# DEPARTMENTS

American College of Preventive Medicine

American Fisheries Society

American Institute of Biological Sciences

American Public Health Association

American Society of Agronomy

American Society of Limnology and Oceanography

Association of Teachers of Preventive Medicine

Crop Science Society of America

Ecological Society of America

Estuarine Research Federation

Institute of Food Technologists

Soil Science Society of America

Society for Conservation Biology

Society of Environmental Toxicology and Chemistry

## Public Affairs Office

The following position statement was hand delivered to all members of the U.S. Congress this summer, and to our knowledge, is the first such statement from the scientific community on this topic.

The goal of the statement was:

1) To produce a useful tool for Members of Congress and their staff to evaluate proposed peer review regimes using criteria developed by scientists.
2) To produce a document that will be accepted and signed by the larger scientific community (medical sciences, geosciences, etc.).
3) To create a tool that scientific societies can use when offering input to policy makers on peer review regimes. Upon completion of the statement, ESA will work with other interested societies to organize a Capitol Hill briefing on peer review.

## Position Statement on Scientific Peer Review

Peer review is an integral component of scientific research and publishing. It allows the scientific community to maintain quality control of research through the review of research proposals, journal manuscripts and other reports. Academic peer review, although far from perfect, is the best tool scientists have to ensure high standards for their professional work.

This idea has been translated into the policy arena through "scientific peer review" the review, by scientific experts, of in-house agency science or the body of science underlying management decisions. These types of reviews are critically important tools for policy makers. They allow experts from both inside and outside the federal government to provide technical advice and analysis, increasing public confidence in federal science, and ensuring that the best quality information is used in decision making.

However, it is critical that scientific peer review programs be carefully designed to maintain objectivity, quality, and thoroughness. While scientific peer review is an important tool for decision makers, a poorly designed process can do more harm than good. It is for this reason that we endorse the following list of important considerations for government scientific peer review of agency-produced science and the body of science underlying management decisions.

- **The first priority in choosing reviewers should be to engage the most competent scientists.** Therefore, conflict of interest exclusions must be carefully designed to balance barring those with a direct conflict of interest and the reality of a finite pool of suitable reviewers. The key issue in selecting reviewers is whether they bring the necessary scientific knowledge and objectivity to reviewing the matter at hand.

- **Scientific peer review should be insulated from politics as much as possible.** Oversight of scientific peer review should be vested in scientists and science managers within the agencies. This adds assurance that the composition of panels is not being unduly influenced by politics and constitutes a representative subset of the scientists most competent to review and assess the topic. The agencies must be trusted to perform the task of constituting and overseeing fair and independent scientific peer review efforts, without interference from political entities

- **Even the best scientific peer review cannot give policy makers the "right" answer.** Scientific peer review can provide assurances that rigorous, conclusions logically follow from the results. However, often more than one interpretation of the data set can be made, and there may be no way to determine which interpretation is 'best.' Where data are limited or other uncertainties abound, scientific peer review can point these problems out, but it cannot overcome them.

- **Scientific peer review must maintain programmatic flexibility.** While guidelines can help to ensure that certain standards are met and maintained, an overly rigid process, particularly for scientific peer review of the body of science underlying policy decisions, will result in inefficient use of time and resources. It may be overly prescriptive to stipulate the number of reviewers, the questions they must answer, or the type of report they must produce for the broad range of agency scientific work.

- **All scientific peer review must be based upon an assumption of integrity.** While common-sense measures can be taken to weed out direct conflicts of interest, an implementable system can never be fully cleared of all potential conflicts of interest. Instead, fair reviews are the product of professional standards of conduct that are a fundamental component of training in scientific research. Scientific peer review must ultimately rest on the presumed integrity of the reviewers.

- **Efforts to revise the process of peer review should acknowledge the differences in professional culture that often divide scientists, policy makers, and the public.** The academic model of peer review calls on reviewers to be as critical as possible. This is done so that authors are able to make improvements where they can and so that the weaknesses of the work are understood and acknowledged. Thus, results from scientific peer review that highlight uncertainties, questions, and alternative explanations do not mean that the science was not well done or that its findings are invalid. Science is inherently uncertain and there will always be unanswered questions and areas where more research is needed. However, acknowledging uncertainty should not be equated with an inability to draw conclusions; managers often must act without complete certainty. Scientific peer review, properly carried out by competent peer scientists, can reassure managers, decision makers, and the public that such difficult decisions are based on research that represents the current state of our scientific understanding.

# Emerging Technologies

## "Emerging Technologies" will replace Technological Tools

*This new column, to be jointly edited by David Inouye and Sam Scheiner, is aimed at highlighting new or emerging areas of technology and methodology in ecology. Topics may range from hardware to software to statistical analyses, or to technologies that are or could be used in ecology. Some of these will be bleeding-edge developments, but they can include long-standing methods from other fields that have not yet caught on in ecology. Here is your chance to share your little-known favorite method or to show off the secret geek side of your personality.*

*Articles should be no longer than a few thousand words. A suggested format for such an article is: (1) a brief depiction of the concepts or ideas addressed by the technology or methodology, (2) a description of that technology or methodology, and (3) references, readings, and commercial or noncommercial sources, perhaps with a few sentences about each.*

*Ideas for articles should be directed to David Inouye (301-405-6946; E-mail: inouye@umd.edu) and Sam Scheiner (703-292-7175; E-mail: sscheine@nsf.gov).*

## Improving the Presentation of Results of Logistic Regression with R

### Introduction

In a recent issue of the *ESA Bulletin*, Smart et al. (2004) proposed an interesting new means of presenting the results of logistic regression, incorporating frequency histograms for each category of the dependent variable and an associated scale on the right-hand axis of the traditional probability plot. The new method of presentation clearly increases the information of the graph, but as they recognize, the manual production of these figures is time consuming. They suggest that software manufacturers should incorporate this type of combination graph in future updates of statistical packages.

In this note I show that we do not have to wait for software updates because we already have an easy means to produce and improve this kind of graph. I also provide some R functions to produce some variants of the combination graph.

