The use of *Gambusia* to control mosquito larvae in abandoned swimming pools: The New Orleans experience

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ABSTRACT. There were approximately 2,300 abandoned swimming pools in New Orleans after Hurricane Katrina, creating breeding habitat for *Culex*, *Culiseta*, and *Anopheles* mosquitoes on a massive scale. West Nile virus was a particularly serious concern. With 750 unmaintained swimming pools already containing fish from the Katrina floodwaters, *Gambusia affinis* were introduced to 1,278 of the remaining unmaintained pools during April-September 2006. Subsequent pool inspections revealed that fish were missing from 14% of those pools. The reasons were (a) stress experienced during transport to the swimming pools, (b) toxicity from rotting materials cast into the pools by the hurricane and flood, and (c) destruction of fish in pools that were drained and subsequently left to collect rainwater. Fish experienced massive deaths when homeowners dumped bleach in unmaintained pools to "clean them up," but fish populations usually rebounded on their own. *Gambusia* introductions continued through 2007, and virtually all unmaintained pools contained lasting fish populations by the end of that year. During 2006-2008, larvae were observed in 2.2% of inspections of pools containing fish, compared to 36.0% of pools that did not contain fish. Ecological measurements revealed four swimming pool habitat types significant for mosquito larvae and fish. The "organic pollution" habitat type, created by decomposing branches and other organic debris, provided ideal habitat for *Cx. quinquefasciatus* larvae. *Gambusia* usually thrived in this habitat type, providing effective control except when toxicity from extreme pollution depressed fish populations. The "saline with floating pine needles" habitat type was particularly suitable for *Anopheles* and *Cx. salinarius* larvae. *Anopheles* larvae sometimes survived even with fish in the pool. The "oak leaves" habitat type was suitable for mosquito larvae of all species but poor habitat for fish. It sometimes contained *Cx. quinquefasciatus* or *Anopheles* larvae even when fish were in the pool. The "floating algal mats" habitat type was poor habitat for mosquito larvae and excellent for fish. Using the presence of mosquito larvae in pools without fish as an indicator of adult mosquito populations, the percentage of pools containing larvae declined from 53% during 2006 to 8% in 2007 and 6% in 2008. The number of West Nile virus cases in New Orleans followed the same pattern, declining from 12 cases in 2006 (which was much more than the years immediately preceding Katrina) to two cases each year during 2007-2008 and none since then. The decline from 2006 to 2007-2008 can be attributed in large part to the fact that the vast majority of unmaintained swimming pools in New Orleans contained fish by the end of 2006. Natural ecological succession during 2006 to 2008, which transformed pools from the "organic pollution" and "saline with floating pine needles" habitat types to "floating algal mats," also contributed to the decline. This report concludes with recommendations based on lessons learned from the New Orleans experience: establishing a source of fish in advance; procedures for

identifying houses with swimming pools; communication with residents; access to private property; ensuring that fish are healthy when introduced to pools; use of larvicides; cleaning trash out of pools; maintaining systematic records; supervision and training of volunteers; organizational self-sufficiency.

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Introduction – The aftermath of Katrina

On August 29, 2005, Hurricane Katrina brought New Orleans a flood of unexpected and devastating consequences. Among them was the sudden creation of several thousand unattended swimming pools, littered with debris from the hurricane and receding flood waters. The mucky water in the pools provided ideal breeding habitat for mosquito vectors of West Nile virus, eastern equine encephalitis, and St. Louis encephalitis.

The city was in chaos when Mosquito Control staff returned to New Orleans to assess the situation about a month after the hurricane. Because the organization's headquarters had been under eight feet of water during the flood, the buildings and equipment there were unusable. Most of the city was without water, electricity, and telephone service. Mosquito Control worked out of a cruise ship docked in New Orleans to provide offices and lodging for government workers.

The New Orleans landscape was a distressing quagmire of mud, filthy puddles, foul-smelling houses, dead animals, hopelessly damaged automobiles, and every imaginable kind of trash. Swimming pools contained a clutter of fallen trees, furniture, rotting mattresses, and other household goods. Although there are no quantitative data for that time, it seemed most of the swimming pools contained mosquito larvae. *Culiseta inornata* was particularly numerous, along with *Culex quinquefasciatus* and *Cx. salinarius*. The larvae were sometimes so numerous that they appeared to form a carpet across a pool. No one knew for sure whether the unprecedented mosquito production from swimming pools could set in motion a serious outbreak of disease at any time. Many people would be living in trailers for extended periods, exposing them to mosquitoes more than before.

Everyone agreed that something should be done about the swimming pools as quickly as possible. Covering the pools was not a viable alternative because covers collected rainwater that continued to provide mosquito breeding habitat. Covers could also be hazardous, particularly for children. It was not feasible to get rid of the pools because most homeowners presumably wanted to keep them. Besides, the whereabouts of many owners of unattended pools was unknown. And it was logistically impossible to fill in a large number of pools in a city that was still in shock and preoccupied with an overwhelming roster of cleanup and reconstruction activities.

Thus began a program of emergency mosquito control for a city in disarray, a program that sometimes had to proceed under makeshift conditions with seriously overextended staff, less than adequate information, and limited time and professional resources for developing solid, science-based protocols – and which continued to be extremely challenging for several years.

By November 2005, Mosquito Control staff were walking through backyards and listing addresses of houses with swimming pools. They applied a larvicide –usually VectoLex® (*Bacillus sphaericus*), which the manufacturer had donated – to all pools observed to have mosquito larvae. However, larvicides could provide only temporary benefits, and the number of pools that could be inspected and treated during the months immediately following Katrina was a small fraction of all those in the city. Larviciding clearly had a role, but it was out of the question to rely entirely on larvicides because Mosquito Control lacked the staff to treat so many pools on a continuing basis. In theory, methoprene (a juvenile growth hormone) was another possibility for long-term suppression of mosquito production. However, Altocid® briquets tested in swimming pools before Hurricane Katrina were ineffective, presumably because the methoprene was diluted by the large volume of water in a pool. Fish seemed most promising because a single treatment could provide long-lasting control.

There were six cases of West Nile Virus diagnosed as Neural-Invasive Disease (NID) in Orleans Parish over the period of August-December 2005, though there had been only one or two cases per year during 2003 and 2004 (Figure 1). There were two cases of Saint Louis Encephalitis (NID), which had not occurred in Orleans Parish for years. Fortunately for disease transmission, there were very few people in New Orleans during the months immediately following Katrina. By the time many people were back, the disease transmission season was apparently over.

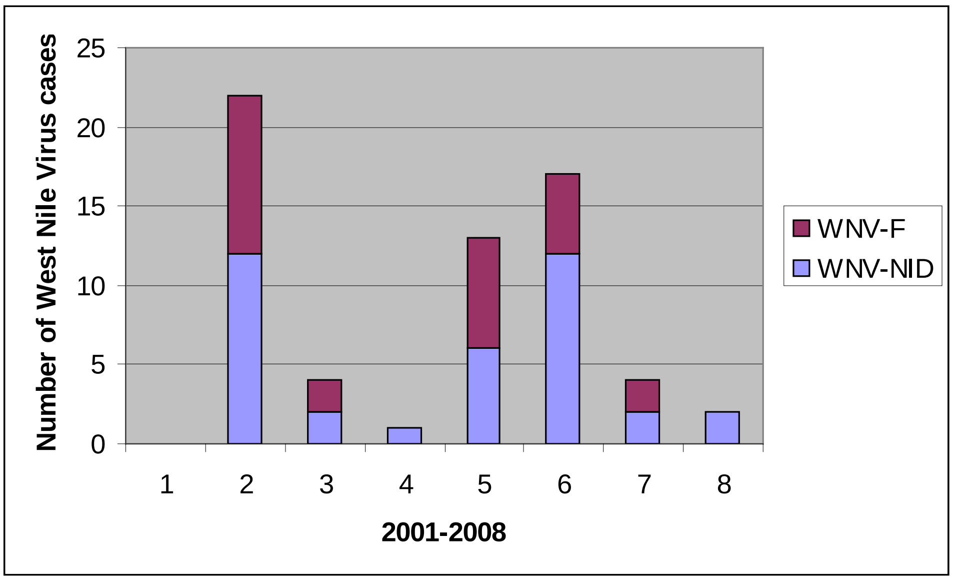


Figure 1. Number of West Nile Virus cases during 2002-2008. 2002 was the first year of West Nile Virus in New Orleans. WNV-NID = Cases diagnosed as “Neural Invasive Disease.” The total number of cases includes cases diagnosed as fever only (WNV-F). NID cases are considered a more reliable reflection of the incidence of the disease than “fever” cases.

Introducing *Gambusia* to swimming pools

Large numbers of mosquito larvae continued to be seen in the swimming pools through the early months of 2006. In January 2006, a decision was made to introduce fish. The effectiveness of fish was apparent in pools that contained fish from the Katrina flood – a natural stocking of approximately 750 pools that was most prominent near Lake Pontchartrain and the numerous canals running through the city. Most of these fish were mosquito fish (*Gambusia affinis*), though sailfin mollies (*Poecillia latipinnia*), least killifish (*Heterandria formosa*), and sheepshead minnows (*Cyprinodon variagatus*) were also present in significant numbers (Caillouët et al. 2008). Pools with these fish sometimes contained a few *Anopheles* larvae but seldom contained *Culex* or *Culiseta*.

A supply of fish was the most immediate concern for an introduction program. New Orleans Mosquito Control had routinely introduced locally-trapped fish, primarily killifish and mollies, into unattended swimming pools during the years preceding Katrina. However, local trapping could not provide enough fish for so many pools. Fortunately, some of the catfish ponds in the region contained large *Gambusia* populations. A catfish farm in Georgia could provide plenty of *Gambusia*, but that source was ruled out because the fish were a mixture of *G. affinis* and *G. holbrooki*. Bringing *G. holbrooki* into Louisiana presented legal obstacles because that species was not known to be in the state. *G. affinis* was common in Louisiana.

In the end, *G. affinis* was transported by truck from a catfish farm in Yazoo, Mississippi. Twenty thousand fish at a time were deposited for holding in two circular, above-ground, aerated swimming pools located in Slidell, Louisiana, on the outskirts of New Orleans. One of the pools was 18 feet in diameter and the other 15 feet in diameter. The cost for purchase and transport was approximately ten cents per fish. The fish sometimes suffered die-offs in the holding pools due to overcrowding and tail rot, but the supply from Mississippi was sufficient to compensate for setbacks.

The introduction of *Gambusia* to swimming pools began in April 2006 (Figure 2). Distributing the fish to so many swimming pools was a massive, labor-intensive job – hot and sweaty during the New Orleans summer. Fortunately, the non-profit organization Operation Blessing, which provided volunteers from outside New Orleans to help with the recovery, assigned some of its volunteers to the swimming pool project (www.ob.org/projects/hurricane_relief/blog/tara_smith.asp). Operation Blessing's participation was critical for completing the fish introductions in a timely manner. In addition to providing volunteers, Operation Blessing covered expenses such as purchase and transport of mosquito fish, holding pools, plastic bags for transporting fish to swimming pools, ice chests, oxygen, signs, fish food, fungicide, and "Bug Buster" tee shirts used by the volunteers. This financial assistance was truly a blessing because it enabled procurement to proceed with flexibility and without the paperwork and delays associated with funding from FEMA or the city government.

Fish distribution started at 8 am each day with an assembly line that netted fish from the holding pools, counted out approximately fifty fish by pouring them into a calibrated cylinder and pouring those fish into a plastic bag, put oxygen into the bags, and tied them. The bags were transported to the pools in large coolers (without ice) in the back of pickup trucks that set out for the entire day. About eight trucks were used each day.

