	.	.	.	141.7
		st.error	0.2262	0.3548	.	.	.	.	.	
		P value	0.1852	0.0009	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	1.4714	-0.297	.	.	.	.	65.0
		st.error	.	0.3664	0.2119	.	.	.	.	
		P value	.	0.0002	0.1685	.	.	.	.	
	ZIB	estimate	-19.3131	1.4714	-0.297	.	.	.	.	67.0
		st.error	5336.82	0.3664	0.2119	.	.	.	.	
		P value	0.9971	0.0002	0.1684	.	.	.	.	
	BH	estimate	0.3023	1.4126	-0.1536	.	.	.	.	143.4
		st.error	0.2262	0.5091	0.2942	.	.	.	.	
		P value	0.1852	0.0069	0.603	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	1.4575	.	.	-0.1151	.	.	65.7
		st.error	.	0.3948	.	.	0.1028	.	.	
		P value	.	0.0006	.	.	0.269	.	.	
	ZIB	estimate	-16.7897	1.4574	.	.	-0.1151	.	.	67.7
		st.error	2686.71	0.3948	.	.	0.1028	.	.	
		P value	0.995	0.0006	.	.	0.269	.	.	
	BH	estimate	0.3023	2.3533	.	.	-0.3286	.	.	137.3
		st.error	0.2262	0.6561	.	.	0.137	.	.	
		P value	0.1852	0.0006	.	.	0.0188	.	.	
Full model	Binomial (NLMIXED)	estimate	.	1.4826	0.575	-0.309	0.1866	-0.04297	-0.00706	69.1
		st.error	.	0.6394	0.8347	0.2432	0.4077	0.0521	0.1047	
		P value	.	0.0254	0.4947	0.211	0.6495	0.4142	0.9465	
	ZIB	estimate	-14.9896	1.4827	0.5748	-0.3089	0.1866	-0.04296	-0.00706	71.1
		st.error	4164.99	0.6395	0.8347	0.2432	0.4077	0.0521	0.1047	
		P value	0.9971	0.0254	0.4948	0.211	0.6496	0.4142	0.9465	
	BH	estimate	0.3023	3.9529	-1.1562	0.4377	-0.9511	0.06511	-0.2459	140.0
		st.error	0.2262	2.2797	2.291	0.6726	1.2352	0.1404	0.427	
		P value	0.1852	0.0868	0.6152	0.517	0.4436	0.644	0.5663	

SM ratio – Sample 1, 2006

May 2006 (Sample=1)									Observations Used: 45 Observations Not Used: 35	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-0.07146	.	.	.	.	.	138.9
		st.error	.	0.1891	.	.	.	.	.	
		P value	.	0.7073	.	.	.	.	.	
	ZIB	estimate	-1.9025	0.2628	.	.	.	.	.	135.3
		st.error	0.7051	0.2419	.	.	.	.	.	
		P value	0.0098	0.283	.	.	.	.	.	
	BH	estimate	0.4578	0.07499	.	.	.	.	.	182.9
		st.error	0.2295	0.2698	.	.	.	.	.	
		P value	0.0494	0.7818	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-0.1389	0.8672	.	.	.	.	138.3
		st.error	.	0.1944	0.621	.	.	.	.	
		P value	.	0.4786	0.1694	.	.	.	.	
	ZIB	estimate	-1.7431	0.2244	2.9314	.	.	.	.	134.3
		st.error	0.6107	0.2421	20.7719	.	.	.	.	
		P value	0.0065	0.359	0.8884	.	.	.	.	
	BH	estimate	0.4578	-0.01998	8.122	.	.	.	.	181.1
		st.error	0.2295	0.2766	962.51	.	.	.	.	
		P value	0.0495	0.9426	0.9933	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-0.09018	.	.	15.3554	.	.	139.4
		st.error	.	0.19	.	.	2064.42	.	.	
		P value	.	0.6374	.	.	0.9941	.	.	
	ZIB	estimate	-1.9317	0.2372	.	.	14.9128	.	.	136.2
		st.error	0.7206	0.243	.	.	1948.84	.	.	
		P value	0.0102	0.3343	.	.	0.9939	.	.	
	BH	estimate	0.4578	0.07499	.	.	0	.	.	184.9
		st.error	0.2295	0.2698	.	.	0	.	.	
		P value	0.0494	0.7818	.	.	.	.	.	Covariance Mtrx
Full model	Binomial (NLMIXED)	estimate	.	-0.1336	-38.3754	23.9747	18.4344	18.4344	0	138.8
		st.error	.	0.1956	3927.22	3513.59	0.000171	0	0	
		P value	.	0.498	0.9922	0.9946	<.0001	<.0001	.	Covariance Mtrx
	ZIB	estimate	-2.1637	0.1528	-17.872	10.6336	18.292	18.292	0	136.9
		st.error	0.03217	.	52.2814	27.0573	0	0	0	
		P value	<.0001	.	0.7341	0.6962	<.0001	<.0001	.	Covariance Mtrx
	BH	estimate	0.458	-0.01994	1.8695	3.739	-1.71E-15	-1.71E-15	0	189.1
		st.error	0.2295	0.2766	655.67	1311.34	0	0	0	
		P value	0.0494	0.9427	0.9977	0.9977	<.0001	<.0001	.	Covariance Mtrx