### An easy R approach

R is a free, open-source environment for statistical computing and graphics (R Development Core Team 2003). Its potential use for ecologists has only been described briefly (Elner 2001, Kangas 2004). Some of the developers of R were also innovators in statistical graphics (e.g., Chambers et al. 1983), so it is not surprising that R has strong capabilities to implement any kind of graphics. But, like the standard statistics packages, R does not have (or at least, I did not find it in the extensive help documentation) a combination graph for logistic regression. However, it has facilities to produce scatterplots and to produce histograms. The difference from other statistics packages (apart from the fact that R is not a "package" but a system or language) is that we can easily access and manipulate the elements of the scatterplots and the histograms and can combine them in a single graph. R also provides the user with a set of functions (e.g., plot, points, lines, axis, polygon, etc.) to modify built-in graphics or to build them from scratch.

In the case of logistic regression the data would usually have two variables: the dependent variable (e.g., coded 0 and 1) and the observed data for the predictor variable (independent variable). The process to build a combination graph in R could be the following:

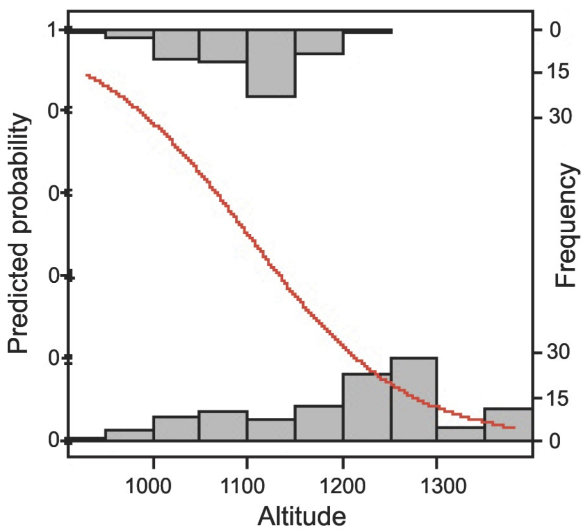
1) Set the draw area with function plot.
2) Use function hist to obtain the boundaries and the counts (i.e., the "heights") of the bins of histograms of the independent variable.
3) Scale the counts to adjust the height of the histograms to the desired height among the 0– 1 scale of the scatterplot. As one of the histograms will be drawn in the top of the graph, subtract from 1 their scaled counts.
4) Use repeatedly the function polygon with the scaled counts and boundaries data to draw the bins of each histogram.
5) Use the function axis and the scaled counts to

draw the right-hand frequency axis.

6) Fit a binomial glm model to the data and add the predicted logistic curve to the graph.

These steps produce the graph of Fig.1, using hypothetical data that describe the probability of occurrence of a tree along an altitudinal gradient.

Fig.1. Fitted logistic regression curve and histograms of both categories of dependent variable.




## Some improvements

Although we know now how to produce the combination graph, it is worth remembering that histograms are not the best method for visual description of univariate data. Ellison (1993) gives some reasons to prefer presentations other than histograms. For example, the number of bins in a histogram is something arbitrary (in the above example it was the default of function hist). Summary statistics cannot be computed from the data illustrated in the histogram, and because of the arbitrariness of the bins, the distribution of data is to some degree distorted or exaggerated. Also, histograms hide the raw data, and although we can present a frequency scale, with the reduced graphics of scientific papers it is almost impossible to ascertain the exact number of counts in each bin.

A possible solution to this problem could be to annotate the number of counts in each bin, although it would not solve the problem of the arbitrary bins. From a biological point of view it would sometimes be desirable to summarize the counts in intervals of ecological interest. In R we can both select between a set of algorithms to construct the histogram, and specify the exact sequence of intervals (even of different amplitude). Fig. 2 shows the histograms built for a sequence of intervals of 20 m of altitude.

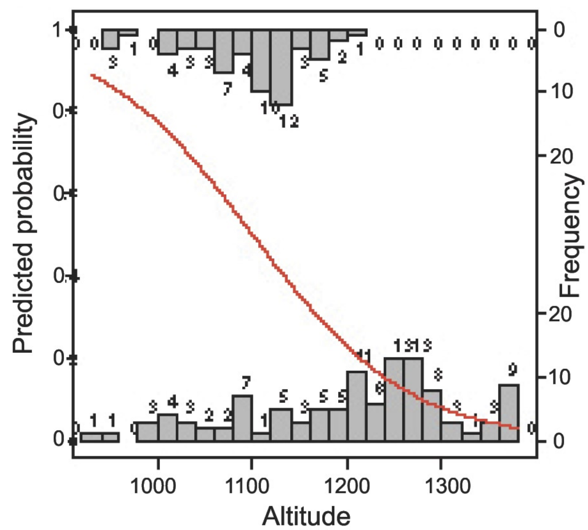



Fig. 2. Fitted logistic regression curve and histograms with bins every 20 m and counts in each bin.

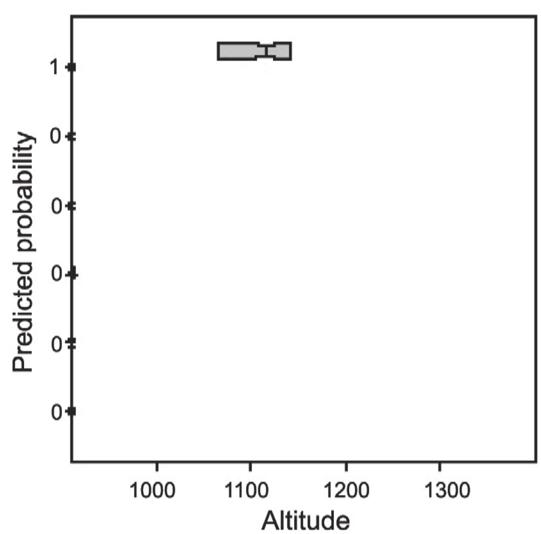



Fig. 3. Fitted logistic Gaussian regression curve with dit plots and box plots of dependent variable categories.

Ellison (1993) suggests the box-and-whisker plot (also called box plot) as an alternative to histograms. Box plots summarize efficiently the information of the data (median, quartiles, ranges, and outliers) and can even present confidence intervals (notched box plots) so that we can compare the distribution of both dependent variable categories. In R, box plots (notched or not) can easily be added to graphs with function boxplot. Fig. 3 shows the possible use of box plots in a combination graph for logistic regression. Another alternative proposed by Ellison is the dit plot. In dit plots each observation is represented by a point placed along the horizontal scale at the exact location of its value. If there are several observations with the same value, they are stacked up (or down) the *y* axis.