The crew for each truck typically consisted of a Mosquito Control employee and two volunteers. Additional volunteers sometimes followed the truck in a van. It would have been an enormous job to check every house in the city for a swimming pool. The crews were able to work with swimming pool address lists running sequentially along the streets. The address lists were based on information from the Real Estate Association Multiple Listing Services and addresses recorded by Mosquito Control staff during the approximately three thousand backyard inspections they had conducted from November 2005 to April 2006.

One bag of fish was poured into each pool, and VectoLex was applied to suppress mosquito production until the fish established a larger population. As the City was under a state of emergency due to public health threats, Mosquito Control crews had the authority to enter backyards even if no one was at the house. However, the policy was not to risk injury by climbing the fences of vacant houses with locked gates. When the crews were unable to enter a yard, they attempted to get fish into the swimming pool by throwing a “fish bomb” – a plastic bag arranged to open on impact – over the fence and into the pool.

Gambusia introductions proceeded intensively through the spring and summer of 2006 (Figure 2). Because of the urgency and scale of the task, virtually all of the effort went into introducing fish. Aside from a few checks to confirm fish survival in pools when the introductions began, the field crews did not return to swimming pools during April-September 2006 to see whether the fish were still there.

Fish were introduced to a total of 1,278 unattended pools by September 2006 (Figure 2), and fish introductions proceeded at a less frantic pace during the autumn and winter. Although there were still swimming pools that had not yet been checked to see whether they needed fish, the swimming pool address lists were seriously incomplete. It was a welcome break in January 2007 when the New Orleans Police 911 Service provided the Pictometry® system for Mosquito Control to use. It was possible to cruise down a street by computer, viewing overhead photos to check the backyards for swimming pools and retrieving from the system the addresses of houses observed to have pools. The first Pictometry photo set that we used was shot before Katrina. Swimming pools were conspicuous in backyards as turquoise rectangles (top of Figure 3). Where further virtual inspection of a yard was required, a property could be seen from four sides with helicopter photos in the system’s data set. Later, we used Pictometry photos taken after Katrina. The unmaintained swimming pools in those photos were brown instead of turquoise (bottom of Figure 3).

Fortunately, there was no large West Nile Virus outbreak during 2006, though the 12 cases of West Nile Virus (NID) recorded in Orleans Parish that year were substantially more than in the years immediately preceding Katrina (Figure 1).

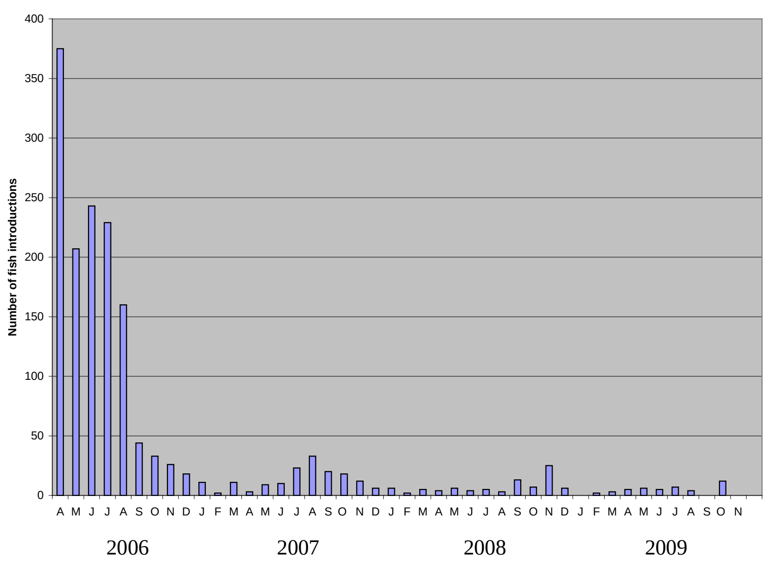


Figure 2. Monthly number of *Gambusia* introductions to swimming pools. Total number of introductions = 1,579.

Figure 3. Areal photos showing the same swimming pools before Hurricane Katrina (top) and after Katrina (bottom). The clean swimming pools before Katrina are turquoise. The unmaintained swimming pools after Katrina are brown. Source: Pictometry.

Return to the swimming pools

In October 2006 the field teams began returning to houses where fish had been introduced during the previous spring and summer. The purpose was to:

- Check whether fish were in the pools. Assessment of fish presence was based on actually seeing the fish or seeing characteristic ripples they made when breaking the surface of the water.
- Confirm that pools containing fish did not have mosquito larvae.
- Assess the magnitude of mosquito breeding in pools that did not yet have fish.

Autumn 2006 and winter 2007 were a time of uncertainty about how well the fish were working because no fish were seen in some of the pools to which they had previously been introduced. The implications were not entirely clear because the failure to see fish, particularly on cold, cloudy days, became more frequent as the winter advanced. Pool temperatures were as low as 11º C. It seemed that fish introductions had actually failed in some pools, but were the fish really missing? Or were we failing to see them because they were inactive? Were the fish reliably suppressing mosquito production when they were present in a pool? We were not sure. *Culex* and *Culiseta* larvae were virtually never seen in the pools where fish also were seen, but there were substantial numbers of larvae in some of the pools where fish were *not* seen. Some of those pools may have contained fish.

We needed some way besides visual inspection to assess whether fish were in a pool. We tried seining pools that we knew to have fish in low or moderate numbers and sometimes did not catch any. We tried the same with commercial minnow traps and got the same result. As it turned out, we never found a reliable method for assessing fish during the winter. We had to wait for warmer temperatures in the spring, when we could rely upon visual assessment.

In May 2007, quality control tests were run with each inspection crew to assess the presence or absence of fish in pools that another inspector had confirmed a few days earlier to contain fish. The same was done with pools known independently *not* to contain fish. The results confirmed visual assessment to be completely reliable outside the winter season. As the summer progressed, field crews returned to pools to which fish had previously been introduced. By the end of the summer nearly six hundred pools had been checked to see if the fish were still there, and 86.4% of those pools contained fish (Table 1). The field crews introduced fish to every pool in which they did not see them. Unattended pools continued to turn up, and by the end of summer 2007, nearly 1,500 swimming pools had received one or more *Gambusia* introductions since the introductions began in April 2006.

The absence of fish from some of the pools to which they had been introduced set us to thinking why introductions would fail. We sometimes saw swimming pools with only one or two feet of water at the bottom. They apparently had been drained by their owners, killing all the fish, and left unmaintained to collect rain water after that, transforming them into mosquito breeding habitat. If a pool contained much trash, the small amount of water in the pool concentrated the organic pollution, creating ideal habitat for *Cx. quinquefasciatus* larvae (Figure 4).

Chlorine was a particular concern because empty bleach bottles were frequently seen at unmaintained swimming pools. It appeared that homeowners who briefly visited their unoccupied houses were alarmed at the unsightly condition of their swimming pool, or a neighbor's pool, and dumped bleach to "clean it up." The bleach could kill the fish, thereby converting the pool into mosquito breeding habitat if left unmaintained after that.

Because well-intentioned but counterproductive interventions seemed to be a serious problem, a sign (shown in Figure 12) with the following message was left at every inspected swimming pool starting in July 2007:

Attention

Mosquito Control has been regularly treating this pool.
Mosquito-eating fish have been released into this pool to control mosquitoes in the area.
To avoid killing the fish, please DO NOT add chemicals
to pool before the pool is in complete working order.
Please inform Mosquito Control if you:

- restrict access to your pool
- drain, fill-in, or remove the pool
- have a mosquito problem at your home.

Table 1. Number of first inspections after *Gambusia* introduction at which fish were observed in the swimming pool. X/Y: X = Number of inspections for which fish were observed at the pool, Y = Total number of inspections.

Month of *Gambusia* introduction

First Inspection[1]	***Apr-06***	***May-06***	***Jun-06***	***Jul-06***	***Aug-06***	***Sep-06***	***Oct-06***	**Nov-06**
Sep-06	12/13	1/2	2/2	5/8	2/2	1/1	---	---
Oct-06	6/7	0/3	3/4	0/0	1/1	0/0	0/0	---
Nov-06	0/0	1/2	0/1	1/1	3/4	0/0	0/0	0/0
Dec-06	7/10	4/5	2/3	3/3	1/1	1/1	1/1	1/1
Jan-07	8/11	4/5	8/10	9/13	6/7	0/1	3/4	0/0
Feb-07	2/3	1/2	0/0	0/1	0/0	0/0	0/0	0/0
Mar-07	10/16	2/5	5/5	4/5	6/8	0/0	0/0	0/0
Apr-07	4/6	0/0	7/7	7/7	7/7	0/0	0/0	1/1
May-07	29/29	13/13	27/29	10/11	10/11	1/1	1/1	0/0
Jun-07	10/11	3/3	9/9	3/4	3/4	2/2	2/2	1/1
Jul-07	17/22	18/20	8/9	6/6	6/6	1/1	1/1	2/2
Aug-07	15/16	14/15	8/10	9/9	9/9	2/2	2/2	1/1
Sep-07	25/28	14/15	10/12	4/4	4/4	0/0	2/2	1/1
Oct-07	8/8	0/0	2/2	2/2	2/2	0/0	0/0	0/0
Total	150/180	75/90	91/105	104/117	60/66	8/9	12/13	7/7
Percentage[2]	85%	83%	87%	88%	91%	90%	92%	100%

[1]Month of first inspection after *Gambusia* introduction.
[2]Percentage of inspections positive for fish. The overall percentage of introductions in 2006 that were positive for fish when checked later was 507/587 = 86.4%.

Figure 4. A pool that was drained and left to collect rain water. Ideal habitat for *Cx. quinquefasciatus* larvae because the fish were wiped out when the pool was drained, and organic pollution from rotting trash was concentrated in the small amount of water out of view beneath the trash.

The research program

Systematic research was initiated in 2007 to provide a more solid foundation for the fish introduction program. Until that time, the overriding and demanding focus was the practical task of delivering fish to the large number of unmaintained swimming pools as quickly as possible. However, the time had come to answer some compelling questions such as:

- How effective were the fish introductions so far?
- Why were fish missing from some of the pools to which they were introduced in 2006?
- Were there other problems? If so, what were they?
- What could we do to make the fish introductions more effective?

Records from the fish introductions and follow-up pool inspections in the fish introduction program provided data for assessing the effectiveness of the introductions. The following information had been recorded during every visit to a swimming pool:

- Whether or not the pool was properly maintained.
- Whether fish were already in the pool.
- Whether there were mosquito larvae in the pool. (If so, a standard number of dips was taken at some of those pools to estimate larval numbers, and a sample of the larvae was preserved in alcohol for species identification).
- Whether fish were introduced at the time of inspection.
- Whether the pool was treated with a larvicide at the time of inspection.

The research program also carried out a small number of swimming-pool experiments to assess (1) the impact of bleach on fish and (2) the impact of VectoLex on mosquito larvae.

In June-July 2007, we began monitoring a selection of pools for fish survival after introduction. *Gambusia* (35 fish per pool) was introduced to 47 pools known *not* to have fish, though fish had been introduced to some of them in 2006. Other pools were new to the program, so it was the first time that fish were introduced. At first, the pools were checked monthly for fish and mosquito larvae. They were checked periodically after that until the end of 2008.

Finally, a broad selection of swimming pools was identified for monitoring ecological conditions including water depth, trash (e.g., wood, furniture, and other household goods), leaves and branches, water quality, aquatic vegetation, aquatic insect predators, mosquito larvae, and fish. Table 2 lists the information recorded at each inspection. Data collection began in May 2007 and ended two years later with a total of 433 pool inspections at 55 swimming pools. Included were:

- Pools with natural fish populations from the Katrina flood.
- Pools containing fish after successful *Gambusia* introduction in 2006 and 2007.
- Pools where *Gambusia* introduction had failed in 2006.
- A small number of "control" pools to which fish had not been introduced. Control pools provided information on the seasonal abundance of different species of mosquito larvae in the surrounding area.