SM ratio – Sample 2, 2006

July 2006 (Sample=2)									Observations Used: 45 Observations Not Used: 34	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-2.179	.	.	.	.	.	207.0
		st.error	.	0.1609	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-2.2258	-1.9391	.	.	.	.	.	204.6
		st.error	0.7741	0.1835	.	.	.	.	.	
		P value	0.0061	<.0001	.	.	.	.	.	
	BH	estimate	0.5447	-2.5168	.	.	.	.	.	200.2
		st.error	0.2334	0.2525	.	.	.	.	.	
		P value	0.0222	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-2.4815	0.2958	.	.	.	.	200.9
		st.error	.	0.2027	0.097	.	.	.	.	
		P value	.	<.0001	0.0038	.	.	.	.	
	ZIB	estimate	-1.9507	-2.2861	0.3782	.	.	.	.	197.6
		st.error	0.6734	0.2275	0.1236	.	.	.	.	
		P value	0.0058	<.0001	0.0037	.	.	.	.	
	BH	estimate	0.5447	-2.8369	0.3814	.	.	.	.	197.2
		st.error	0.2334	0.3123	0.149	.	.	.	.	
		P value	0.0222	<.0001	0.0124	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-2.4965	.	.	0.3695	.	.	198.6
		st.error	.	0.2016	.	.	0.1192	.	.	
		P value	.	<.0001	.	.	0.0033	.	.	
	ZIB	estimate	-2.4989	-2.292	.	.	0.3226	.	.	199.2
		st.error	1.0509	0.2513	.	.	0.1249	.	.	
		P value	0.0217	<.0001	.	.	0.0131	.	.	
	BH	estimate	0.5447	-2.4149	.	.	-0.1471	.	.	201.9
		st.error	0.2334	0.3265	.	.	0.3224	.	.	
		P value	0.0222	<.0001	.	.	0.6495	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-2.4942	0.1746	0.000499	-0.1021	0.04724	0.1059	199.3
		st.error	.	0.2816	0.3547	0.06186	0.3224	0.06154	0.1114	
		P value	.	<.0001	0.625	0.9936	0.7529	0.4467	0.3466	
	ZIB	estimate	-1.9621	-2.3204	0.4402	-0.03528	-0.7655	0.3103	0.03747	
		st.error								ERROR: Optimization cannot be completed
		P value								
	BH	estimate	0.6063	-2.6191	0.2522	0.0111	-1.1758	0.2833	0.1856	197.7
		st.error	0.2354	0	0	0	0	0	0	
		P value	0.0119	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	Covariance Mtrx

SM ratio – Sample 3, 2006

Septmeber 2006 (Sample=3)									Observations Used: 45 Observations Not Used: 34	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-2.0713	.	.	.	.	.	147.4
		st.error	.	0.1906	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-0.06197	-0.4421	.	.	.	.	.	103.3
		st.error	0.3655	0.257	.	.	.	.	.	
		P value	0.8661	0.0923	.	.	.	.	.	
	BH	estimate	1.2205	-0.7300	.	.	.	.	.	120.5
		st.error	0.2682	0.2989	.	.	.	.	.	
		P value	<.0001	0.0168	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-2.7692	0.9641	.	.	.	.	131.0
		st.error	.	0.2871	0.2243	.	.	.	.	
		P value	.	<.0001	<.0001	.	.	.	.	
	ZIB	estimate	-0.1452	-1.0425	0.6624	.	.	.	.	99.4
		st.error	0.384	0.3779	0.2878	.	.	.	.	
		P value	0.7071	0.0084	0.0261	.	.	.	.	
	BH	estimate	1.2205	-1.1176	0.5063	.	.	.	.	120.3
		st.error	0.2682	0.4184	0.3377	.	.	.	.	
		P value	<.0001	0.0092	0.1378	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-2.4587	.	.	0.3233	.	.	143.0
		st.error	.	0.2588	.	.	0.1225	.	.	
		P value	.	<.0001	.	.	0.0114	.	.	
	ZIB	estimate	-0.07551	-0.5492	.	.	0.06654	.	.	105.0
		st.error	0.3689	0.3443	.	.	0.1400	.	.	
		P value	0.8387	0.1177	.	.	0.6369	.	.	
	BH	estimate	1.2205	-0.8625	.	.	0.08086	.	.	122.3
		st.error	0.2682	0.4209	.	.	0.1735	.	.	
		P value	<.0001	0.0438	.	.	0.6424	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-3.1905	1.5825	0.1257	-0.1013	0.2416	-0.659	129.1
		st.error	.	0.4299	0.6783	0.3008	0.3127	0.09438	0.218	
		P value	.	<.0001	0.0242	0.6779	0.7473	0.0139	0.0041	
	ZIB	estimate	-0.1856	-1.4485	2.0888	-0.123	-0.4924	0.3408	-0.7987	101.6
		st.error	0.3902	0.5457	0.9221	0.372	0.4723	0.2055	0.4773	
		P value	0.6367	0.0109	0.0284	0.7425	0.3027	0.1042	0.1012	
	BH	estimate	1.2205	-1.1161	8.5621	-3.8376	-4.2306	1.8805	-2.5125	
		st.error								ERROR: Optimization cannot be completed
		P value								