In R we can combine dit plots with logistic regression curves following the next steps:

1) Get the unique values with function unique.
2) Get the number of repeated observations for each value with functions unique and length. Add (or subtract in the case of the upper dit plot) a sequential increment to the *y* value of each repeated observation.
3) Represent each observation with function points.
4) Fit a binomial glm model to the data and add the predicted logistic curve to the graph.

With appropriate dit plots we can present the raw data in full; it seems a good alternative (with or without box plots) to histograms in the combined graphs.

## It could be even easier than that

Function plot.logi.hist, (Appendix A) is an R function (actually a set of functions) for the naive R user that can be used to produce all the combination graphs mentioned in the text. To produce a combination graph you need only have a working R environment (download it from your nearest mirror site at cran.r-project.org), type or read in your data (you can read your data in several formats, e.g., from a csv or tab-delimited ascii file with read.table; from SAS or SPSS files with library foreign, or from Excel files with library gregmisc), and paste and use function plot.logi.hist. For example, if "tree" is the dependent variable with the presence/absence data and "altitude" the predictor variable with the observational data, typing

```
plot.logi.hist (altitude, tree)
```

will produce a combined graph with logistic curve, dit, and box plots. Other plots and combinations can be produced, adding parameters to the function. For example

```
plot.logi.hist (altitude, tree, type = "hist",
count.hist = TRUE)
```

will produce the graph with box plot, histograms, and will annotate the counts in each bin.

Graphs can be copied to the clipboard as bitmaps or metafiles or can be saved in a variety of formats, so they can easily be used for papers, presentations, etc.

Like most R functions, plot.logi.hist is a text file; it can be edited with a word processor and customized to accomplish more specific needs of the user.

## Literature cited


Chambers, J. M., W. S. Cleveland, B. Kleiner, and P. A. Tukey. 1983. Graphical methods for data analysis. Wadsworth, Belmont, California, USA.