The original data are shown in Appendix 1. ***Spearman rank correlation coefficients*** were calculated for every pair of variables (37 variables and 666 correlations coefficients). Spearman correlations are non-parametric and therefore capture any association between two variables – not just the linear component of association reflected by conventional correlation coefficients. Spearman correlations between (a) mosquito larvae, pupae, and fish and (b) the physical, chemical, and biological variables in Table 2 are shown in Appendix 2. Spearman correlations among the physical, chemical, and biological variables in Table 2 are shown in Appendix 3.

Multiple regression analysis of the data in Appendix 1 provided ***regression coefficients*** presented in Tables 7, 10, and 11, pointing to variables that had the strongest association with a designated "dependent variable" (e.g., the abundance of fish or a particular species of mosquito larvae) after removing the "effect" of other correlated variables in the same data set. Multiple regression coefficients were the closest we could come to identifying direct causal relationships.

Table 2. Information recorded during each swimming pool inspection in the research program.

1. Address and date
2. Pine needles (PIN) – None=0, Low=1, Medium=2, High=3
3. Oak leaves (OAK) – None=0, Low=1, Medium=2, High=3
4. Miscellaneous leaves, not oak or pine (MLE) – None=0, Low=1, Medium=2, High=3
5. Sticks (twigs) floating on the water (STI) – None=0, Low=1, Medium=2, High=3
6. Tree branches (TB) – None=0, Low=1, Medium=2, High=3
7. Wood (boards and smaller pieces) (WOO) – None=0, Low=1, Medium=2, High=3
8. Grass growing into the water at the edge of the pool (GRA) – None=0, Low=1, Medium=2, High=3
9. Filamentous algae mats (ALG) – None=0, Low=1, Medium=2, High=3
10. Plastic bags (PLB) – None=0, Low=1, Medium=2, High=3
11. Plastic objects such as toys (PLO) – None=0, Low=1, Medium=2, High=3
12. Large objects such as furniture and appliances (LO) – None=0, Low=1, Medium=2, High=3
13. Glass bottles (GLB) – None=0, Low=1, Medium=2, High=3
14. Empty bleach bottles around the pool (BLB) – None=0, Low=1, Medium=2, High=3
15. Brown water color (BRW) – None=0, Low=1, Medium=2, High=3
16. Green water color (GRW) – None=0, Low=1, Medium=2, High=3
17. Foul water odor (WSM) – None=0, Low=1, Medium=2, High=3
18. pH (PH)
19. Salinity (SAL) – Parts per thousand
20. Chlorine (CHL) – Parts per million
21. Nitrate (NO3) – Parts per million
22. Nitrite (NO2) – Parts per million
23. Oxygen (OXY) – Parts per million
24. Ammonia (NH3) – Parts per million
25. Temperature (TEM) – Degrees centigrade
26. Secchi disk (SEC) – Water clarity (meter depth of disk visibility)
27. Backswimmers (BSW) – None=0, Low=1, Medium=2, High=3
28. Water boatmen (WBO) – None=0, Low=1, Medium=2, High=3
29. Diving beetles (DBE) – None=0, Low=1, Medium=2, High=3
30. Dragonfly/mayfly nymphs (DRA) – None=0, Low=1, Medium=2, High=3
31. Water striders (WST) – None=0, Low=1, Medium=2, High=3
32. Mosquito pupae (PUP) – Number in eight dips (all species combined)
33. *Culex quinquefasciatus* larvae (CXQ) – Number in eight dips
34. *Culex salinarius* larvae (CXS) – Number in eight dips
35. *Anopheles* larvae (AN) – Number in eight dips (all species)
36. *Culex coronator* larvae (CXC) – Number in eight dips
37. Fish abundance (FISH) – None=0, Low=1, Medium=2, High=3

Mosquito larvae in the swimming pools

Several questions were particularly urgent:

- How many of the swimming pools contained mosquito larvae?
- What kind of larvae? How many larvae?
- How was this affected by whether there were fish in the pools?

The data to answer these questions, which came from inspection records in the fish introduction program (2006-2009) and research program (2007-2009), are listed in Appendix 4 and Appendix 5. While all inspection records in the research program included quantitative information on fish abundance and the abundance of each species of mosquito larvae, most records in the fish introduction program noted only whether fish or mosquito larvae were in the pool without specifying what kind of larvae or how many. Mosquito larvae were identified and counted in the laboratory only from a subsample of pool inspections in the fish introduction program.

Figure 5 shows conspicuous month-to-month fluctuations in the percentage of inspected *pools without fish* that contained mosquito larvae. The peaks were not in the same months each year, though they were never in the summer.

Appendix 4 shows the counts of each mosquito species in larval samples taken from pools without fish. Every species had less than one larva/dip in most pools but much larger numbers in some pools. *Culex quinquefasciatus* sometimes numbered hundreds of larvae/dip. Figure 6 (top) shows the month-to-month *number of pools without fish* that were observed to contained larvae of each mosquito species. Figure 6 (bottom) shows the month-to-month *total number of larvae* of each mosquito species in the samples. *Culex quinquefasciatus* was the most abundant species – present throughout the year though numbers dropped in July and August. *Anopheles* larvae (*An. crucians* and *An. quadrimaculatus*) were also in pools throughout the year, but their numbers were generally much lower than *Cx. quinquefasciatus*. *Culex salinarius* and *Cx. restuans* were most conspicuous from October to April, and *Cs. inornata* was numerous from November to March. *Culex coronator* and *Cx. erraticus* extended from July to November with large numbers of *Cx. coronator* also seen in January.

The downward trend in Figure 5 is of particular practical interest because larval populations in swimming pools without fish reflect adult mosquito populations in the vicinity of the pools. Whereas 53% of inspected pools without fish contained larvae during March-August 2006, only 8% contained larvae during the same months in 2007 and 6% in 2008. This difference suggests a dramatic decline in adult mosquito populations from 2006 to 2007-2008, and a corresponding decline in the potential for disease transmission. While natural changes in the pools from 2006 to 2008 rendered them less favorable for mosquito larvae (see "Ecological succession of habitat types" below), we can surmise that the *Gambusia* introductions were also a major contributing factor.

How effective were the fish at preventing mosquito breeding in pools? While it was unusual to see mosquito larvae in *pools with fish*, it did happen. There were larvae in 36.0% of the 2,697 inspections of pools without fish, but there were larvae in only 2.2% of the 3,186 inspections of pools that contained fish (Table 3). Figure 7 shows substantial month-to-month variation in the percentage of pools with fish that were observed to contain mosquito larvae as well.

What kinds of mosquito larvae were in the pools with fish? Appendix 5 shows the counts from larval samples. Almost all the larvae in pools with fish were *Cx. quinquefasciatus* or *Anopheles*. (Exceptions: Two *Cs. inornata* larvae were collected from one pool with fish; a single *Cs. inornata* larva was collected from another pool with fish; and a single *Cx. salinarius* larva was collected from a pool with fish.) The larvae most frequently seen in pools with fish were *Anopheles*, but *Cx. quinquefasciatus* larvae were sometimes seen, and when present, they were typically much more numerous than *Anopheles*.

Among pools containing fish, was larval control most complete where fish numbers were high and less complete where fish numbers were low? This seems to be the case. In our research inspections, the abundance of mosquito larvae in a pool was correlated negatively with the abundance of fish in that pool (Table 4). This was so for every species of mosquito larvae, as well as mosquito pupae (all species combined). For example, we never saw *Cx. quinquefasciatus* larvae in pools with thriving fish populations. They were seen only in pools where fish numbers were low. There were large numbers of *Cx. quinquefasciatus* larvae only in the unusual circumstance of fish appearing unhealthy (i.e., not fleeing as quickly as they normally would when disturbed). On the other hand, while *Anopheles* larvae had a negative correlation with fish abundance, small numbers of *Anopheles* larvae were sometimes seen even in pools with abundant and apparently healthy fish.

Table 3. Number of inspections in which mosquito larvae were observed in swimming pools containing fish and pools not containing fish. This table is based on all inspections in the fish introduction program plus inspections in the research program.

	Fish present			Fish absent			
Month	Larvae present	Larvae absent	Total	Larvae present	Larvae absent	Total	Total inspections
Jan-06	0	5	5	0	6	6	11
Feb-06	0	6	6	0	8	8	14
Mar-06	9	14	23	8	12	20	43
Apr-06	0	617	617	255	346	601	1218
May-06	2	319	321	121	69	190	511
Jun-06	15	295	310	231	21	252	562
Jul-06	6	86	92	134	191	325	417
Aug-09	1	96	97	46	79	125	222
Sep-06	1	42	43	18	77	95	138
Oct-06	0	74	74	23	57	80	154
Nov-06	0	126	126	24	142	166	292
Dec-06	1	106	107	10	64	74	181
Total-06	**35**	**1786**	**1821**	**870**	**1072**	**1942**	**3763**
Jan-07	0	30	30	12	58	70	100
Feb-07	3	55	58	10	2	12	70
Mar-07	3	186	189	8	70	78	267
Apr-07	2	101	103	12	108	120	223
May-07	12	77	89	4	70	74	163
Jun-07	3	119	122	10	45	55	177
Jul-07	0	133	133	3	75	78	211
Aug-07	0	89	89	0	42	42	131
Sep-07	0	225	225	14	37	51	276
Oct-07	7	18	25	4	6	10	35
Nov-07	0	14	14	0	15	15	29
7-Dec	2	14	16	10	5	15	31
Total-07	**32**	**1061**	**1093**	**87**	**533**	**620**	**1713**
Jan-08	0	75	75	5	11	16	91
Feb-08	0	27	27	1	13	14	41
Mar-08	1	52	53	4	27	31	84
Apr-08	1	58	59	3	20	23	82
May-08	1	20	21	1	13	14	35
Jun-08	0	21	21	1	29	30	51
Jul-08	0	12	12	0	6	6	18
Aug-08	0	4	4	0	1	1	5
Total-08	**3**	**269**	**272**	**15**	**120**	**135**	**407**
Total Inspections	**70**	**3116**	**3186**	**972**	**1725**	**2697**	**5883**

Table 4. Spearman rank correlations between fish abundance and abundances of mosquito larvae and pupae. Based on the data in Appendix 1. N = 433. The top number in each cell of the table is the Spearman correlation coefficient. The number beneath the correlation coefficient is the level of significance (two-tailed test). Asterisks indicate P<.05. (Appendix 2 and Appendix 3 provide the Spearman correlation coefficients among all physical, chemical, and biological variables listed in Table 2.)

	Fish abundance	Culex quinquefasciatus	Culex salinarius	Culex coronator	Anopheles	Pupae
Fish abundance	1.000	-.223*	-.072	-.122*	-.222*	-.180*
	.	.000	.134	.011	.000	.000
Culex quinquefasciatus	-.223*	1.000	.149*	.223*	.370*	.339*
	.000	.	.002	.000	.000	.000
Culex salinarius	-.072	.149*	1.000	-.013	.203*	.353*
	.134	.002	.	.783	.000	.000
Culex coronator	-.122*	.223*	-.013	1.000	.175*	.167*
	.011	.000	.783	.	.000	.000
Anopheles	-.222*	.370*	.203*	.175*	1.000	.370*
	.000	.000	.000	.000	.	.000
Pupae	-.180*	.339*	.353*	.167*	.370*	1.000
	.000	.000	.000	.000	.000	.