SE ratio – Sample 1, 2005

May 2005 (Sample=1)									Observations Used: 71 Observations Not Used: 9	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	0.3629	.	.	.	.	.	218.2
		st.error	.	0.123	.	.	.	.	.	
		P value	.	0.0043	.	.	.	.	.	
	ZIB	estimate	-3.6607	0.4043	.	.	.	.	.	219.7
		st.error	1.7009	0.1376	.	.	.	.	.	
		P value	0.0348	0.0044	.	.	.	.	.	
	BH	estimate	-1.033	0.4586	.	.	.	.	.	258.6
		st.error	0.2541	0.1393	.	.	.	.	.	
		P value	0.0001	0.0015	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	0.3682	-0.03778	.	.	.	.	220.2
		st.error	.	0.1302	0.3029	.	.	.	.	
		P value	.	0.0061	0.9011	.	.	.	.	
	ZIB	estimate	-3.6023	0.4174	-0.07513	.	.	.	.	221.7
		st.error	1.6301	0.1477	0.3074	.	.	.	.	
		P value	0.0303	0.0061	0.8076	.	.	.	.	
	BH	estimate	-1.033	0.4837	-0.1487	.	.	.	.	260.4
		st.error	0.2541	0.1492	0.3153	.	.	.	.	
		P value	0.0001	0.0017	0.6385	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	0.3542	.	.	0.02971	.	.	220.2
		st.error	.	0.135	.	.	0.1906	.	.	
		P value	.	0.0106	.	.	0.8766	.	.	
	ZIB	estimate	-3.6641	0.4035	.	.	0.002206	.	.	221.7
		st.error	1.7338	0.1544	.	.	0.1952	.	.	
		P value	0.0381	0.0110	.	.	0.9910	.	.	
	BH	estimate	-1.033	0.4715	.	.	-0.03712	.	.	260.6
		st.error	0.2541	0.1556	.	.	0.1986	.	.	
		P value	0.0001	0.0033	.	.	0.8522	.	.	
Full model	Binomial (NLMIXED)	estimate	.	0.3847	-2.6346	2.2499	0.6351	-0.3267	-1.4071	223.6
		st.error	.	0.144	1.3891	1.3142	1.2579	0.6448	1.3824	
		P value	.	0.0094	0.062	0.0913	0.6152	0.614	0.3122	
	ZIB	estimate	-3.4315	0.4549	-2.7161	2.2612	0.5752	-0.3142	-1.3595	224.9
		st.error	1.4317	0.168	1.3936	1.3153	1.2785	0.6539	1.3879	
		P value	0.0192	0.0085	0.0553	0.0899	0.6542	0.6323	0.3306	
	BH	estimate	-1.0331	0.5356	-15.1903	14.603	0.8222	-0.4609	-13.6596	261.3
		st.error	0.2541	0.1688	515.78	515.78	1.4532	0.7392	515.78	
		P value	0.0001	0.0021	0.9766	0.9775	0.5731	0.5347	0.9789	

SE ratio – Sample 2, 2005

July 2005 (Sample=2)

Observations Used: 59
Observations Not Used: 21

Model			a0 (α0) Zero-Inflation	b0 (β0) Intercept only	b1 (β1) YNS	b11 (β11) YNS_2	b2 (β2) PNS	b22 (β22) PNS_2	b12 (β12) YNS*PNS	AIC Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-0.2558	.	.	.	.	.	140.7
		st.error	.	0.1555	.	.	.	.	.	
		P value	.	0.1052	.	.	.	.	.	
	ZIB	estimate	-15.2706	-0.2559	.	.	.	.	.	142.7
		st.error	1135.53	0.1555	.	.	.	.	.	
		P value	0.9893	0.1051	.	.	.	.	.	
	BH	estimate	-0.05001	-0.2035	.	.	.	.	.	195.2
		st.error	0.2237	0.2049	.	.	.	.	.	
		P value	0.8237	0.3235	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-0.4724	0.04143	.	.	.	.	141.1
		st.error	.	0.2339	0.03314	.	.	.	.	
		P value	.	0.048	0.2161	.	.	.	.	
	ZIB	estimate	-15.259	-0.4724	0.04143	.	.	.	.	143.1
		st.error	1000.07	0.2339	0.03314	.	.	.	.	
		P value	0.9879	0.0480	0.2161	.	.	.	.	
	BH	estimate	-0.05001	-0.6382	0.0777	.	.	.	.	194.4
		st.error	0.2237	0.3432	0.04724	.	.	.	.	
		P value	0.8237	0.0666	0.1040	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-0.4421	.	.	0.09171	.	.	140.0
		st.error	.	0.1949	.	.	0.05731	.	.	
		P value	.	0.027	.	.	0.1149	.	.	
	ZIB	estimate	-15.9348	-0.442	.	.	0.09172	.	.	142.0
		st.error	1882.44	0.1949	.	.	0.05731	.	.	
		P value	0.9933	0.0270	.	.	0.1148	.	.	
	BH	estimate	-0.05001	-0.5164	.	.	0.1558	.	.	192.6
		st.error	0.2237	0.2607	.	.	0.07472	.	.	
		P value	0.8237	0.0510	.	.	0.0403	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-1.2163	0.2322	-0.01038	0.2323	-0.0042	-0.01605	141.1
		st.error	.	0.400	0.1037	0.0065	0.1775	0.0151	0.0161	
		P value	.	0.0035	0.0289	0.1179	0.1956	0.7818	0.324	
	ZIB	estimate	-17.2039	-1.2163	0.2322	-0.01038	0.2324	-0.00421	-0.01606	143.1
		st.error	1802.1	0.4000	0.1037	0.006543	0.1775	0.01511	0.01614	
		P value	0.9924	0.0035	0.0289	0.1179	0.1955	0.7817	0.3238	
	BH	estimate	-0.05001	-1.4395	0.2137	-0.00708	0.2916	-0.00688	-0.01139	196.5
		st.error	0.2237	0.6957	0.1924	0.0112	0.2479	0.02077	0.03241	
		P value	0.8236	0.0418	0.2701	0.5292	0.243	0.7412	0.7263	