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*Appendices follow...*

## Appendix A

```
# Function plot.logi.hist  is a set of R functions
# to plot combined graphs for logistic regression. Its
# arguments are: independ (explanatory variable), depend
# (dependent variable), logi.mod (type of fitting, 1 =
# logistic; 2 = "gaussian" logistic), type (type of
# representation, "dit" = dit plot; "hist" = histogram),
# boxp (TRUE = with box plots, FALSE = without), rug
# (TRUE = with rug plots, FALSE = without), las.h
# (orientation of axes labels (0 = vertical, 1 =
# horizontal).



plot.logi.hist <- function (independ, depend, logi.mod = 1,
    type = "dit", boxp = TRUE, rug = FALSE,
    las.h = 1, ...){

# get the label for the x-axis
xlabel <- paste(deparse(substitute(independ)))

# define functions:

# set the draw area if no box plots are to be drawn
 logi.scater <- function (independ, depend, scater = "n",
    x.lab = xlabel, las =las.h){
 plot(independ, depend, cex = 1, type = scater,
    ylab = "Predicted probability", xlab = x.lab,
    cex.lab = 1.5, las = las)
 }

# add rug plot if desired; you could change pch.rug
# (symbol type) or cex.rug (symbol size)
 logi.rug <- function (independ, depend, pch.rug = 16,
    cex.rug = 1){
points(independ, depend, pch = pch.rug ,cex = cex.rug)
 }

# set the draw area and add box plots; you could change
# cold.box (color of the boxes)
logi.box <- function(independ, depend, col.box = "gray",
  x.lab = xlabel, las = las.h){
plot(independ, depend, cex = 1, type = "n",
```

```
   ylim = c(-0.1,1.1), ylab = "Predicted probability",
   xlab = x.lab, cex.lab = 1.5, las = las)
 indep.1 <- independ[depend == 1]
 indep.0 <- independ[depend == 0]
 boxplot(indep.1, horizontal = TRUE, add = TRUE,
    at = 1.05, boxwex = 0.1, col = col.box, notch = T)
boxplot(indep.0, horizontal = TRUE, add = TRUE,
   at = -0.05, boxwex = 0.1, col = col.box, notch = T)
 }

# fit binomial glm and add predicted curve; you could
# change col.cur (color of the curve) or lwd.cur(width
# of the curve)
logi.curve <- function(independ, depend, mod = logi.mod,
    col.cur = "red", lwd.cur = 4){
if (mod == 1) mod3 <- glm(depend ~ independ,
    family = binomial)
if (mod == 2) mod3 <- glm(depend ~ independ +
    I(independ^2), family = binomial)
x.new <- seq(min(independ), max(independ), len = 100)
y.new <- predict(mod3, data.frame(independ = x.new),
    type = "response")
lines(x.new, y.new, lwd = lwd.cur, col = col.cur)
}

# add dit plot; you may want to change pch.dit (type of
# points), cex.p (size of points), and incre (space
# between points)
logi.dit <- function (independ, depend, cex.p = 1,
    pch.dit = 1, incre = 0.02){

 indep.0 <- independ[depend == 0]
 indep.1 <- independ[depend == 1]
 uni.plot.0 <- function(x) length(which(indep.0 == x))
 uni.plot.1 <- function(x) length(which(indep.1 == x))

 # get the number of repeated values of "independ":

 cosa.0 <- apply(as.matrix(unique(indep.0)), 1, uni.plot.0)
 cosa.1 <- apply(as.matrix(unique(indep.1)), 1, uni.plot.1)

 # start ploting:
 points(independ, depend, pch = pch.dit, cex = cex.p)
```

```
 for (i in 1:max(cosa.0)){
     for (j in 1:i){
        points(unique(indep.0)[which(cosa.0 == i+1)],
         rep(0 + incre*j, length(which(cosa.0 == i+1))),
         pch = pch.dit, cex = cex.p)
     }
 }

 for (i in 1:max(cosa.1)){
    for (j in 1:i){
        points(unique(indep.1)[which(cosa.1 == i+1)],
         rep(1 - incre*j, length(which(cosa.1 == i+1))),
         pch = pch.dit, cex = cex.p)
    }
 }
}

# add histograms and frequency axes; you may want to change
# scale.hist (factor to scale histogram height to 0-1
# interval) or col.hist (color of histogram)
 logi.hist <- function(independ, depend, scale.hist = 5,
    col.hist = gray(0.7), count.hist = FALSE,
    intervalo = 0, las.h1 = las.h){

  # get the position of bins
   h.br <- hist(independ, plot = F)$br
   if (intervalo > 0) h.br <- seq(from = range(h.br)[1],
     to = range(h.br)[2], by = intervalo)
   h.x <- hist(independ[depend == 0], breaks = h.br,
     plot = F)$mid

  # get counts in each bin
    h.y0 <- hist(independ[depend == 0], breaks = h.br,
      plot = F)$counts
    h.y1 <- hist(independ[depend == 1], breaks = h.br,
      plot = F)$counts

  # scale the histogram bars to max desired length:
    h.y0n <- h.y0/(max(c(h.y0,h.y1))* scale.hist)
    h.y1n <- 1 - h.y1/(max(c(h.y0,h.y1))* scale.hist)

  # draw bottom histogram:
   for (i in 1:length(h.y0n)){
     if (h.y0n[i] > 0)
```

```
      polygon(c(rep(h.br[i], 2), rep(h.br[i+1], 2)),
        c(0, rep(h.y0n[i], 2), 0), col = col.hist)
   }

  # draw top histogram:
   for (i in 1:length(h.y1n)){
     if (h.y1n[i] < 1)
      polygon(c(rep(h.br[i], 2), rep(h.br[i+1], 2)),
        c(h.y1n[i], 1, 1, h.y1n[i]), col = col.hist)
   }

  # add counts to bins if required:
   if (count.hist == TRUE)
    for (i in 1 : length(h.x)){
     text(h.x[i], h.y1n[i], h.y1[i], cex = 1, pos = 1)
     text(h.x[i], h.y0n[i], h.y0[i], cex = 1, pos = 3)
    }

  # plot the axes of histograms:
   axis.hist <- function (h.y0, h.y1, scale.hist,
      las = las.h1){
    tope <- max(c(h.y0, h.y1))
    label.down <- c(0, (ceiling(tope/10))*5,
      (ceiling(tope/10))*10)
    label.up <- c((ceiling(tope/10))*10,
      (ceiling(tope/10))*5, 0)
    at.down <- label.down/(tope * scale.hist)
    at.up <- 1 - (label.up/(tope * scale.hist))
    at.hist <- c(at.down, at.up)
    label.hist <- c(label.down, label.up)
    axis(side = 4, at = at.hist, labels = label.hist,
      las = las)
    mtext("Frequency", side = 4, line = 2, cex = 1.5)
   }
   axis.hist(h.y0, h.y1, scale.hist)
   axis (side = 2, las = las.h1)
 }


# set the margins of plot area
old.mar <- par()$mar
par(mar = c(5.1,4.1,4.1,4.1))

# plot the combined graph
```

```
if (boxp == TRUE) logi.box(independ, depend)
if (boxp == FALSE) logi.scater(independ, depend)
if (type != “dit”) logi.hist(independ, depend,...)
if (rug == TRUE) logi.rug (independ, depend)
logi.curve(independ, depend)
if (type == “dit”) logi.dit(independ, depend)

# reset the margins to old margins
par(mar = old.mar)
}


# Example data, from library gravy of J. Oksanen

altitude <- c(930, 945, 955, 955, 960, 970, 990, 1000, 1000, 1005, 1010, 1010,
1015, 1015, 1020, 1020, 1020, 1030, 1030, 1030, 1030, 1030, 1035, 1045, 1050,
1050, 1050, 1060, 1065, 1065, 1065, 1070, 1070, 1075, 1080, 1080, 1080, 1085,
1090, 1090, 1090, 1090, 1095, 1100, 1100, 1100, 1100, 1100, 1110, 1110, 1110,
1110, 1120, 1120, 1120, 1120, 1120, 1120, 1120, 1125, 1130, 1130, 1130, 1130,
1130, 1130, 1135, 1135, 1140, 1140, 1140, 1140, 1140, 1140, 1140, 1140, 1150,
1150, 1160, 1160, 1160, 1160, 1165, 1170, 1170, 1170, 1175, 1180, 1180, 1180,
1180, 1180, 1185, 1190, 1190, 1190, 1195, 1200, 1200, 1205, 1210, 1210, 1215,
1215, 1215, 1220, 1220, 1220, 1220, 1220, 1220, 1225, 1230, 1230, 1235, 1240,
1240, 1250, 1250, 1250, 1250, 1250, 1250, 1255, 1255, 1255, 1255, 1260, 1260,
1260, 1265, 1265, 1270, 1270, 1270, 1270, 1275, 1275, 1275, 1275, 1275, 1275,
1280, 1285, 1285, 1290, 1290, 1290, 1300, 1300, 1300, 1310, 1310, 1310, 1330,
1350, 1355, 1360, 1365, 1365, 1365, 1365, 1370, 1370, 1370, 1370, 1380)


tree <- c(0, 1, 1, 1, 0, 1, 0, 0, 0, 1, 0, 1, 1, 0, 0, 1, 0, 0, 1, 1, 0, 0, 1, 1,
1, 0, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1, 1,
1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0,
0, 1, 0, 1, 1, 0, 0, 1, 1, 1, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0)
```

# Focus on Field Stations

## University of Michigan Biological Station (UMBS)

Without the sign at the main entrance of the University of Michigan Biological Station UMBS), you might not suspect that this driveway leads to land that has been a research and teaching field station since 1909. And without a map, you might not have realized that during the last two miles of your drive you were already surrounded by the Station's property. The Biological Station manages 10,000 acres (4050 ha) bounded by undeveloped shoreline, including 9 km on Douglas Lake (15.2 $km^2$ area) and 2.5 km on Burt Lake (69.29 $km^2$) (Fig. 1).