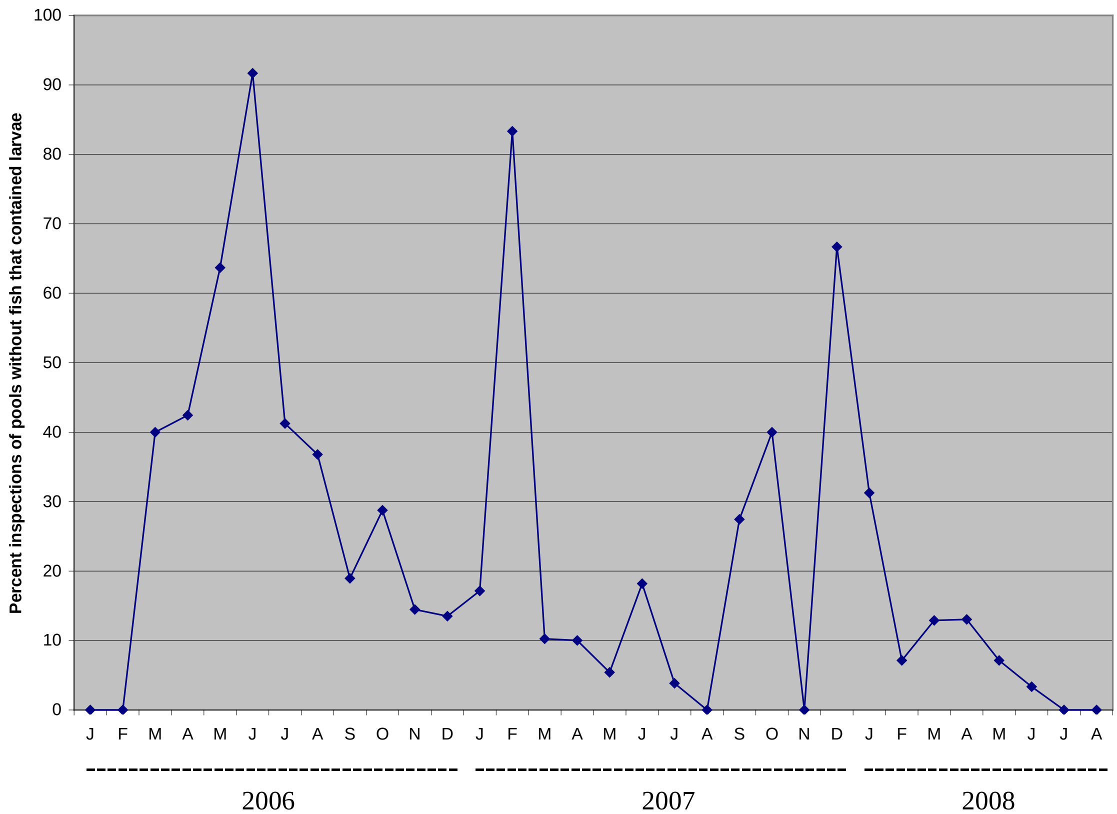
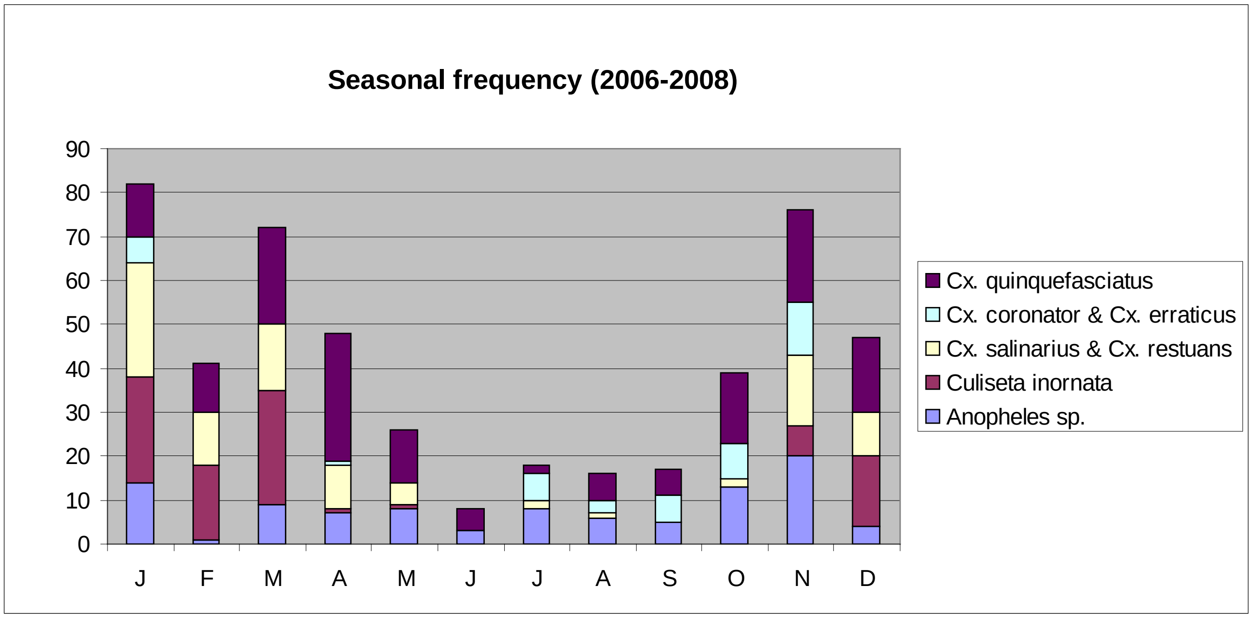


Figure 5. Percentage of inspections for which mosquito larvae were present in pools that *did not contain fish* (based on Table 3).



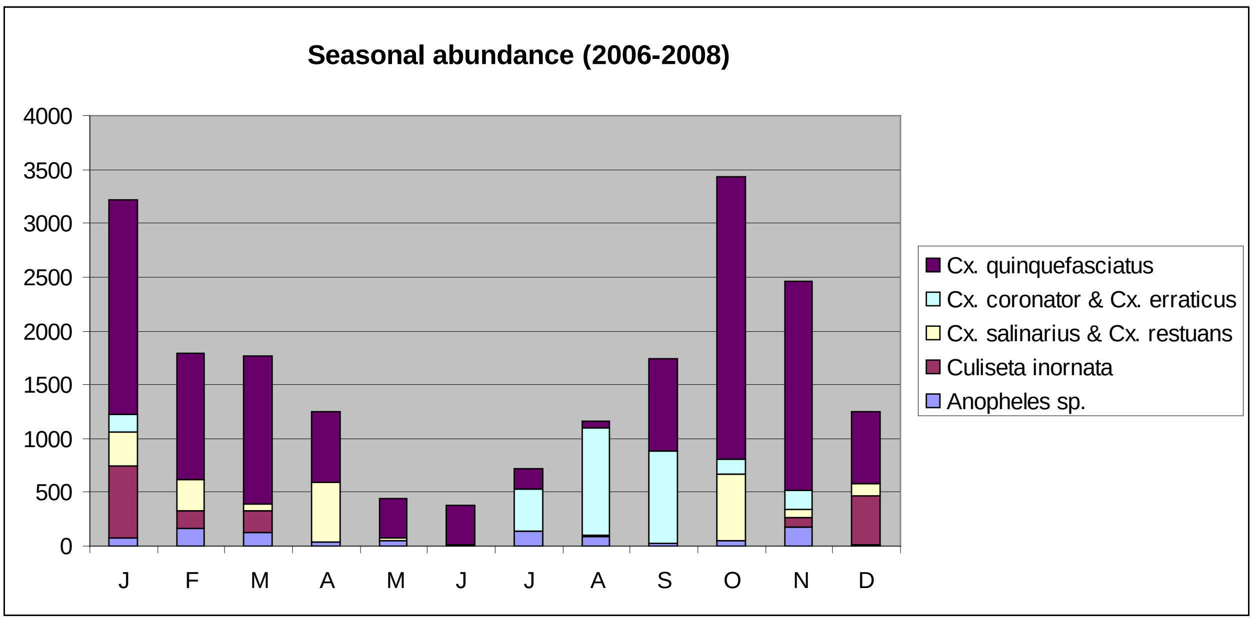


Figure 6. Representation of various species of mosquito larvae in swimming pools without fish (based on Appendix 4). The top graph shows the number of pools in which each species was found. The bottom graph shows the total number of larvae counted.

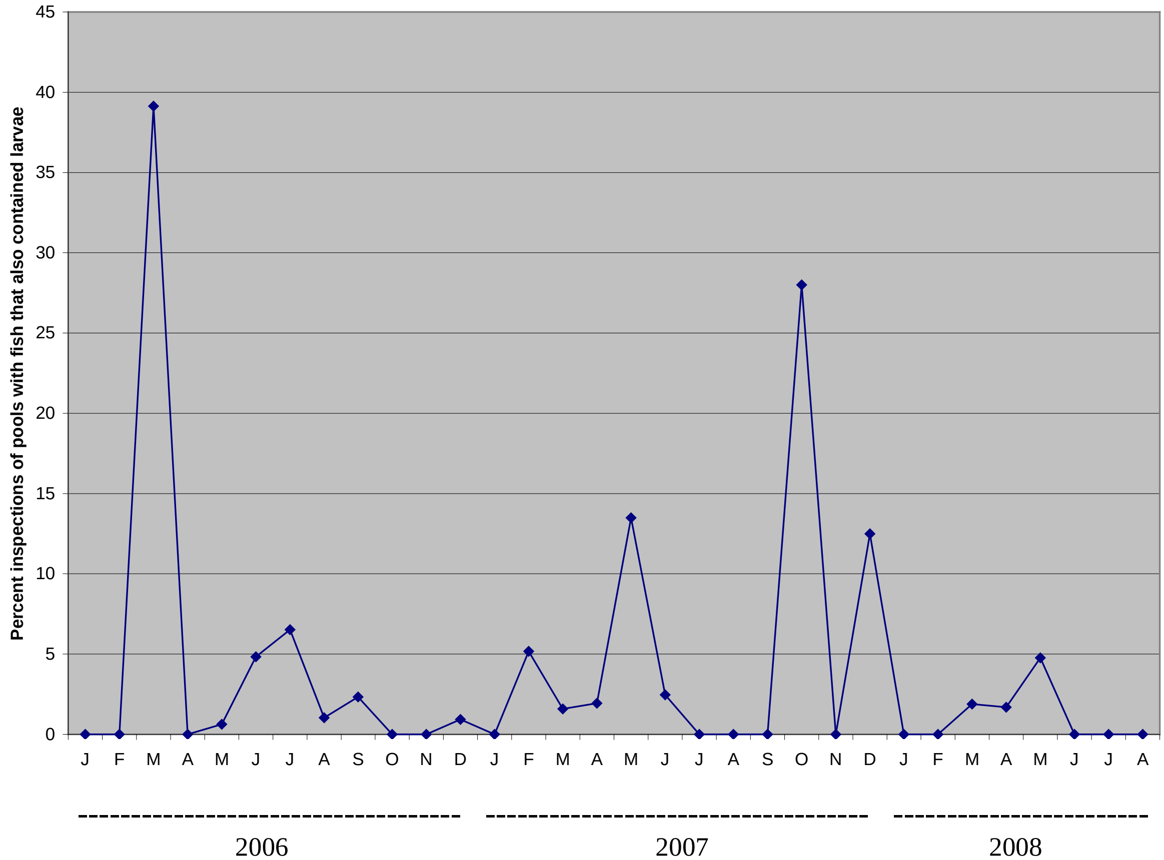


Figure 7. Percentage of inspections for which mosquito larvae were present in pools that *contained fish* (based on Table 3). The highest peaks are not precise because of small sample sizes for those months.

Fish survival in swimming pools

A central question was what had happened in the 14% of the pools that did not have fish after the introductions in 2006.

- Did the fish fail to establish a population in those pools? If so, was this still a problem with introductions currently under way?
- Or did the fish successfully establish populations in some or all of those pools, but for some reason established fish populations were lost before the pools were checked? If so, were fish still disappearing from pools in which they had established a population?

We had a subjective impression that virtually all the fish populations, once established in a pool, continued to inhabit the pool for as long as there was water. The main times that we observed fish to disappear from pools were when pools were completely drained. Although homeowners sometimes demolished or maintained their pools after draining them, some pools were left unmaintained after draining, leaving them to collect rainwater and produce mosquitoes because they no longer contained fish. However, pools that were left unmaintained after draining were not numerous enough to account for the 14% of pools that were missing fish after the introductions in 2006.