SE ratio – Sample 3, 2005

September 2005 (Sample=3)									Observations Used: 79 Observations Not Used: 1	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-1.626	.	.	.	.	.	179.8
		st.error	.	0.1412	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-1.610	-1.433	.	.	.	.	.	180.0
		st.error	0.8603	0.1954	.	.	.	.	.	
		P value	0.0650	<.0001	.	.	.	.	.	
	BH	estimate	0.3023	-1.3861	.	.	.	.	.	197.5
		st.error	0.2262	0.1977	.	.	.	.	.	
		P value	0.1852	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-1.7272	0.1272	.	.	.	.	180.9
		st.error	.	0.180	0.1324	.	.	.	.	
		P value	.	<.0001	0.3397	.	.	.	.	
	ZIB	estimate	-1.6126	-1.5372	0.1294	.	.	.	.	181.2
		st.error	0.8699	0.2285	0.1417	.	.	.	.	
		P value	0.0675	<.0001	0.3640	.	.	.	.	
	BH	estimate	0.3023	-1.6091	0.2481	.	.	.	.	197.4
		st.error	0.2262	0.2642	0.1703	.	.	.	.	
		P value	0.1852	<.0001	0.1491	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-1.3337	.	.	-0.1115	.	.	178.3
		st.error	.	0.2056	.	.	0.0618	.	.	
		P value	.	<.0001	.	.	0.0751	.	.	
	ZIB	estimate	-1.103	-0.8926	.	.	-0.1609	.	.	176.3
		st.error	0.5881	0.2907	.	.	0.06946	.	.	
		P value	0.0644	0.0029	.	.	0.0232	.	.	
	BH	estimate	0.3023	-0.683	.	.	-0.2279	.	.	191.0
		st.error	0.2262	0.2892	.	.	0.08394	.	.	
		P value	0.1852	0.0206	.	.	0.0081	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-1.4095	0.1123	0.07507	-0.2436	0.02756	-0.07149	182.7
		st.error	.	0.336	0.453	0.137	0.222	0.030	0.060	
		P value	.	<.0001	0.8047	0.5862	0.2754	0.3589	0.2399	
	ZIB	estimate	-1.0665	-0.9831	-0.3426	0.5082	-0.4029	0.05000	-0.2247	172.2
		st.error	0.4737	0.3885	0.6648	0.2696	0.2679	0.03608	0.08014	
		P value	0.0271	0.0134	0.6078	0.0632	0.1365	0.1698	0.0064	
	BH	estimate	0.3023	-0.8841	-1.4059	1.1563	-0.7482	0.09795	-0.4938	175.6
		st.error	0.2262	0.6351	1.2452	0.5249	0.5064	0.06673	0.1921	
		P value	0.1852	0.1677	0.2622	0.0305	0.1435	0.1461	0.0120	

SE ratio – Sample 1, 2006

May 2006 (Sample=1)

Observations Used: 62
Observations Not Used: 18

Model			a0 (α0) Zero-Inflation	b0 (β0) Intercept only	b1 (β1) YNS	b11 (β11) YNS_2	b2 (β2) PNS	b22 (β22) PNS_2	b12 (β12) YNS*PNS	AIC Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-1.4404	.	.	.	.	.	160.5
		st.error	.	0.1513	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-1.4949	-1.1942	.	.	.	.	.	159.9
		st.error	0.739	0.2062	.	.	.	.	.	
		P value	0.0474	<.0001	.	.	.	.	.	
	BH	estimate	0.4578	-1.2895	.	.	.	.	.	173.7
		st.error	0.2295	0.2144	.	.	.	.	.	
		P value	0.0494	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-1.4255	-0.09201	.	.	.	.	162.3
		st.error	.	0.1575	0.285	.	.	.	.	
		P value	.	<.0001	0.7479	.	.	.	.	
	ZIB	estimate	-1.3453	-1.1146	-0.2474	.	.	.	.	161.2
		st.error	0.6646	0.2212	0.2953	.	.	.	.	
		P value	0.0473	<.0001	0.4054	.	.	.	.	
	BH	estimate	0.4578	-1.2055	-0.3237	.	.	.	.	174.7
		st.error	0.2295	0.2272	0.3609	.	.	.	.	
		P value	0.0494	<.0001	0.3725	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-1.4188	.	.	-0.7784	.	.	161.8
		st.error	.	0.1531	.	.	1.0652	.	.	
		P value	.	<.0001	.	.	0.4676	.	.	
	ZIB	estimate	-1.3806	-1.1346	.	.	-1.0626	.	.	160.7
		st.error	0.6735	0.2098	.	.	1.0748	.	.	
		P value	0.0446	<.0001	.	.	0.3267	.	.	
	BH	estimate	0.4579	-1.2241	.	.	-14.9635	.	.	172.9
		st.error	0.2295	0.2163	.	.	.	.	.	
		P value	0.0494	<.0001	.	.	.	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-1.4015	-0.0208	-0.04159	-0.3979	-0.3979	0	169.7
		st.error	.	0.1595	0.05705	0.1141	0.533	0.533	0	
		P value	.	<.0001	0.7167	0.7167	0.4582	0.4582	.	Covariance Mtrx
	ZIB	estimate	-1.2218	-1.0378	-0.05717	-0.1143	-0.5797	-0.5797	0	167.7
		st.error	0.6015	0.2254	0.05923	0.1185	0.539	0.539	0	
		P value	0.0465	<.0001	0.3382	0.3382	0.2863	0.2863	.	Covariance Mtrx
	BH	estimate	0.4579	-1.1248	-0.0728	-0.1456	-7.4464	-7.4464	0	179.7
		st.error	0.2295	0.2299	0.07226	0.1445	.	.	0	
		P value	0.0494	<.0001	0.3167	0.3167	.	.	.	Covariance Mtrx

SE ratio – Sample 2, 2006

July 2006 (Sample=2)