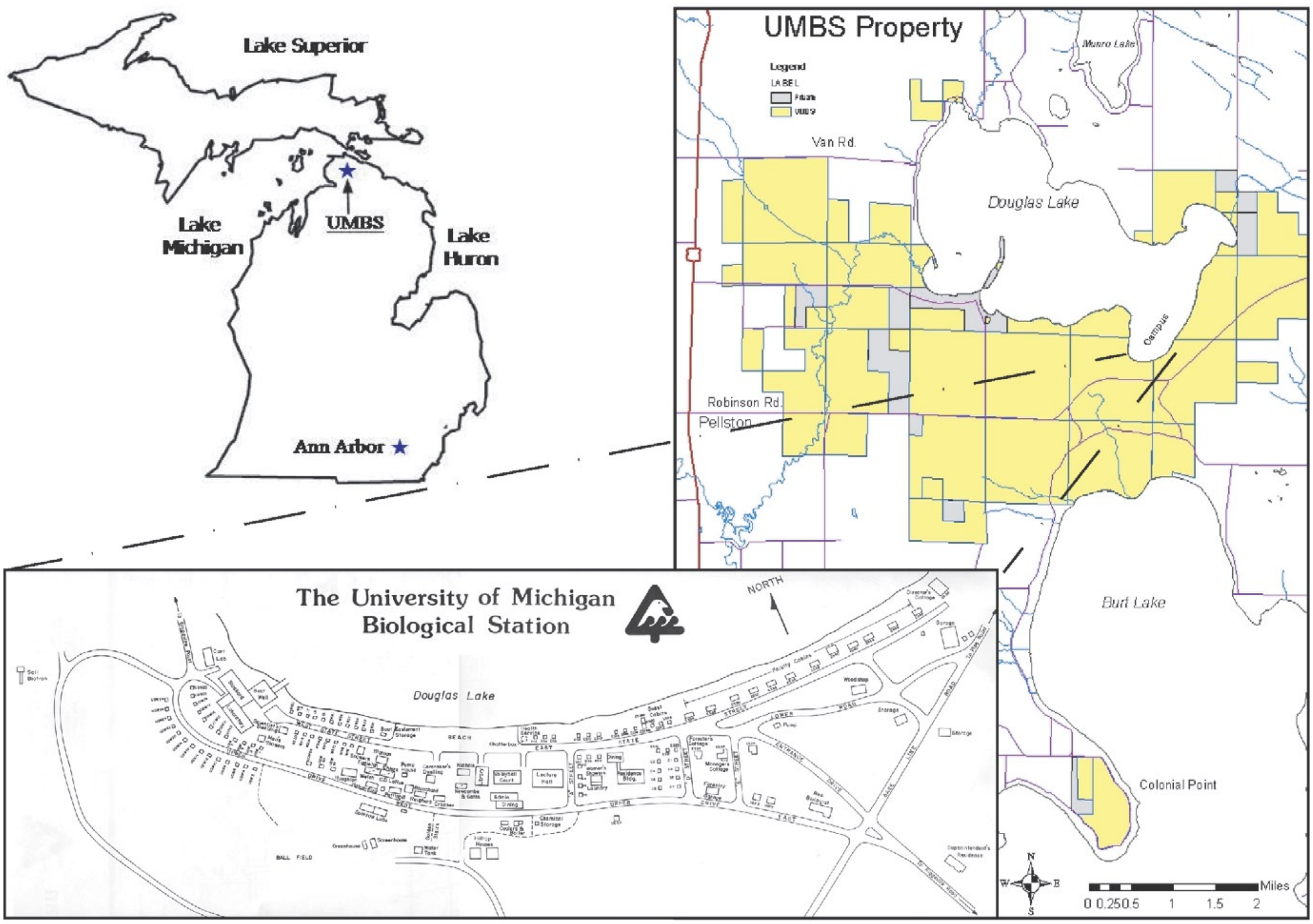


Fig. 1. Location of the University of Michigan Biological Station in northern Michigan. The principal land holdings (~10,000 acres [4050 ha]) of the UMBS are shown in yellow in the first inset. The campus (housing, laboratories, classrooms, laboratories, service buildings) is shown in the second inset. Sugar Island structures and land (~3,200 acres [ ~1300 ha]), about 60 miles [97 km] north) are not shown.

The holdings contain a rich diversity of natural habitats: extensive forests of pine, northern hardwoods, conifer swamps, and successional aspen stands, fields and meadows, pine plains, rivers, streams, and wetlands. Designated as a research and natural area available for use by students, faculty, and visiting researchers, public access is allowed, but off–road motorized vehicles are prohibited. Farther north, UMBS

Fig. 2. A 1909 photograph overlooking the engineering camp before cabins were built, with Douglas Lake and Grapevine Point in the background.

manages another 3200 acres (1300 ha) on Sugar Island in the St. Mary's River between Michigan's Upper Peninsula and Canada. UMBS researchers also have ready access to extensive areas of surrounding public lands, the shores of Lakes Michigan and Huron within 20 miles (32 km), and Lake Superior, which is less than 2 hours away.

In 1908, when Colonel and Mrs. Charles Bogardus gave the first 1441 acres (580 ha) to the University of Michigan for research and education purposes, it was a worn piece of land. With soil too sandy for successful agriculture, and stripped of saleable lumber, it was a clear-cut, burnt piece of Northern Michigan, 260 miles north of the University's Ann Arbor campus, and 20 miles south of the Straits of Mackinaw, which divides Michigan's Upper and Lower Peninsulas (Fig. 2).

Now numbering among North America's oldest continuously operating field stations, UMBS held its first summer session in 1909. The campus was initially shared with the University's Civil Engineering department for student training in surveying, and the engineers' legacy of precisely built rows of tin–sided shacks are still used by students—the biologists contented themselves with setting up tents farther down the lake. However, as the land recovered and plants and trees reestablished themselves (Figs. 3 and 4), the property became less useful for teaching surveying methods, and in 1929 the engineers moved to Wyoming. After they left, the biologists happily moved into the empty engineers' facilities, and have expanded them considerably in the years since.

Fig. 3. Looking west through the Douglas Lake campus in 1910

In its 96 years of operation, UMBS has served more than 8400 students, and research based at this field station is described in >2660 publications, including 202 theses and dissertations, fulfilling the mission of the Biological Station: the integration of research and education in field biology. Fundamental work in parasitology, plant ecology, animal behavior, limnology, global change research, and atmospheric science has been carried out here. Due to a tradition of linked education and research programs, and to the presence of diverse habitats protected within its boundaries, the UMBS is designated as a Biosphere Reserve by the U.N. Man and the Biosphere Program and as an Experimental Ecological Reserve by the National Science Foundation.

## Today's station

Fig. 4. . . . and looking west through the Douglas Lake campus in 2003.

The center of UMBS is laid out in the form of a small village on Douglas Lake's South Fishtail Bay (Fig. 5). About 150 buildings serve the community's needs for housing, dining, teaching, research, maintenance, and recreation. In the summer, our peak time, with nearly 300 residents, housing is provided by 70 one-room, two-bed cabins, 30 larger two- and six-room cabins, and a 14-room residence hall with 30 beds. These residences can all be used from April through October. The rest of the year, residents and visitors live in 14 winterized cabins or in the 30-bed dormitory. Our dining hall is capable of serving our maximum population in a single sitting, and is open from mid-May through early fall.