Records from swimming pool inspections provided quantitative information to assess whether established fish populations were, for whatever reason, disappearing from swimming pools on a significant scale. We tabulated the presence or absence of fish with regard to the number of months that had passed between introducing the fish to a pool and the first inspection of that pool after the fish introduction (Table 5). Because some inspections happened only a few months after introducing the fish, and others were more than a year later, it was possible to see whether the percentage of pools positive for fish declined with the passage of time after the fish were introduced. A decline would indicate that some of the pools were losing their fish populations each month. However, the Spearman rank correlation between the percentage of inspected pools containing fish and the passage of time was positive (r=0.61; p =0.0025), not negative, strongly indicating there was no decline. It therefore appears that *loss of established fish populations before the pools were checked* is not an explanation for the 14% of pools without fish after introduction in 2006.

The monitoring of 47 pools to which fish were introduced during June-July 2007 reinforced this conclusion. Every one of those pools had a thriving fish population within a month, and sustained the population for the duration of the monitoring as long as the pool contained water. The same was true for other pools that we knew to have fish and revisited on later occasions during 2007-2008.

We were left with the conclusion that most instances of fish missing from pools after their introduction in 2006 were because the fish failed to establish a population in the first place. An explanation that immediately came to mind was the trauma that some fish experienced during transport to the pools. Transport during this period was in plastic bags in large ice chests (without ice), and the fish sometimes appeared in poor condition (swimming at a slant and moving erratically) when poured from the plastic bags into pools, particularly if they had been in the bags from early morning until late afternoon on a hot day.

The percentages for April-November 2006 at the bottom of Table 1 show how many pools subsequently had fish after each month of *Gambusia* introductions. The success rate of *Gambusia* introductions during 2006 improved with experience. While only 84% percent of the pools to which fish were introduced during the first two months of the program (April-May) still had fish when next inspected, this measure of success increased month by month to 95% for pools receiving introductions during October-November 2006. With a less overwhelming workload during 2007-2009, we were able to transport fish quickly and directly to swimming pools. Nearly all the introductions were successful in 2007, the only exceptions being a very few pools that were too polluted for fish to thrive. All the introductions were successful during 2008 and 2009.

Table 5. *Gambusia* survival in swimming pools as a function of time since introduction.[1] Based on Table 1.

Number of months since fish introduction[1]	Number of inspections with fish present	Total number of inspections	Percentage of inspections with fish present
1	5	6	87%
2	10	14	71%
3	10	12	83%
4	7	11	64%
5	22	28	79%
6	19	26	73%
7	21	27	78%
8	27	32	84%
9	26	31	84%
10	29	35	83%
11	55	63	87%
12	50	53	94%
13	60	62	97%
14	59	65	91%
15	45	53	85%
16	31	33	94%
17	25	28	89%

[1] First inspection since fish introduction.

Water quality and fish survival

While analysis of records from the fish introductions led us to the conclusion that fish were missing from pools mainly because they failed to establish a population in the first place, we were still grappling with the question of why that had happened. Trauma during transport to the pools was clearly a factor, but we also wondered whether toxic conditions in some pools were so severe that they killed the fish before they could establish a population. If so, was this still happening?

The “*Gambusia* tolerance” column in Table 6 provides a summary of physical/chemical factors known to be harmful to *Gambusia* when extreme. Comparing the column for “extreme observed values” in Table 6 with the “*Gambusia* tolerance” column, observed values of temperature, pH, and salinity were always comfortably within the range of published tolerances for *Gambusia*. The positive regression coefficient for pH (dependent variable: fish abundance) in Table 7 shows that fish were more abundant under less acidic conditions, an observation in accord with published information that a pH of 7.2-8.2 is optimal for *Gambusia* (Walton 2007).

The pools were observed to be clustered into two salinity ranges when quantitative water-quality data collection began in May, 2007:

- Pools that had been flooded with brackish water from Lake Pontchartrain during the Katrina flood (salinity in a range of 4.0-9.0 ppt).
- Pools that had not been flooded with brackish water (salinity in a range of 0.1-0.3 ppt).

The salinity of pools flooded with brackish water declined steadily over time. Most of those pools were in a salinity range of 1.5-5.0 ppt by the middle of 2008, and almost all were less than 2.0 ppt by the middle of 2009. The salinity of pools not flooded with brackish water remained in a range of 0.1-0.3 throughout the entire period.

In 2007, we found only one swimming pool in which *Gambusia* introductions failed repeatedly (Figure 9). The pool was littered with trash and contained a few feet of putrid water at the deep end. The water smelled like sewage and was never observed to contain measurable oxygen. Walton (2007) specified 0.2 ppm as the lower limit for *Gambusia*'s oxygen tolerance, but we observed thriving *Gambusia* populations in some pools with an oxygen concentration of 0.1 ppm. The ammonia concentration in this pool at different times fell in a range of 6-10 ppm, well above the published tolerance of 1 ppm for *Gambusia* based on laboratory studies (Walton 2007). However, Hubbs (2000) reported that *Gambusia* survived in heavily-polluted field conditions with an ammonia concentration of 10 ppm. Among the 55 swimming pools that we monitored with quantitative data collection, we saw seven pools that had ammonia concentrations greater than 10 ppm at one time or another (including a pool with 40 ppm for an extended period), and fish persisted in all seven of those pools. However, even though fish managed to survive in the presence of such high ammonia concentrations, the negative regression coefficient for ammonia (dependent variable: fish abundance) in Table 7 shows that fish numbers were distinctly reduced where ammonia concentrations were high.

High concentrations of nitrite, a decomposition byproduct toxic to fish, could also be a problem. The nitrite concentration at one swimming pool was 6 ppm on one occasion, and 2 ppm at another pool, more than *Gambusia*'s published tolerance of 1.5 ppm (Lewis & Morris 1986), but the fish seemed healthy. Although we had no evidence that nitrite was completely excluding fish from swimming pools, the negative regression coefficient for nitrite in Table 7 indicates there were smaller fish populations in pools with higher nitrite populations.

Turning to the survival of established populations in the pools, we needed to reconcile our concern about bleach dumping with results from our inspection records that indicated established populations were not disappearing on a significant scale. In July 2007, we assessed the impact of bleach dumping on fish survival by pouring four gallons of bleach into each of three pools that had thriving *Gambusia* populations and no detectable chlorine in the water (Figure 8). The bleach was introduced by walking around each pool and pouring the bleach at the edge. The chlorine concentration in the pools immediately increased to 0.1-0.5 ppm, and massive fish deaths followed within a few hours. No fish were seen in any of the pools the next day, when chlorine levels had dropped to less than 0.1 ppm. Nonetheless, every pool once again had a thriving fish population within a month, despite the fact no fish were reintroduced to those pools. (Recovery of fish populations after bleach dumping could be slower at winter temperatures.)

Although it is conceivable to exterminate all the fish in a pool with bleach, it appears difficult, particularly since our experiments employed more bleach than people told us they had used. Furthermore, it was unusual to encounter detectable concentrations of chlorine in the pools, though toxic concentrations were observed on a few occasions. Nonetheless, bleach is still a concern because the negative regression coefficient for bleach bottles in Table 7 suggests that fish populations were smaller at pools where bleach dumping had occurred. Moreover the positive regression coefficient for chlorine in Table 10 suggests that bleach dumping was translating into larger numbers of *Cx. quinquefasciatus* larvae.

Table 6. Summary of physical/chemical conditions recorded during 433 swimming pool inspections in the research program.

		Observed		
	Gambusia tolerance[1]	Common values[2]	Extreme values	% extreme[3]
Oxygen (ppm)[4]	0.2–35	0.8 – 12	0–0.3	4%
Ammonia (ppm)	0–1	0–0.2	4–40	7%
Temperature (ºC.)[5]	0.5–42	10–35	-----	-----
pH[4]	4.7–10.2	6–9	5.0–5.5	1%
Salinity (ppt)[6]	0–58	0.1–6	8–10	3%
Chlorine (ppm)	0–0.8	0	0.2–1.5	1%
Nitrite (ppm)	0–1.5	0	0.2–2.0	1%

[1]Source: Walton (2007). Source for nitrite tolerance: Lewis & Morris (1986). Interpretation of published tolerances is difficult because they are typically based on laboratory tests reported as LC50 values for various periods of exposure, a testing procedure that does not have clear implications for the performance of entire populations.
[2] 90% of the pool inspections were within this range.
[3]Percentage of pool inspections in the extreme range.
[4]For oxygen and pH, the extreme values of interest (i.e., possibly harmful to fish) are less than the “common values.”
[5]All observed values for temperature were within the “common values” range indicated in the table.
[6]Pools in the 2-10 ppt salinity range appeared to have been flooded with brackish water from Lake Pontchartrain during Hurricane Katrina.

Table 7. Normalized multiple regression coefficients (Dependent variable: Fish abundance). Based on inspections of swimming pool *containing fish* in the data set in Appendix 1.

Positive coefficients

	Coefficient	***Significance***[1]
Algae mats	.18	.015
Tree branches	.15	.067
pH	.15	.026

Negative coefficients

	Coefficient	***Significance***[1]
Water boatmen	-.30	.001
Ammonia	-.18	.006
Pine needles	-.16	.05
Nitrite	-.11	.08
Bleach bottles	-.09	.21

1. Two-tailed test.

Figure 8. One of the swimming pools treated experimentally with bleach to see its impact on the fish population. Fish normally thrived in this pool. Pouring four gallons of bleach into the pool led to high fish mortality, but the fish population recovered within a month.

The significance of swimming pool habitat types for fish and mosquito larvae

Every unmaintained swimming pool is an aquatic ecosystem that provides (1) a setting for mosquito production and (2) the ecological context for adding fish to reduce or eliminate the mosquito production. A central question is ***"How do ecological conditions in swimming pools affect the abundance of mosquito larvae, fish abundance, and the effectiveness of fish for larval control?"*** The data in Appendix 1 (443 pool inspections covering the variables in Table 2) provide a basis for answering that question.

Factor analysis, a statistical method previously used by Marten et al. (1989) to classify *An. albimanus* breeding habitats in Colombia, identified groups of intercorrelated variables in the data of Appendix 1. The factor analysis used principle components with varimax rotation as described by Tabachnick (2007). Factor analysis computations were done separately for the data from pools containing fish (results in Table 8) and the data from pools without fish (results in Table 9).

Each *factor group* in Tables 8 and 9 is a subset of all the variables in Table 2, corresponding to a different major ecological situation represented in the data (i.e., a *habitat type*). The *factor loading* of a particular variable for each factor group in Tables 8 and 9 represents the strength of that variable's association with the group. The suite of variables in a particular factor group conveys the character of the ecotype it represents, providing insights into:

- which habitat types are favorable or unfavorable for each species of mosquito larvae;
- which habitat types are favorable or unfavorable for fish;
- how the abundance of mosquito larvae is associated with the absence, presence, or abundance of fish in each habitat type.

Habitat types in pools without fish

The factor analysis revealed four conspicuous habitat types in pools without fish (Table 8).

- ***Organic pollution (Figure 9).*** Factor Group 1 in Table 8 represents pools cluttered with tree branches and other rotting debris, leading to low oxygen concentrations, a characteristic foul odor, high ammonia concentration, high pH, and large numbers of *Cx. quinquefasciatus* larvae. The positive factor loading for water temperature indicates that this habitat type was stronger during the summer, when decomposition was most intense. The negative factor loading of "time" for Group 1 indicates that this habitat type diminished during the two years covered by the data (May 2007 – May 2009). The positive regression coefficient for foul odor and the negative coefficient for oxygen (dependent variable: *Cx. quinquefasciatus*) in Table 10 suggest that putrid water and low oxygen were the elements of this habitat type that most directly connected *Cx. quinquefasciatus* larvae to it.