Observations Used: 79
Observations Not Used: 0

Model			a0 (α0) Zero-Inflation	b0 (β0) Intercept only	b1 (β1) YNS	b11 (β11) YNS_2	b2 (β2) PNS	b22 (β22) PNS_2	b12 (β12) YNS*PNS	AIC Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-2.6457	.	.	.	.	.	159.5
		st.error	.	0.1578	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-1.1683	-2.3546	.	.	.	.	.	159.7
		st.error	0.8298	0.251	.	.	.	.	.	
		P value	0.1631	<.0001	.	.	.	.	.	
	BH	estimate	0.5447	-2.3555	.	.	.	.	.	168.6
		st.error	0.2334	0.2587	.	.	.	.	.	
		P value	0.0222	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-2.4864	-0.1008	.	.	.	.	159.9
		st.error	.	0.1998	0.0865	.	.	.	.	
		P value	.	<.0001	0.2476	.	.	.	.	
	ZIB	estimate	-1.3392	-2.2482	-0.09421	.	.	.	.	160.6
		st.error	0.9547	0.2738	0.09208	.	.	.	.	
		P value	0.1646	<.0001	0.3094	.	.	.	.	
	BH	estimate	0.5447	-2.3166	-0.02759	.	.	.	.	170.5
		st.error	0.2334	0.3219	0.1409	.	.	.	.	
		P value	0.0222	<.0001	0.8453	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-2.758	.	.	0.1047	.	.	159.6
		st.error	.	0.1809	.	.	0.07038	.	.	
		P value	.	<.0001	.	.	0.1407	.	.	
	ZIB	estimate	-1.422	-2.5073	.	.	0.08308	.	.	160.6
		st.error	1.0992	0.3002	.	.	0.07587	.	.	
		P value	0.1996	<.0001	.	.	0.2768	.	.	
	BH	estimate	0.5447	-2.2066	.	.	-0.1815	.	.	169.6
		st.error	0.2334	0.2899	.	.	0.2099	.	.	
		P value	0.0222	<.0001	.	.	0.3899	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-2.5996	-0.08477	-0.01644	0.1584	-0.01307	0.03036	164.5
		st.error	.	0.2496	0.2044	0.03391	0.1732	0.02762	0.05972	
		P value	.	<.0001	0.6795	0.6292	0.3634	0.6375	0.6127	
	ZIB	estimate	-1.8533	-2.438	-0.06336	-0.01904	0.1264	-0.0115	0.02992	166.1
		st.error	1.6555	0.3481	0.2202	0.03654	0.1843	0.02828	0.06168	
		P value	0.2663	<.0001	0.7743	0.6038	0.4948	0.6853	0.6289	
	BH	estimate	0.5447	-2.2336	0.2974	-0.06726	-0.3297	-0.01181	0.06729	177.0
		st.error	0.2334	0.3763	0.5406	0.1078	0.4326	0.07049	0.1674	
		P value	0.0222	<.0001	0.5838	0.5344	0.4482	0.8674	0.6888	

SE ratio – Sample 3, 2006

Septmeber 2006 (Sample=3)									Observations Used: 79 Observations Not Used: 0	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-3.7694	.	.	.	.	.	143.6
		st.error	.	0.1817	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	0.6681	-2.4957	.	.	.	.	.	122.9
		st.error	0.3408	0.2432	.	.	.	.	.	
		P value	0.0534	<.0001	.	.	.	.	.	
	BH	estimate	1.2205	-2.5775	.	.	.	.	.	123.4
		st.error	0.2682	0.2638	.	.	.	.	.	
		P value	<.0001	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-3.9154	0.142	.	.	.	.	145.1
		st.error	.	0.2693	0.1818	.	.	.	.	
		P value	.	<.0001	0.4372	.	.	.	.	
	ZIB	estimate	0.6523	-2.6363	0.1258	.	.	.	.	124.6
		st.error	0.3444	0.357	0.2239	.	.	.	.	
		P value	0.0619	<.0001	0.5759	.	.	.	.	
	BH	estimate	1.2205	-2.5494	-0.02804	.	.	.	.	125.4
		st.error	0.2682	0.3870	0.2858	.	.	.	.	
		P value	<.0001	<.0001	0.9221	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-4.0781	.	.	0.2458	.	.	140.8
		st.error	.	0.2421	.	.	0.1028	.	.	
		P value	.	<.0001	.	.	0.0192	.	.	
	ZIB	estimate	0.608	-2.652	.	.	0.08013	.	.	124.4
		st.error	0.3645	0.3391	.	.	0.1116	.	.	
		P value	0.0992	<.0001	.	.	0.475	.	.	
	BH	estimate	1.2205	-2.6327	.	.	0.03205	.	.	125.3
		st.error	0.2682	0.3617	.	.	0.1386	.	.	
		P value	<.0001	<.0001	.	.	0.8177	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-4.1754	0.4256	-0.09597	0.06015	0.09772	-0.1799	147.0
		st.error	.	0.3692	0.558	0.1778	0.2787	0.07312	0.144	
		P value	.	<.0001	0.4479	0.5908	0.8297	0.1852	0.2151	
	ZIB	estimate	0.5576	-2.9078	0.6098	-0.1646	-0.03968	0.07725	-0.1473	131.5
		st.error	0.3811	0.5267	0.7274	0.2598	0.3618	0.1254	0.2419	
		P value	0.1474	<.0001	0.4044	0.5283	0.9129	0.5397	0.5443	
	BH	estimate	1.2205	-2.6674	1.5367	-0.8137	-0.584	0.1439	0.000637	130.5
		st.error	0.2682	0.5816	1.161	0.5862	0.565	0.1988	0.3794	
		P value	<.0001	<.0001	0.1895	0.169	0.3045	0.4713	0.9987	