Our lecture hall has a 250-seat auditorium, a 100-seat seminar room, and a kitchenette. The LaRue Library, the northernmost shelves in the University of Michigan Library system, holds over 16,000 volumes and is one of the best among inland field stations. It is noted for its collections in limnology, ornithology, ecology, systematics, and natural history. A full-time librarian is present in the summertime.

Fig. 5. An aerial view of the UMBS central "village" on Douglas Lake's South Fishtail Bay.

## Education /outreach

Field-centered coursework is offered in a 4-week spring term (mid-May to mid-June) and an 8-week summer term (mid-June to mid-August). Classes are taught by 15–20 faculty members, most of whom also conduct research at UMBS. Enrolled students typically take a single 5-credit course in spring term and two 5-credit courses in summer term. Classes are small, with 6–18 students per course section. Every summer *General Ecology* and *Natural History and Evolution* are taught alongside other upper-level courses such as limnology, entomology, parasitology, mammalogy, behavioral ecology, ornithology, phycology, ichthyology, ethnobotany, and field botany (Fig. 6). We also teach an entry-level course, *Introduction to Natural Sciences,* during spring term.

Fig. 6. The 1910 plant ecology class doing plane table mapping.

The Station has close links to the University's Ecology and Evolutionary Biology department where Director Knute Nadelhoffer is a professor. Students and researchers from other UM units, including the School of Natural Resources and the Environment, and the College of Engineering, participate in UMBS programs, as do faculty and students from across the United States and around the world (In 2004, 12 of our faculty were from institutions other than the University of Michigan.) In addition to our 15–20 faculty, our field seasons usually include ~100 undergraduate

Fig. 7. . . . and birding with Dr. James Watson (UMBS alumnus from 1946) during his 2003 visit to give the Pettingill Lecture in Natural History, part of the UMBS summer lecture series.

students, 25 principal investigators, 50 graduate student investigators, and 40 research assistants at the Douglas Lake facility. In 2003, Station visitors came from 34 different universities, colleges, and agencies.

For the past 20 summers we have offered adult, noncredit mini-courses at our site. Practicing naturalists, retired biologists, students, alumni, and other interested individuals spend 5 days living at the Station. Our 2004 mini-courses featured studies of mollusks, northern Michigan flora, northern Michigan birds, American nature writing, aquatic vascular plants, art in nature, forest and landscape ecology, northern Michigan fungi, and photography in nature. Each course is taught by a faculty member who is well acquainted with the Biological Station and the northern Michigan region. Beginning last year, we initiated a children's mini-course, "*Be a Biologist: Science Adventure for Kids*."

UMBS hosts many lectures, workshops, symposia, and short visits by classes from the Ann Arbor campus or from other colleges and universities, public school groups, and community organizations. During the summer, we regularly invite to the Station speakers who give evening lectures in the auditorium or seminar room (Fig. 7). In 2004, our various symposia and research meetings, departmental retreats, local elementary, middle, and high school classes, church groups, and open houses for the surrounding community had visitor counts ranging from 50 to 150 people. Additionally, a large number of hikers, birders, snowshoers, and cross-county skiers traverse our lands. Such passive use is encouraged on all but the most sensitive research areas.

Fig. 8. The Alfred H. Stockard Lakeside Laboratory is the largest building at UMBS, with 24,000 square feet (2230 $m^2$) of floor space.

## Research

The Station's largest building is the Alfred H. Stockard Lakeside Laboratory (Fig. 8) with 24,000 square feet (2230 $m^2$) of floor space. This laboratory is centrally heated and ventilated and provides electricity, hot and cold water, de-ionized water, lake water, gas, compressed air, and Ethernet throughout. Special features include a computer laboratory, photo darkrooms, a stockroom, a large, enclosed boatwell connected to Douglas Lake, and an analytical chemistry facility. The chemistry facility is managed by a chemist and provides residents with access to special analytical equipment including a Bran and Luebbe autoanalyzer, a CHN analyzer, a Packard liquid scintillation counter, and a Finnigan Delta Plus XL isotope ratio mass spectrometer (IRMS). Other equipment available for general use includes freezers and refrigerators, a lyophilizer, autoclaves, spectrophotometers, ovens, incubators, balances, centrifuges, and microscopes. The stockroom provides consumable chemicals, standard glassware, and a wide variety of field equipment and sampling apparatus (plankton nets, snowshoes, tree ladders …).

## Long-term research record

The UMBS has been a center of research on organisms, habitats, and ecosystems of the Upper Great Lakes region since its founding. Data records and ongoing activities include: meteorological records (since 1912), lakewater chemistry (since 1913), parasite–host records (since the 1920s), forest succession on controlled burn plots (since 1936), forest succession (50-year and forestry) plots (since 1938), breeding bird diversity and abundances (since 1941), vegetation responses to lake level changes (since 1971), precipitation chemistry (since 1979), soil temperature recording (since 1987), small-mammal abundances (since 1989), mercury deposition (since 1992), and UV-B monitoring (since 1994). These longitudinal databases and others provide an exceptional opportunity to compare today's organisms and ecosystems with those of past decades. Specimen collections are available to researchers and are especially extensive in birds, fishes, insects, invertebrates, algae, parasites, vascular plants, mosses, and lichens.

Fig. 9. The 50-m Ameriflux tower, with Douglas Lake in the background. This photograph was taken from the 35-m Prophet tower. Both towers are equipped with sensors for monitoring forest–atmosphere gas exchanges

When visiting investigators or research groups collect data on our permanent plots or historical aquatic sites we request they provide the resulting data for our archives. This might mean, as examples, that another year of tree diameter measurements is added to the Excel file of a permanent vegetation plot, or that another season of bird observation data is added to the long-term census plot data. All investigators, whether students or Ph.D level scientists, are required to submit their research product: a thesis, a dissertation, or a publication. All of these publications are incorporated into a bibliography database, which can then be searched by site (our Gazetteer has presently 530 named sites on our property and across northern and upper Michigan) and by other variables. In addition, the student papers bibliography (presently 3424 project publications) describes use of many of those same sites by students in the courses taught by many of the primary investigators.