- ***Saline with floating pine needles (Figure 10).*** Factor Group 2 in Table 8 represents pools with a large quantity of floating pine needles, or sometimes twigs. Salinity was high (4-8 ppt), apparently due to flooding with brackish water from Lake Pontchartrain. Floating pine needles and twigs apparently had not sunk to the bottom because of the buoyancy and strong surface tension of saline water. The "saline with floating pine needles" habitat type was particularly favorable for *Anopheles* and *Culex salinarius* larvae as well as other aquatic insects such as dragonfly/mayfly nymphs, water striders, and water boatmen. Backswimmers and diving beetles were also seen, though no more so than in other habitat types. The negative factor loading of "foul odor" for Factor Group 2 shows that the water in this habitat type lacked the putrid quality of water in the "organic pollution" habitat type. While *Cx. quinquefasciatus* larvae were sometimes seen in the "saline with floating pine needles" habitat type it was far from ideal habitat for that species. The positive regression coefficients for pine needles and grass (dependent variable: *Anopheles*) in Table 11 indicate that these factors were particularly significant for connecting *Anopheles* larvae to this habitat type. It was common to see *Anopheles* larvae clinging to floating pine needles clustered around the edge of a pool or grass growing into the water from the edge (Figure 11). The *aufwuchs* film of microalgae and bacteria on the surface of floating pine needles, grass, twigs, and wood (with wood having a positive regression coefficient in Table 11), provided a concentration of food for *Anopheles* larvae. The positive regression coefficients for water boatmen (dependent variables: *Cx. quinquefasciatus* and *Anopheles*) in Tables 10 and 11 suggest that these predators served as indicators of aquatic ecosystems where predators and mosquito larvae thrived together.

- ***Oak leaves (Figure 12).*** Factor Group 3 in Table 8 represents pools with oak leaves, distinctively brown water (from tannins in oak leaves), and an abundance of water boatmen. This habitat type was favorable for both *Cx. quinquefasciatus* and *Anopheles* larvae. The high regression coefficient for oak leaves (dependent variable: *Cx. quinquefasciatus*) in Table 10 suggests that oak leaves were the most direct connection between *Cx. quinquefasciatus* larvae and this habitat type. The positive factor loading for nitrate in Factor Group 3, and the positive regression coefficient for nitrate (dependent variable: *Anopheles*) in Table 11 suggest that this habitat type provided particularly favorable conditions for *Anopheles* larvae because high nitrate concentrations stimulated production of their microalgae food. The strong factor loading for water boatmen in this habitat type suggests that water boatmen were an indicator species reflecting the suitability of this habitat type for mosquito larvae.

- ***Floating algal mats (Figure 13).*** Factor Group 4 in Table 8 represents pools with floating mats of filamentous algae (tentatively identified as *Pithophora*), backswimmers, diving beetles, and water striders. Secchi disk readings were high, indicating clear water, presumably because shading from algal mats suppressed phytoplankton. Mosquito larvae of all species were generally absent from these pools. The positive factor loading for water temperature in Factor Group 4 indicates that this habitat type was stronger during the summer, when there was more light to support algal growth. The negative regression coefficient for algal mats (dependent variable: *Cx. quinquefasciatus*) in Table 10 indicates that the filamentous algae were particularly significant for the negative association of *Cx. quinquefasciatus* larvae with this habitat type. Because algal mats covered so much of the water surface, they not only suppressed production of phytoplankton food for mosquito larvae but may also have interfered with oviposition. The negative regression coefficients for water striders (dependent variable: *Cx. quinquefasciatus*) in Table 10 and backswimmers and diving beetles (dependent variable: *Anopheles*) in Table 11 suggest that predation by these aquatic insects may have contributed to low numbers of mosquito larvae in this habitat type.

Habitat types in pools that contained fish

Table 9 shows the groups of intercorrelated variables identified for ***pools that contained fish***. The ecological situations (i.e., habitat types) represented by the groups in Table 9 bear a striking resemblance to those already seen in Table 8 for pools without fish. It is reassuring that the factor analysis found the same habitat types in the two independent data sets – with and without fish.

This result reflects not only the reality of these habitat types but also the quality of the data that revealed them.

However, in addition to the similarities between Tables 8 and 9, there are some significant differences between the two tables. While it seems that the presence or absence of fish did not significantly affect physical/chemical conditions in the pools, the presence of fish dramatically impacted the abundance of mosquito larvae and other aquatic insects.

- ***Organic pollution.*** Factor Group 1 in Table 9 represents pools littered with trash and characterized by turbid water (i.e., low Secchi disk reading), low oxygen, foul odor, and high ammonia. The physical/chemical characteristics of this ecological situation are very similar to Factor Group 1 in Table 8. However, *Cx. quinquefasciatus* larvae were not associated with this habitat type when fish were in the pool (Table 9), despite the fact that *Cx. quinquefasciatus* larvae thrived in this habitat type when fish were absent (Table 8). The explanation for the difference seems to be predation by fish, an interpretation supported by the highly significant negative regression coefficient for fish abundance (dependent variable: *Cx. quinquefasciatus*) in Table 10. Fish usually did well in this habitat type. The positive regression coefficient for tree branches (dependent variable: fish abundance) in Table 7 indicates that the clutter of tree branches characteristic of this habitat type made it a favorable habitat for fish as long as ammonia or nitrite was not at toxic concentrations. The prominence of water striders in this habitat type, and their negative regression coefficient in Table 10, suggest that predation by water striders may also have contributed to the reduction of *Cx. quinquefasciatus* larvae in this habitat type.

- ***Saline with floating pine needles.*** Factor Group 2 in Table 9 represents conditions that were unpolluted (i.e., a negative factor loading for foul odor) and particularly favorable for *Anopheles* larvae and other aquatic insects such as dragonfly/mayfly nymphs, water striders, and water boatmen. This is very similar to Factor Group 2 in Table 8. "Saline with floating pine needles" was the best habitat type for *Anopheles* larvae if fish were present. *Anopheles* were able to conceal themselves from fish predation by clinging to pine needles, twigs, and grass. *Culex salinarius* larvae were prominent in this habitat type when fish were absent (Table 8) but not associated with this habitat type when fish were present (Table 9).

- ***Oak leaves.*** Factor loadings for Factor Group 3 in Table 9 represent pools with a large quantity of oak leaves, a low number of fish, and positive factor loadings for *Cx. quinquefasciatus*, *Cx. salinarius*, and *Anopheles* larvae. This habitat type is very similar to Factor Group 3 in Table 8. Although fish reduced the number of mosquito larvae in all habitat types, "oak leaves" was the best habitat type for *Cx. quinquefasciatus* if fish were in the pool. The explanation is presumably that fish numbers were depressed in this habitat type, and fish predation on mosquito larvae was correspondingly diminished.

- ***Floating algal mats.*** Negative factor loadings for Factor Group 3 in Table 9 indicate an ecological situation that was the opposite of that represented by the positive factor loadings for Factor Group 3 in Table 9. With algal mats, clear water, high fish abundance, and high temperatures, the habitat type represented by negative factor loadings for Factor Group 3 in Table 9 is similar to Factor Group 4 (the "floating algal mats" habitat type) in Table 8. Mosquito larvae were never seen in this habitat type when fish were in the pool, apparently due to a combination of the clear water and high predation by robust fish populations. The negative association of this habitat type with the "oak leaves" habitat type is probably because shading from oak trees is unfavorable for algae growth.

Ecological succession of habitat types

Factor scores (Tabachnick 2007) were calculated to show how strongly the data for each swimming pool inspection in the research program (Appendix 1) fitted each of the factor groups in Tables 8 and 9. The factor scores told us which habitat type prevailed in a pool at the time of an inspection. While most pools fell clearly within a single habitat type, some had high factor scores for two factor groups at the same time. In other words, some pools displayed the characteristics of two habitat types at the same time. This could happen because (a) the pool history and environment surrounding the pool fostered two habitat types (e.g., flooding with brackish water and oak trees above the pool) or (b) a pool was in transition through ecological succession from one habitat type to another (for example from "organic pollution" to "floating algal mats").

Table 12 shows the frequencies of the four habitat types in 2007 and 2008. The "organic pollution" and "saline with floating pine needles" habitat types were common in 2007, but were no longer significant in 2008. (There were still some pools with positive factor scores for these two habitat types in 2008, but the factor scores were not strong enough to include those pools in the tallies for these two habitat types.) The number of pools with the "floating algal mats" habitat type increased from 2007 to 2008, in part because many "organic pollution" and "saline with floating pine needles" pools changed to "floating algal mats." All "oak leaves" pools in 2007 continued with the "oak leaves" habitat type in 2008.

Tables 8-9 and Table 12 are based on quantitative data starting in May 2007. What are the implications for the time before data collection began? Because the four habitat types can be recognized by just looking at them, we know from visual observations during 2006 that all four habitat types were already conspicuous at that time. In fact, the "organic pollution" and "saline with floating pine needles" habitat types were even more common and more pronounced during 2006 than they were during 2007.

Management insights from the habitat types

The fact that such similar habitat types emerged from two independent data sets – swimming pools with fish (Table 9) and pools without fish (Table 8) – confirms the reality of the habitat types and their value for clarifying pool-to-pool differences in larval abundance, fish abundance, and the effectiveness of fish for larval control. The habitat types provide a basis for tailoring the management of unmaintained swimming pools to ecological conditions in the pools.

The "organic pollution" habitat type, so suitable for *Cx. quinquefasciatus* larvae, was a product of rotting materials cast into pools by the hurricane and flood. Fish provided effective control in this habitat type, except when pollution was extreme. This habitat type persisted for as much as two years in pools that were never cleaned out, gradually declining as the organic debris decomposed. Draining and cleaning a pool with this habitat type, and then refilling it with water and stocking it with fish, should eliminate the pollution and ensure effective mosquito control even if the pool continues without further maintenance. If thorough cleaning is not feasible, simply removing trash should help to wind down the organic pollution more quickly.

The “saline with floating pine needles” habitat type sometimes contained *Anopheles* larvae even with fish in a pool, particularly if the pool contained a large quantity of floating leaves, twigs, small wood fragments, or grass. This habitat type, associated with high salinity, diminished in strength with the passage of time, apparently because the salinity that was keeping pine needles and other materials afloat was decreasing with time. The most important management is to replace the water in the pool with non-saline water and/or remove pine needles, grass, and other floating materials to eliminate refuge for *Anopheles* larvae to evade predation by fish.

The “oak leaves” habitat type, which supported all species of mosquito larvae, was a consequence of location (i.e., unmaintained swimming pools with overhanging oak trees). The number of pools with this habitat type did not decline with the passage of time, and control by fish was sometimes incomplete because of low fish populations. Since pools with a continuous influx of leaves from overhanging oak trees can continue to produce mosquitoes even with fish in the pool, such pools should be priority candidates for demolition or conversion to full and proper maintenance.

The “floating algal mats” habitat type was a “pond” that supported thriving fish populations. This habitat type appeared in some swimming pools during the first year after Katrina but was particularly common by the third year, when the “organic pollution” and “saline with floating pine needles” habitat types faded away – a natural ecological succession from more favorable to less favorable conditions for mosquito larvae. Floating algal mats look messy, but this habitat type produces few mosquitoes. With fish, it provides excellent long-term mosquito control.

Table 8. Intercorrelated variables for swimming pools not containing fish. Factor loadings (shown in parentheses for each variable) represent the strength of each variable's correlation with other variables in the same group. Negative factor loadings indicate variables positively correlated with each other but negatively correlated with the variables having positive factor loadings.