ME ratio – Sample 1, 2005

May 2005 (Sample=1)									Observations Used: 53 Observations Not Used: 27	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-1.7228	.	.	.	.	.	84.7
		st.error	.	0.2428	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-0.5062	-1.0757	.	.	.	.	.	84.6
		st.error	0.7843	0.4559	.	.	.	.	.	
		P value	0.5215	0.0220	.	.	.	.	.	
	BH	estimate	1.3863	-1.2808	.	.	.	.	.	100.0
		st.error	0.2795	0.5168	.	.	.	.	.	
		P value	<.0001	0.0153	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-1.7836	0.3581	.	.	.	.	86.3
		st.error	.	0.2666	0.5801	.	.	.	.	
		P value	.	<.0001	0.5397	.	.	.	.	
	ZIB	estimate	-0.5487	-1.1242	0.1382	.	.	.	.	86.6
		st.error	0.8461	0.5242	0.7162	.	.	.	.	
		P value	0.5195	0.0366	0.8477	.	.	.	.	
	BH	estimate	1.3863	-1.6111	0.8114	.	.	.	.	101.4
		st.error	0.2795	0.7267	1.0442	.	.	.	.	
		P value	<.0001	0.0295	0.4394	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-1.5628	.	.	-1.1871	.	.	83.1
		st.error	.	0.2502	.	.	0.8594	.	.	
		P value	.	<.0001	.	.	0.173	.	.	
	ZIB	estimate	-0.8336	-1.0705	.	.	-1.2912	.	.	83.9
		st.error	0.9981	0.4701	.	.	0.9150	.	.	
		P value	0.4074	0.0268	.	.	0.1641	.	.	
	BH	estimate	1.3862	-1.2112	.	.	-14.018	.	.	101.5
		st.error	0.2795	0.5183	.	.	409.01	.	.	
		P value	<.0001	0.0219	.	.	0.9727	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-1.6864	6.3618	-5.6871	8.8416	-8.5417	-26.5726	88.0
		st.error	.	0.2811	0.3240	0.3240	1273.25	1273.25	0	
		P value	.	<.0001	<.0001	<.0001	0.9945	0.9947	<.0001	Covariance Mtrx
	ZIB	estimate	-1.3993	-1.3709	2.8967	-2.3274	11.1221	-11.0091	-17.245	89.6
		st.error	1.7423	0.5785	0.3830	0.3830	0.6131	0.6131	5053.25	
		P value	0.4255	0.0215	<.0001	<.0001	<.0001	<.0001	0.9973	Covariance Mtrx
	BH	estimate	1.3863	-1.5076	0.354	0.354	-6.85	-6.85	0	109.0
		st.error	0.2795	0.7288	0.5228	0.5228	73.8201	73.8201	0	
		P value	<.0001	0.0418	0.5003	0.5003	0.9263	0.9263	.	Covariance Mtrx

ME ratio – Sample 2, 2005

July 2005 (Sample=2)

Observations Used: 51
Observations Not Used: 29

Model			a0 (α0) Zero-Inflation	b0 (β0) Intercept only	b1 (β1) YNS	b11 (β11) YNS_2	b2 (β2) PNS	b22 (β22) PNS_2	b12 (β12) YNS*PNS	AIC Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-2.3770	.	.	.	.	.	53.7
		st.error	.	0.3524	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	0.6801	-0.9320	.	.	.	.	.	54.2
		st.error	0.8913	0.9378	.	.	.	.	.	
		P value	0.4489	0.3250	.	.	.	.	.	
	BH	estimate	2.1972	-1.494	.	.	.	.	.	61.0
		st.error	0.3727	1.1708	.	.	.	.	.	
		P value	<.0001	0.2056	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-2.6884	0.05661	.	.	.	.	55
		st.error	.	0.5308	0.0647	.	.	.	.	
		P value	.	<.0001	0.3857	.	.	.	.	
	ZIB	estimate	0.4526	-1.4664	0.05557	.	.	.	.	55.9
		st.error	1.1156	1.2591	0.09587	.	.	.	.	
		P value	0.6866	0.2496	0.5647	.	.	.	.	
	BH	estimate	2.1972	-2.0226	0.06539	.	.	.	.	62.9
		st.error	0.3727	2.1136	0.194	.	.	.	.	
		P value	<.0001	0.3415	0.7369	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-2.3961	.	.	0.01097	.	.	55.7
		st.error	.	0.4325	.	.	0.1419	.	.	
		P value	.	<.0001	.	.	0.9387	.	.	
	ZIB	estimate	0.7230	-0.8021	.	.	-0.04146	.	.	56.1
		st.error	0.8546	1.0610	.	.	0.1740	.	.	
		P value	0.4015	0.4532	.	.	0.8127	.	.	
	BH	estimate	2.2935	-0.4704	.	.	-5.1824	.	.	
		st.error			.	.		.	.	ERROR: Optimization cannot be completed.
		P value			.	.		.	.	
Full model	Binomial (NLMIXED)	estimate	.	-3.8144	0.3910	-0.0179	0.2981	-0.0110	-0.0276	60.7
		st.error	.	1.1876	0.2903	0.01751	0.4732	0.03531	0.04618	
		P value	.	0.0023	0.1839	0.3124	0.5316	0.7563	0.5526	
	ZIB	estimate	0.6422	-2.3773	0.6542	-0.02349	-1.0015	0.2406	-0.1331	58.7
		st.error	0.5274	1.5452	0.4883	0.02777	1.1151	0.1867	0.09627	
		P value	0.229	0.1301	0.1863	0.4015	0.3733	0.2033	0.1729	
	BH	estimate	1.9244	-0.9023	-0.6962	0.1082	-0.3424	0.3412	-1.1809	64.7
		st.error	0.3354	4.0574	3.0463	0.3422	31.3147	5.3143	1.4628	
		P value	<.0001	0.8246	0.8198	0.7527	0.9913	0.949	0.4219	

ME ratio – Sample 3, 2005

September 2005 (Sample=3)