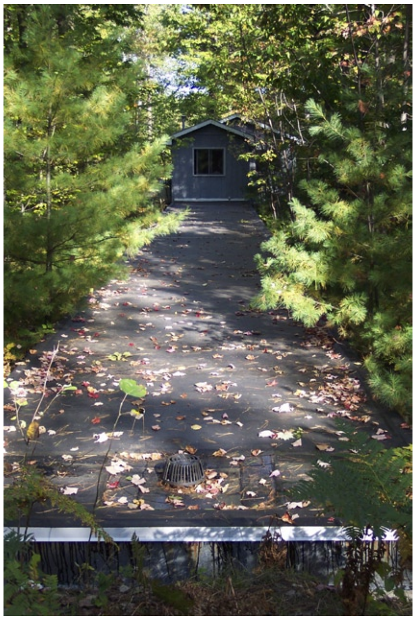

Fig. 10. A view along the roof of the underground laboratory space of the UMBS Soil Biotron, a belowground laboratory that provides rare opportunities to view and study roots, fungal hyphae, soil invertebrates, and microbes in situ in the upper 1.2 m of soil.

## Forest carbon and nitrogen cycles

As a location to investigate atmospheric–ecosystem interactions, the UMBS is outstanding. We operate two towers (within 100 m of each other) with sensors for monitoring forest–atmosphere gas exchanges (Fig. 9). The PROPHET tower (Program for Research on Oxidants: PHotochemistry, Emissions, and Transport) is 35 m tall and was constructed in 1996 to measure above-canopy concentrations and fluxes, in order to study atmospheric, chemical, and meteorological processes linked to tropospheric ozone and oxidant formation, as well as how the atmosphere affects the forest nitrogen budget (Carroll et al. 2001). The UMBS Carbon Flux Study (part of the US DOE AMERIFLUX network) uses a 50-m eddy covariance tower, erected in 1998, to study forest–atmosphere $CO_2$, water, and energy exchanges (Curtis et al. 2002, Schmid et al. 2003). Both towers operate year-round. The UMBS Carbon Flux Study also measures a suite of physical, ecological, and soil data to follow carbon flows into vegetation and belowground.

## Soil Biotron

The UM Biological Station also has a belowground laboratory located in a mixed hardwood forest that provides rare opportunities to view and study roots, fungal hyphae, soil invertebrates, and microbes in situ in the upper 1.2 m of soil (Fig. 10). The Soil Biotron was built in 1987 with NSF support to facilitate observations and experiments in soil environments (Teeri 1992). After the building was constructed, soil from a nearby plot was excavated in thin layers and the profiles were carefully reconstructed alongside the Biotron observation windows. It differs from most lysimeter-rhizotrons in having removable windows to allow sampling or manipulation of soil biota. A total of 34 1.2 × 1.2 m observation windows, each with 16 0.3 × 0.3 m removable panes, yields a total of 544 0.9-$m^2$ sampling areas. Nearly 500 nearby trees (bigtooth aspen, red oak, red maple, beech, red pine, and small white pine) are permanently tagged and their diameters recorded. Roots of these trees, including mycorrhizae, are visible from the windows. The Biotron has enabled studies of carbon flow to roots, root turnover, soil plant–fungal–animal dynamics, mycorrhizal nutrient dynamics, and root turnover in relation to water and nutrient patchiness.

Fig. 11. During the breeding season, the Great Lakes Piping Plover ecology and conservation team uses UMBS as a research base.

## Elevated $CO_2$, trace gas, and other facilities

Specialized research facilities also include a greenhouse, an elevated $CO_2$ facility (open-top chamber arrays for studying the responses of multiple trophic levels of terrestrial and aquatic ecosystems to elevated atmospheric $CO_2$), and monitoring stations for measuring precipitation chemistry (NADP), ultraviolet radiation (USDA UV-B), and mercury deposition.

Other important groups based at and using station facilities include the Piping Plover ecology and conservation team (Wemmer et al. 2001) (Fig. 11), the elevated $CO_2$ facility team (Zak et al. 2000), the artificial stream laboratory group, the Michigan gradient plots group, and the ecosystem mappers. Global change biologists have published 51 papers from work done at the elevated $CO_2$ facility. The Artificial Stream Lab group has produced 18 papers at the artificial stream lab facility (Fig. 12), where water can be pumped out of the East Branch of the Maple River to a concrete pad and distributed into artificial streams. Much of that work has focused on chemical communication in crayfish, insect behavior, and benthic algal growth (Adams et al. 2003). In 1987 the University of Michigan, Michigan State University, and Michigan Technological University began a long-term study of the effects of climate and atmospheric deposition on forest productivity and ecosystem process in the Great Lakes region. The principal objective was to evaluate the role of deposition in producing significant changes in forest ecosystems (Pregitzer et al. 1995). Since 1994 the focus has shifted somewhat to the effects of chronic nitrogen deposition and experimental nitrate additions. By 2000 this group had produced 70 publications. The ecosystem mapping group, headed by UM Professor Burton Barnes, has been working at UMBS since 1988. They have produced ecosystem and cover type maps for our Douglas Lake property (and extensive data from the plots used to make the types) that have proved extremely useful to many other researchers and students on our campus.

Fig. 12. Experimental streams built at the UMBS Artificial Stream Laboratory, where water can be pumped out of the East Branch of the Maple River to a concrete pad and distributed into artificial streams.

## The future

As the University of Michigan Biological Station prepares to celebrate its centenary in 2008, we look forward to integrating our research and teaching programs more closely, and to actively involving students at all levels in field studies of organisms, ecological processes, and ecosystem–climate interactions. As we move into the 21st century and towards our second hundred years as a field station, we will increasingly rely on long-term databases and the knowledge of organisms and local ecological communities to define and inform our linked teaching and research activities. Courses are being designed that will incorporate new environmental sensing technologies, modeling tools, natural history information, and crossdisciplinary activities into our field-based curriculum. We aim to provide current and future students with skills and tools that will enable them to identify key ecological questions and to solve environmental problems associated with increased human activities, changes in ecological communities and ecosystems, and climate change.