FACTOR GROUP 1

Positive factor loadings	***Negative factor loadings***
Tree branches (.64)	Oxygen (-.57)
Large items (.54)	Time (-.56)
pH (.52)	
Water temperature (.51)	
Foul odor (.45)	
Ammonia (.36)	
Cx. quinquefasciatus larvae (.30)	
Temperature (.17)	

FACTOR GROUP 2

Positive factor loadings	***Negative factor loadings***
Dragonfly/mayfly nymphs (.68)	Time (-.30)
Pine (.57)	Algal mats (-.21)
Anopheles larvae (.56)	Foul odor (-11)
Water strider (.51)	
Water boatmen (.45)	
Cx. salinarius larvae (.43)	
Salinity (.40)	
Grass (.31)	

FACTOR GROUP 3

Positive factor loadings	***Negative factor loadings***
Oak leaves (.60)	Large items (-.40)
Plastic bags (.47)	Tree branches (-.36)
Cx. quinquefasciatus larvae (.43)	Wood (-.33)
Water boatmen (.36)	
Nitrate (.38)	
Brown water (.27)	
Foul odor (.26)	
Anopheles larvae (.21)	

FACTOR GROUP 4

Positive factor loadings	***Negative factor loadings***
Secchi disk (.61)	Grass (-.34)
Backswimmers (.56)	*Anopheles* larvae (-.29)
Diving beetles (.53)	*Cx. quinquefasciatus* larvae (-.29)
Algae mats (.47)	*Cx. coronator* larvae (-.26)
Water striders (.38)	*Cx. salinarius* larvae (-.20)
Sticks (.33)	
Temperature (.28)	

Table 9. Intercorrelated variables for swimming pools containing fish. Factor loadings (shown in parentheses for each variable) represent the strength of each variable's correlation with other variables in the same group. Negative factor loadings indicate variables positively correlated with each other but negatively correlated with the variables having positive factor loadings.

FACTOR GROUP 1

Positive factor loadings	***Negative factor loadings***
Tree branches (.72)	Oxygen (-.38)
Water boatmen (.71)	Secchi disk (-.32)
Backswimmers (.64)	Grass (-.30)
Water striders (.55)	Time (-28)
Diving beetles (.54)	
Dragonfly/mayfly nymphs (.34)	
Ammonia (.37)	
Large items (.35)	
Sticks (.30)	
Foul odor (.24)	

FACTOR GROUP 2

Positive factor loadings	***Negative factor loadings***
Salinity (.74)	Time (-.63)
Dragonfly/mayfly nymphs (.64)	Large items (-.50)
Water striders (.58)	Foul odor (-.34)
Pine needles (.53)	Algal mats (-.25)
Plastic items (.50)	
Sticks (.46)	
Anopheles larvae (.39)	
Grass (.38)	
Water boatmen (.28)	

FACTOR GROUP 3

Positive factor loadings	***Negative factor loadings***
Cx. quinquefasciatus larvae (.55)	Algae mats (-.52)
Brown water (.53)	Fish abundance (-.50)
Oak leaves (.52)	Water temperature (-.46)
Cx. salinarius larvae (.43)	Time (-.33)
Water boatmen (.33)	
Anopheles larvae (.19)	
Foul odor (.19)	

Table 10. Normalized multiple regression coefficients (Dependent variable: number of *Cx. quinquefasciatus* larvae) [1]

	Positive coefficients			Negative coefficients	
	Coefficient	*Significance*[2]		*Coefficient*	*Significance*[2]
Foul odor	.21	<.001	Fish abundance	-.16	.001
Chlorine	.19	<.001	Water striders	-.11	.11
Oak leaves	.16	.003	Oxygen	-.10	.06
Water boatmen	.10	.10	Water temperature	-.09	.08
			Algae mats	-.07	.14

1. Based on all swimming pools.
2. Two-tailed test.

Table 11. Normalized multiple regression coefficients (Dependent variable: number of *Anopheles* larvae) [1]

	Positive coefficients			Negative coefficients	
	Coefficient	*Significance*[2]		*Coefficient*	*Significance*[2]
Water boatmen	.19	.001	Fish abundance	-.22	<.001
Nitrate	.17	<.001	Diving beetles	-.11	.04
Pine needles	.14	.01	Water temperature	-.10	.05
Dragonfly nymphs	.11	.09	Backswimmers	-.10	.06
Wood	.10	.04			
Grass	.07	.18			

1. Based on all swimming pools.
2. Two-tailed test.

Table 12. Percentage of monitored swimming pools that were in each habitat type. Based on "factor scores" for each pool inspection with respect to each factor group in Tables 8 and 9.[1]

	2007	**2008**
Organic pollution	35%	2%
Saline with floating pine needles	23%	0 %
Oak leaves	14%	14%
Floating algal mats	16%	51%

[1]Number of swimming pools monitored each year = 43. The percentages in this table are not precise estimates of each habitat type in the city's entire unmaintained pool population because monitored pools were not a random sample of all pools. However, the percentages convey the approximate occurrence of each habitat type and reflect real changes from 2007 to 2008.

Figure 9. An example of the "organic pollution" habitat type (Group 1 in Tables 8 and 9): foul odor, turbid water, and ammonia. Pollution from the large quantity of trash was concentrated in the small volume of water, giving the water the gray hue and foul odor typically associated with large numbers of *Cx. quinquefasciatus* larvae. *Gambusia* tolerated the low oxygen in this habitat type but suffered if ammonia was high.

Figure 10. An example of the "saline with floating pine needles" habitat type (Group 2 in Tables 8 and 9): large populations of aquatic invertebrates. Favorable habitat for *Anopheles* larvae. Floating pine needles (the brown strip around the edge of the pool) provided refuge for *Anopheles* larvae.

Figure 11. Grass growing into the water from the edge of the pool provided refuge for *Anopheles* larvae.

Figure 12. An example of the "oak leaves" habitat type (Group 3 in Tables 8 and 9): Heavy influx of oak leaves and typically dark brown water due to tannins from the oak leaves. Favorable habitat for *Culex* and *Anopheles* larvae but inhibiting for fish. A Mosquito Control sign with information for homeowners is next to the pool.

Figure 13. An example of the "floating algal mats" habitat type (Group 4 in Table 8 and negative Group 3 factor loadings in Table 9): A large cover of floating algal mats and clear water. Unfavorable habitat for mosquito larvae but favorable habitat for fish.

VectoLex performance

It was standard procedure in the swimming pool program to treat all pools with VectoLex (*Bacillus sphaericus*) at the same time *Gambusia* was introduced, even if no mosquito larvae were seen in the pool. In addition, pools that contained larvae but no fish were treated with VectoLex whenever no *Gambusia* were on hand to introduce. The purpose of VectoLex treatment was temporary suppression of mosquito production, presumably extending beyond the treatment day because *B. sphaericus* can "recycle". This could bridge the gap until introduced *Gambusia* built up a larger population or someone returned to a pool to introduce *Gambusia*.

Was VectoLex really performing as expected? To check, in June 2007 three swimming pools were monitored for mosquito larvae after treating them with VectoLex. At the same time, water samples were taken from the pools approximately twice a week to assay the survival of newly hatched *Cx. quinquefasciatus* larvae in the laboratory.

Two of the pools contained moderately turbid, brown water (Secchi disk visible to 1.3 meters below the surface of the pool), a common condition for unmaintained pools. One of those pools averaged 60 *Cx. quinquefasciatus* larvae/dip at the time of VectoLex treatment, and the other averaged 8 larvae/dip. In both pools, all the larvae were dead within a day after VectoLex treatment, and no *Culex* larvae were seen in these two pools during the two weeks of observation after that. Water samples from these pools a day after treatment killed all *Cx. quinquefasciatus* larvae in the laboratory assay, but water samples collected from the pools during the 6th to 14th day after treatment killed only 15% - 65% of the larvae. One of the pools averaged approximately two *Anopheles* larvae/dip at the time of VectoLex treatment, and the number of *Anopheles* larvae in that pool remained about the same after the treatment.

The third pool had a strong organic loading. Its water was very turbid (Secchi disk visible to only 0.8 meters) and distinctly foul-smelling. There were approximately 500 *Cx. quinquefasciatus* larvae/dip and 200 pupae/dip at the time of VectoLex treatment. All the larvae were apparently killed within a day after treatment, but there were 1-2 pupae/dip during the following 10 days. New *Cx. quinquefasciatus* larvae started appearing in the pool 10 days after treatment. Water samples up to 10 days after treatment killed all *Cx. quinquefasciatus* larvae in the laboratory assay, but only 30% of larvae died in water samples collected 14 days after treatment.

Hot tubs attached to two pools were subjected to the same procedure of VectoLex treatment and monitoring. One contained 20 *Cx. quinquefasciatus* larvae/dip and the other 50 larvae/dip at the time of treatment. No larvae were observed in the hot tubs until three weeks after the treatment. Water samples from the tubs a day after treatment killed all *Cx. quinquefasciatus* larvae in the laboratory assay. Water samples from one of the hot tubs killed all larvae during the following two weeks that samples were collected, while water samples from the other tub during that period killed 87% - 97% of the larvae.

In conclusion, VectoLex killed all the larvae in a swimming pool at the time of application, but it killed only a fraction of the larvae after that. As expected for *B. sphaericus*, persistence (presumably due to "recycling") was greater in the swimming pool with higher organic loading, but even there the kill was ineffective by the 10th day. For practical purposes, VectoLex treatment seems not much different than applying oil to the surface of a swimming pool.

The discrepancy between observed VectoLex performance in swimming pools and what might have been expected with "recycling" can be attributed to the fact that prior information on VectoLex performance has come primarily from use in shallow water. The incomplete kill in swimming pools after the first day is not surprising, since *B. sphaericus* can be expected to sink to the bottom, beyond the reach of *Cx. quinquefasciatus* larvae. VectoLex in shallow hot tubs performed better, for at least a few weeks after treatment, probably because the larval feeding zone was replenished with *B. sphaericus* "recycling" from the bottom. The failure of VectoLex to suppress *Anopheles* production is no surprise as *B. sphaericus* is known to be ineffective against *Anopheles* and *Aedes* larvae (Lacey 2007).

Summary and conclusions

New Orleans Mosquito Control checked nearly every swimming pool in the city to ascertain whether it was properly maintained. "Pictometry" aerial photographs were a big help for locating swimming pools and preparing address lists of houses to be visited for possible *Gambusia* introduction. Pictometry reduced the number of houses to check in the field from thousands that had no swimming pools to a number that was manageable with available manpower.

Culex quinquefasciatus and *Anopheles* (*An. crucians* and *An. quadrimaculatus*) were the mosquito larvae most frequently seen in swimming pools. *Culex quinquefasciatus* larvae were present throughout the year. They were sometimes very numerous, though less common during the summer. *Anopheles* larvae were also seen throughout the year, but their numbers were seldom large. *Culiseta inornata*, *Cx. salinarius*, and *Cx. restuans* larvae could be very numerous during the winter, and *Cx. coronator* during late summer and autumn.

Approximately 750 pools contained fish introduced into them by the Katrina flood (mainly *Gambusia affinis*). The fish introduction program began in April 2006. By the end of 2006, *Gambusia affinis* was introduced to 1,335 unattended swimming pools that did not already contain fish. *Gambusia* was introduced to 136 pools during 2007, 82 pools during 2008, and 40 pools during 2009.

VectoLex was applied to pools at the same time fish were introduced. The purpose was larval control until the fish population was large enough to take over. Although VectoLex did not kill *Anopheles* larvae, we could count on VectoLex to kill all the *Culex* larvae in a swimming pool at the time of application, followed by partial mortality of new larvae during the next two weeks, and no impact after that. This was not long enough to be sure of total larval control until the introduced fish was population large enough to take over control. The limited residual effect of *B. sphaericus* was apparently due to the relatively deep water in swimming pools. After a few days, *B. sphaericus* sank to the bottom of a pool, beyond the reach of *Culex* larvae feeding at the surface.