Observations Used: 78
Observations Not Used: 2

Model			a0 (α0) Zero-Inflation	b0 (β0) Intercept only	b1 (β1) YNS	b11 (β11) YNS_2	b2 (β2) PNS	b22 (β22) PNS_2	b12 (β12) YNS*PNS	AIC Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-2.7759	.	.	.	.	.	86.0
		st.error	.	0.2365	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	-0.6812	-2.3214	.	.	.	.	.	86.9
		st.error	1.0818	0.4446	.	.	.	.	.	
		P value	0.5307	<.0001	.	.	.	.	.	
	BH	estimate	1.4663	-2.3736	.	.	.	.	.	95.3
		st.error	0.2864	0.4885	.	.	.	.	.	
		P value	<.0001	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-3.2173	0.4415	.	.	.	.	83.1
		st.error	.	0.3389	0.1911	.	.	.	.	
		P value	.	<.0001	0.0235	.	.	.	.	
	ZIB	estimate	-0.9145	-2.8900	0.5171	.	.	.	.	83.7
		st.error	1.0162	0.4662	0.2189	.	.	.	.	
		P value	0.3709	<.0001	0.0206	.	.	.	.	
	BH	estimate	1.4663	-2.3000	-0.09429	.	.	.	.	97.2
		st.error	0.2864	0.5979	0.475	.	.	.	.	
		P value	<.0001	0.0002	0.8431	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-2.8268	.	.	0.01696	.	.	88.0
		st.error	.	0.3727	.	.	0.09456	.	.	
		P value	.	<.0001	.	.	0.8581	.	.	
	ZIB	estimate	-0.7093	-2.3989	.	.	0.02381	.	.	88.9
		st.error	1.0812	0.5444	.	.	0.09849	.	.	
		P value	0.5138	<.0001	.	.	0.8096	.	.	
	BH	estimate	1.4663	-3.5523	.	.	0.2278	.	.	95.6
		st.error	0.2864	1.2745	.	.	0.1942	.	.	
		P value	<.0001	0.0066	.	.	0.2443	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-3.0486	0.01772	0.1876	-0.2428	0.04632	-0.06807	87.5
		st.error	.	0.6662	0.8027	0.1944	0.3692	0.04584	0.08589	
		P value	.	<.0001	0.9824	0.3374	0.5127	0.3155	0.4304	
	ZIB	estimate	-1.8189	-2.9817	0.0908	0.1692	-0.1504	0.03441	-0.06994	89.4
		st.error	2.9867	0.7068	0.8539	0.2038	0.4543	0.05676	0.09465	
		P value	0.5443	<.0001	0.9156	0.4091	0.7415	0.5462	0.4622	
	BH	estimate	1.4669	-36.0172	0.9288	-0.1781	15.1964	-1.4664	0.1511	97.2
		st.error	0.2865	0.6828	1.272	0.3023	0.9156	0.1295	0.1881	
		P value	<.0001	<.0001	0.4674	0.5574	<.0001	<.0001	0.4243	

ME ratio – Sample 1, 2006

May 2006 (Sample=1)									Observations Used: 59 Observations Not Used: 21	
Model			**a0 (α0)** Zero-Inflation	**b0 (β0)** Intercept only	**b1 (β1)** YNS	**b11 (β11)** YNS_2	**b2 (β2)** PNS	**b22 (β22)** PNS_2	**b12 (β12)** YNS*PNS	**AIC** Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-1.3689	.	.	.	.	.	240.3
		st.error	.	0.1471	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	0.2516	-0.3612	.	.	.	.	.	197.9
		st.error	0.3225	0.1893	.	.	.	.	.	
		P value	0.4384	0.0613	.	.	.	.	.	
	BH	estimate	1.0986	-0.3828	.	.	.	.	.	213.2
		st.error	0.2582	0.1927	.	.	.	.	.	
		P value	<.0001	0.0504	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-1.2920	-0.8827	.	.	.	.	237.7
		st.error	.	0.1496	0.5319	.	.	.	.	
		P value	.	<.0001	0.1023	.	.	.	.	
	ZIB	estimate	0.2399	-0.4007	16.5343	.	.	.	.	196.3
		st.error	0.3239	0.1912	2253.51	.	.	.	.	
		P value	0.4618	0.0404	0.9942	.	.	.	.	
	BH	estimate	1.0986	-0.4110	15.8170	.	.	.	.	212.4
		st.error	0.2582	0.1942	1566.26	.	.	.	.	
		P value	<.0001	0.0374	0.9920	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-1.3286	.	.	-15.075	.	.	238.2
		st.error	.	0.1477	.	.	1.22E+03	.	.	
		P value	.	<.0001	.	.	0.9901	.	.	
	ZIB	estimate	0.2057	-0.3664	.	.	-15.8626	.	.	198.7
		st.error	0.3279	0.1898	.	.	1663.28	.	.	
		P value	0.5328	0.0583	.	.	0.9924	.	.	
	BH	estimate	1.0986	-0.3828	.	.	0	.	.	215.2
		st.error	0.2582	0.1927	.	.	0	.	.	
		P value	<.0001	0.0504	.	.	.	.	.	Covariance Mtrx
Full model	Binomial (NLMIXED)	estimate	.	-1.2679	65.117	-36.7161	-86.8028	-86.8028	0	230.4
		st.error	.	0.1513	172.19	344.39	0	0	0	
		P value	.	<.0001	0.7067	0.9155	<.0001	<.0001	.	Covariance Mtrx
	ZIB	estimate	0.1924	-0.4064	19.1784	17.9648	-4.8888	-4.8888	0	203.2
		st.error	0.003183	.	0	0.00E+00	40.3439	40.3439	0	
		P value	<.0001	.	<.0001	<.0001	0.904	0.904	.	Covariance Mtrx
	BH	estimate	1.0986	-0.4108	7.4867	7.4867	0	0	0	220.4
		st.error	0.2582	0.1942	513.65	513.65	0	0	0	
		P value	<.0001	0.0375	0.9884	0.9884	.	.	.	Covariance Mtrx