We invite creative researchers from across the world to visit and work at our field station. We strongly encourage students, both undergraduates and graduates, to consider enrolling in our courses or applying to our research programs. Many possibilities for scholarship and fellowship aid are available to motivated students. Information on opportunities for study and research is available at our web site: ‹www.lsa.umich.edu/umbs/›

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## Ecological Education for Schools K–12

Welcome to our new column, which is specifically targeted at ecological education in schools. We are starting this column for several reasons. First and foremost, ecological education at all levels is a key mission of the ESA, and while we already have some key initiatives in education, we want to provide a forum that stimulates and shares good practice in schools. Engaging young people in the wonders of ecological science in school can be life changing for them, and can often stimulate interest in further study in ecology. Talented teachers need support and a forum for disseminating activities that work, and beginning teachers need access to this material. There are also many ecological educators working with schools who are not in the school system. We envisage this column as accepting a wide and diverse range of submissions—from a diverse population—we are open to suggestions! However, we would like to encourage material which is critical, science of ecology driven, and related to Junior and Senior High School science curriculum. Because this is an electronic medium, we have huge potential; let's use it!

We would like to include:

- ideas and lesson plans for science of ecology;
- practical activities for the classroom or field;
- resources to liven up classroom teaching or home study, e.g., downloadable movies, photos, graphs, animations;
- concept introductions for different grade levels;
- teaching evaluation of student learning;
- developments in science education and education research of interest to
- teachers;
- other web material.

It would be very useful if submissions could include web links and a few key references, as well as addressing standard criteria for good practice in teaching, i.e., it should be safe, ethically acceptable, environmentally responsible, and copyright free.

Any queries, suggestions or submissions please contact:

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# Society Section and Chapter News

## Applied Ecology Section Newsletter

The Applied Ecology section of ESA is the second largest and third oldest of the active sections within this Society. The Section was established in 1971 and has a twofold purpose: (1) to facilitate communication of the application of ecological principles to the solution of practical environmental problems, and (2) to encourage liaison with specialists in policy, administration, planning, health, agriculture, and natural resource management who use ecological principles in resolutions of their problems.

### New officers

Ballots are in and our new officers for 2005–2006 are:

Co-Chairs, Deborah Ulinski Potter ‹dapotter@fs.fed.us› and Martin A. Spetich ‹mspetich@fs.fed.us›;

Vice Chair, Becky Kay Kerns ‹bkerns@fs.fed.us›; and Secretary, Neal T. Butt ‹Nbutt@cabq.gov›.

### Student travel awards

The Applied Ecology Section seeks to support students in their efforts to present their work at the 90th ESA Annual Meeting in Montréal, Canada, 7–12 August 2005. The Section is now calling for nominations for scholarships, with individual awards up to $750. The deadline for receipt of applications is 15 May. Instructions and details for the application process can be found at the Applied Ecology Section web page: ‹http://www.esa.org/applied/›

### Rapid response teams

The Applied Ecology Section is helping the Public Affairs Office of ESA develop Rapid Response Teams to assist in responding to environmental policy issues that have an important science component. The Section is looking for members to develop a pool of people with a number of areas of expertise who would comment on legislation, write editorials, give congressional briefings, or provide testimony before Congress. Subject areas for the rapid response teams are: biogeochemical cycling, invasive species, conservation biology, marine ecology, global change, agroecology, aquatic ecology, and forest ecology. If you are interested, or would like to nominate someone, please contact a Section officer.

## Canada Chapter Newsletter

The new Canada Chapter was approved by Council at the ESA Annual Meeting in Portland in 2004. An organizational meeting was held in Portland to set an agenda for our first year, based on e-mails that were circulated. The meeting was attended by 45–50 people, with Sina Adl chairing. The Chapter is developing its web site to provide links to ecology in Canada, and to communicate with members. A symposium proposal was submitted jointly with the Biogeosciences Section for the Montreal meeting in 2005. We anticipate a larger than usual number of Canadian graduate students to attend this meeting. One or two prizes will be given for student presentations.

The Chapter will initiate a subcommittee to list important ecological issues in Canada, and to help liaise between ESA and the Canadian Federal government. We hope to have many of these issues presented on our web site. Sina Adl has agreed to continue chairing the Chapter and to initiate work on these tasks.

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## Southeastern Chapter Newsletter

### Chapter officers

Chair: James Luken (2004–2006) ‹JoLuken@coastal.edu›
Vice-Chair: Joan Walker (2003–2005) ‹joanwalker@fs.fed.us›
Secretary/Treasurer: Nicole Turrill Welch (2004–2006) ‹nwelch@mtsu.edu›
Web-Master: Mark Mackenzie ‹mackenzi@forestry.auburn.edu›
Chapter Home page: ‹http://www.auburn.edu/seesa/›

### 2005 ASB Meeting

The 2005 meeting of the Association of Southeastern Biologists will be held 13–16 April 2005 in Florence, Alabama, hosted by the University of North Alabama.

### SE-ESA Chapter luncheon

We will have our traditional luncheon on Friday, 15 April 2005, 12:15–1:30 pm, following the ASB Business Meeting

### Elsie Quarterman-Catherine Keever Award for best student poster

This award is sponsored by our chapter and will be presented for the first time at the 2005 ASB Meeting. Undergraduate and graduate students are eligible, and the student must be the sole or senior author on a poster clearly dealing with an ecological topic and representing a completed research project**.** Dr. Howard Neufeld, Department of Biology, Appalachian State University, ‹neufeldhs@appstate.edu› is the chair of the award committee and is seeking volunteers to judge this year's nominees. Please contact Dr. Neufeld if you are interested in judging these posters.

### Eugene P. Odum Award for best student paper

Our chapter also sponsors this award. Undergraduate and graduate students are eligible, and the student must be the sole or senior author on a paper presentation clearly dealing with an ecological topic and representing a completed research project**.** Dr. Jake Weltzin, Department of Ecology and Evolutionary Biology, University of Tennessee, ‹jweltzin@utk.edu› is the chair of this award committee. Volunteers are needed to judge these paper presentations; contact Dr. Weltzin if you are interested.

### Membership renewal and award support

Please remember to renew your membership in the SE chapter when you renew your ESA membership. Your donations to the Eugene P. Odum Fund and the new Quarterman-Keever Fund support the student awards mentioned above.

### Keeping in touch

Check the Chapter home page: ‹http://www.auburn.edu/seesa/› for updates and additional information. Join the Southeastern Chapter of ESA LISTSERVER: To join the ListServer, send a message to majordomo@mail.auburn.edu with "subscribe scesa" in the body of the message. Please send news or announcements to scesa@mail.auburn.edu for distribution to the listserv, or to ‹nwelch@mtsu.edu› for inclusion in the next quarterly newsletter.

Respectfully submitted,

Nicole Turrill Welch
Secretary/Treasurer