ME ratio – Sample 2, 2006

July 2006 (Sample=2)										Observations Used: 79 Observations Not Used: 0
Model			a0 (α0) Zero-Inflation	b0 (β0) Intercept only	b1 (β1) YNS	b11 (β11) YNS_2	b2 (β2) PNS	b22 (β22) PNS_2	b12 (β12) YNS*PNS	AIC Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-0.4667	.	.	.	.	.	729.3
		st.error	.	0.06544	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	0.5291	0.3195	.	.	.	.	.	404.4
		st.error	0.2408	0.07988	.	.	.	.	.	
		P value	0.0309	0.0001	.	.	.	.	.	
	BH	estimate	0.5996	0.3299	.	.	.	.	.	406.9
		st.error	0.2352	0.07942	.	.	.	.	.	
		P value	0.0127	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	0.008536	-0.4117	.	.	.	.	646.1
		st.error	.	0.08422	0.05327	.	.	.	.	
		P value	.	0.9195	<.0001	.	.	.	.	
	ZIB	estimate	0.4938	0.6761	-0.3414	.	.	.	.	367.2
		st.error	0.244	0.1004	0.05849	.	.	.	.	
		P value	0.0464	<.0001	<.0001	.	.	.	.	
	BH	estimate	0.5996	0.6807	-0.3323	.	.	.	.	370.7
		st.error	0.2352	0.1002	0.05851	.	.	.	.	
		P value	0.0127	<.0001	<.0001	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-0.3498	.	.	-0.1602	.	.	721.5
		st.error	.	0.07555	.	.	0.05511	.	.	
		P value	.	<.0001	.	.	0.0047	.	.	
	ZIB	estimate	0.5307	0.2559	.	.	0.1163	.	.	404.5
		st.error	0.2406	0.09247	.	.	0.08675	.	.	
		P value	0.0303	0.0070	.	.	0.1840	.	.	
	BH	estimate	0.5996	0.2668	.	.	0.1153	.	.	407.1
		st.error	0.2352	0.09199	.	.	0.08629	.	.	
		P value	0.0127	0.0048	.	.	0.1854	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-0.04075	-0.5133	0.02848	0.4783	-0.1494	-0.0294	637.7
		st.error	.	0.107	0.117	0.02164	0.1795	0.0498	0.04725	
		P value	.	0.7044	<.0001	0.1919	0.0094	0.0036	0.5356	
	ZIB	estimate	0.4322	0.4114	-0.4213	0.03434	0.9632	-0.05897	-0.3107	347.9
		st.error	0.2478	0.1330	0.1891	0.03437	0.1983	0.03489	0.1139	
		P value	0.0850	0.0027	0.0287	0.3209	<.0001	0.0950	0.0079	
	BH	estimate	0.5996	0.3788	-0.3217	0.01581	1.103	-0.1122	-0.3519	350.3
		st.error	0.2352	0.1356	0.1977	0.03613	0.2552	0.1176	0.1624	
		P value	0.0127	0.0065	0.1078	0.6629	<.0001	0.3431	0.0332	

ME ratio – Sample 3, 2006

Septmeber 2006 (Sample=3)									Observations Used: 79 Observations Not Used: 0	
Model			a0 (α0) Zero-Inflation	b0 (β0) Intercept only	b1 (β1) YNS	b11 (β11) YNS_2	b2 (β2) PNS	b22 (β22) PNS_2	b12 (β12) YNS*PNS	AIC Fit statistics
Intercept only	Binomial (NLMIXED)	estimate	.	-1.6981	.	.	.	.	.	748.4
		st.error	.	0.06935	.	.	.	.	.	
		P value	.	<.0001	.	.	.	.	.	
	ZIB	estimate	0.000539	-1.0420	.	.	.	.	.	557.9
		st.error	0.2383	0.07594	.	.	.	.	.	
		P value	0.9982	<.0001	.	.	.	.	.	
	BH	estimate	0.1268	-1.0261	.	.	.	.	.	562.2
		st.error	0.2255	0.07508	.	.	.	.	.	
		P value	0.5756	<.0001	.	.	.	.	.	
YNS only	Binomial (NLMIXED)	estimate	.	-1.152	-0.817	.	.	.	.	671.4
		st.error	.	0.08745	0.1042	.	.	.	.	
		P value	.	<.0001	<.0001	.	.	.	.	
	ZIB	estimate	-0.1571	-0.6791	-0.6675	.	.	.	.	523.9
		st.error	0.2589	0.09444	0.1178	.	.	.	.	
		P value	0.5458	<.0001	<.0001	.	.	.	.	
	BH	estimate	0.1268	-0.6741	-0.6255	.	.	.	.	531.2
		st.error	0.2255	0.09438	0.1182	.	.	.	.	
		P value	0.5756	<.0001	<.0001	.	.	.	.	
PNS only	Binomial (NLMIXED)	estimate	.	-1.6503	.	.	-0.05027	.	.	749.6
		st.error	.	0.08644	.	.	0.05595	.	.	
		P value	.	<.0001	.	.	0.3717	.	.	
	ZIB	estimate	0.005726	-0.838	.	.	-0.1904	.	.	549.0
		st.error	0.2378	0.09652	.	.	0.06066	.	.	
		P value	0.9809	<.0001	.	.	0.0024	.	.	
	BH	estimate	0.1268	-0.8134	.	.	-0.2026	.	.	552.4
		st.error	0.2255	0.09619	.	.	0.06317	.	.	
		P value	0.5756	<.0001	.	.	0.0019	.	.	
Full model	Binomial (NLMIXED)	estimate	.	-1.1652	-1.1063	-0.1439	0.3196	-0.1458	0.372	663.3
		st.error	.	0.1065	0.2864	0.1796	0.1361	0.0522	0.1238	
		P value	.	<.0001	0.0002	0.4255	0.0214	0.0066	0.0036	
	ZIB	estimate	-0.2004	-0.7498	-0.7814	-0.00519	0.2284	-0.05476	0.0419	529.6
		st.error	0.2719	0.1125	0.3095	0.1533	0.1600	0.0541	0.1206	
		P value	0.4632	<.0001	0.0136	0.9731	0.1573	0.3145	0.7293	
	BH	estimate	0.1267	-0.7786	-0.7257	0.2053	0.2812	-0.04648	-0.1724	534.1
		st.error	0.2255	0.1153	0.3195	0.1967	0.1877	0.06749	0.1404	
		P value	0.5756	<.0001	0.0259	0.2996	0.1381	0.4931	0.2231	