When pools were checked after the introductions in 2006, fish were missing from 14% of the pools to which they had been introduced. It was important to know what happened to those fish. Were they unable to establish populations in” problem pools” because those pools contained polluted water or were in some other way unsuitable for *Gambusia* survival? Did the fish successfully establish populations that disappeared from the pools later?

Gambusia was impressively resistant to the organic pollution that was so common in the swimming pools during 2006-2007. The fish seemed to have thriving populations in pools with an oxygen concentration close to zero. They were also seen in pools with high levels of ammonia and nitrite associated with severe organic pollution, though their populations were generally reduced at high concentrations of ammonia or nitrite. During the research program in 2007, we found a very small percentage of pools to be so polluted that fish failed to establish a population when introduced, or managed to establish only a small and sickly population. Since severe organic pollution was more common in 2006, it appears to be responsible for at least some of the failed fish introductions in 2006.

The fact that people sometimes dumped bleach into unmaintained swimming pools to “clean them up” was of particular concern because bleach could conceivably eliminate the fish, thereby converting that pool into mosquito breeding habitat. Experimental dumping of bleach into swimming pools confirmed that bleach caused massive fish deaths immediately after application, but in every instance some of the fish survived and their populations were quickly back to normal. The main way that established fish populations were lost from pools was when pools were drained. Such pools could subsequently become mosquito breeding habitat if left to collect rainwater.

Although severe organic pollution, bleach dumping, and pool draining were destructive to fish, it appears that most of the pools without fish after the introductions in 2006 were missing the fish because of trauma to the fish during transport to the pools. The pace during 2006 was intense, and the fish sometimes appeared in poor condition when poured from the plastic bags into pools. This was particularly so if it was hot and late in the day, when the fish had been in transit since early in the morning.

The success rate of *Gambusia* introductions during 2006 improved with experience. While 84% percent of the pools to which fish were introduced during the first two months of the program (April-May) still had fish when next inspected, this measure of success increased month by month to 95% for pools receiving introductions during October-November 2006. With a less demanding fish introduction workload during 2007-2009, we were able to transport fish quickly and directly to the swimming pools. Except for a very small number of severely polluted pools in 2007, the introductions during 2007-2009 were always successful, including reintroductions to pools where fish failed to establish a population the first time, and robust fish populations continued for as long as the pools contained water.

Mosquito larvae were seen in only 2.2% of inspected pools containing fish, compared to 36% of inspected pools without fish (based on all swimming pool inspections during 2006-2008). The larvae in pools with fish were most frequently *Anopheles*. *Culex* larvae were only occasionally seen in pools with fish, but *Cx. quinquefasciatus* numbers could be high in the unusual circumstance that fish numbers were exceptionally low.

Our quantitative documentation of habitat conditions in the swimming pools (data in Appendix 1) started in May 2007 (20 months after Hurricane Katrina), and ended two years later. The following “habitat types” appeared most significant for mosquito production (Tables 8 and 9):

- ***Organic pollution***. Turbid and foul-smelling water, associated with a large quantity of rotting materials, provided particularly favorable habitat for *Cx. quinquefasciatus* larvae when there were no fish in a pool. This habitat type could be traced back to plant debris and other trash cast into pools by the hurricane and flood. *Gambusia* generally provided effective mosquito control in this habitat type. The characteristic low oxygen concentrations did not seem to bother the fish, though ammonia and nitrite concentrations were high enough in a small percentage of pools to suppress fish populations so much that *Cx. quinquefasciatus* larvae were able to survive.

- ***Saline with floating pine needles***. Some pools were saline because they were flooded with brackish water during Hurricane Katrina. The ecological conditions in these pools favored *Anopheles* larvae and often supported large numbers of aquatic insect predators such as dragonfly/mayfly nymphs, water boatmen, and water striders. These pools did not have the putrid conditions and numerous *Cx. quinquefasciatus* larvae so characteristic of pools with organic pollution. *Anopheles* larvae frequently survived even in the presence of healthy fish populations, apparently because the larvae were able to avoid predation by clinging to floating pine needles, small sticks, or grass around the edge of a pool.

- ***Oak leaves.*** Pools with a large number of oak leaves provided favorable habitat for both *Culex* and *Anopheles* larvae. Fish populations were generally low in this habitat. *Culex* and *Anopheles* larvae sometimes survived in this habitat even when fish were in the pool.

- ***Floating algal mats.*** Pools with a dense cover of algal mats and clear, shaded water contained few mosquito larvae, even in the absence of fish. Fish thrived in this habitat, and mosquito control was virtually 100% when fish were present.

Most kinds of predatory aquatic insects seemed to have little negative impact on mosquito larvae. Except for a negative association of backswimmers and diving beetles with *Anopheles* larvae and a negative association of water striders with *Cx. quinquefasciatus* larvae, mosquito larvae tended to be most abundant where aquatic insect predators, particularly water boatmen, were also abundant. Apparently, conditions favorable for mosquito larvae were favorable for all.

The results in Tables 7-11 are based on data collected during May 2007 to May 2009. What are the implications of those results for the period dating from Hurricane Katrina to the time that data collection began? Because the habitat types identified by the factor analysis in Tables 8-9 can be recognized by just looking at them, we know from our experience with the swimming pools during that period that the same four habitat types were conspicuous before systematic data collection began. Two of those habitat types, were highly "enriched": (1) the "organic pollution" habitat type, with its foul odor, turbid water, and dense populations of *Cx. quinquefasciatus* larvae, was enriched by rotting debris; (2) the "saline with floating pine needles" habitat type, which supported large populations of aquatic insects including mosquito larvae, was enriched by nitrate-rich brackish floodwaters. The "organic pollution" and "saline with floating pine needles" habitat types were particularly strong after Katrina and declined gradually during 2006 and 2007, as the organic materials in "organic pollution" pools rotted away and the salinity in "saline with floating pine needles" pools declined with the passage of time. As the "organic pollution" and "saline with floating pine needles" habitats phased out, they were transformed through ecological succession into "floating algal mats," which became the prevailing habitat by 2008. This natural succession to "floating algal mats" reduced mosquito production and provided ideal habitat for fish to thrive and control mosquito larvae. In contrast, the "oak leaves" habitat type, which is associated with overhanging oak trees, has not diminished in intensity with the passage of time. It would not be expected to change to "algal mats" because there is not enough sunlight under oak trees to support the algae.

Because swimming pools without fish are similar in function to gravid traps used to monitor *Culex* populations, the abundance of mosquito larvae in pools without fish reflects the abundance of adult mosquito populations in the immediate vicinity. The percentage of such pools containing larvae was high during 2006 and much lower during 2007-2008, suggesting that adult mosquito populations were also lower at that time. The number of West Nile Virus cases in New Orleans followed the same pattern, dropping from a high in 2006 to a low in 2007-2008 (Figure 1). It seems this decline in mosquitoes and West Nile Virus from 2006 to 2007-2008 can be attributed in large part to the fact that the vast majority of unmaintained swimming pools in New Orleans contained fish by the end of 2006. It is also likely that some of the decline in mosquitoes and West Nile Virus can be attributed to the decline in the "organic pollution" and "saline with floating pine needles" swimming pool habitat types from 2006 to 2008.

Many of the swimming pools that needed emergency fish introductions in 2006 are now under owner maintenance or have been filled in (Table 13). By 2012, fish were still providing mosquito control in approximately 600 unmaintained pools. Approximately a hundred unattended pools never had fish introduced because of inability to access the property or for other reasons. A new crop of unattended swimming pools has emerged in recent years, primarily because people have abandoned their homes due to mortgage defaults or other reasons.

Table 13. Status of swimming pools when first visited after Katrina and when last visited (or checked with the Pictometry aerial photo system). This table was prepared in 2009.

	Status at first visit				
		Not maintained			
Status at last visit	Owner maintained	Natural fish[1]	No fish[2]	Drained[3]	Total
Owner maintained	2370	261	507	11	3149
Natural fish[1]	0	199	0	0	199
Gambusia[4]	38	53	489	0	580
Drained[3]	0	4	11	0	15
Removed[5]	94	153	307	13	567
Don't know[6]	1673	83	137	49	1942
Total	4175	753	1451	73	6452

1. Fish populations introduced to swimming pools by the Katrina flood.
2. *Gambusia* were introduced to unmaintained pools that did not already contain fish (unless the pool was completely drained).
3. Although it was not possible to introduce fish to drained pools, such pools were considered potential mosquito breeding sites because they might later collect rainwater.
4. Pools to which *Gambusia* were introduced previously and there were still *Gambusia* in the pool at the last visit.
5. Pools filled in or otherwise destroyed.
6. Pools not checked after the first visit.

Recommendations

The following recommendations come from our experience with fish introductions after Hurricane Katrina. The recommendations should be relevant not only to hurricanes and floods but to other disasters that interfere with swimming pool maintenance, such as severe earthquakes. Many of the recommendations should also apply to controlling mosquito production in abandoned swimming pools under less traumatic circumstances, such as the large number of abandoned pools now appearing around the country due to home mortgage defaults.

Lining up a reliable source of fish in advance. The beginning of our fish introduction program was delayed several months while tracking down an adequate supply of fish.

Identifying houses with swimming pools. The *Pictometry aerial photo system* and Google Earth proved critical for listing the addresses of swimming pools without walking up and down streets to find them. Up-to-date images not only provide addresses but also show whether a pool is maintained or not. *Past building permits and real estate listings* are another source of information for swimming pool addresses. It is best to arrange access to this information ahead-of-time because government permitting offices and real estate associations may not be functioning in the aftermath of disaster. *Neighborhood associations* can also be a source of information about swimming pool locations and provide manpower for reconnaissance after a disaster.

Communicating with residents. There should be a clear policy concerning what the public should know about the fish introduction program and what is expected from the public to help the program succeed. Public service announcements through the media proved particularly helpful at paving the way for inspection or fish-introduction teams. In addition, if a resident is at home when fish are introduced, that person can receive appropriate information first hand from the people who introduce the fish. If no one is home, a notice or sign should be posted to provide the information. Expectations for resident cooperation might include:

- Putting no chemicals harmful to fish in the swimming pool.
- Draining the pool only if it will be filled in immediately, kept completely dry, or put into proper maintenance.
- Informing the mosquito control agency if the fish disappear (so fish can be reintroduced).
- Informing the mosquito control agency if an unmaintained pool is converted to proper maintenance (so it is no longer necessary for the agency to continue the pool in its management system).

Access to properties. Access can be particularly difficult when residents are not at home and gates are locked. It can be dangerous to enter a backyard without explicit permission from the resident. The legal basis for access to properties should be clear ahead-of-time and updated according to circumstances after the disaster. The public should be thoroughly informed about access policies and procedures.

Introducing healthy fish. Fish in holding tanks should be free of disease and other stresses such as crowding, low oxygen, or extreme temperatures. In New Orleans, the most serious stress occurred during transport from holding tanks to swimming pools, the stress being particularly severe during high summer temperatures. Fish for introduction in the afternoon should be collected from holding tanks at mid-day, so transport time from storage tank to swimming pool is no more than a few hours, and fish should be protected from heat stress during that time. Staff should be alert to telltale signs of unhealthy fish (e.g., abnormal movement), so only healthy fish are placed in swimming pools. During the early months of fish introduction, we put the fish in oxygenated plastic bags because we considered it the safest way to transport the fish. Plastic bags also had the advantage that inexperienced volunteers could introduce fish by simply pouring the contents of a bag into a pool. However, we later switched to transporting fish in large coolers without bags. It saved the work of putting fish in bags, and fish seemed to arrive at the pools in better condition.

Larvicides. It may be necessary to use larvicides on an unprecedented scale until mosquito production in swimming pools is controlled by fish introductions. It is best to work out a large-scale larviciding strategy ahead-of-time: what larvicides will be used; how large quantities can be obtained quickly; how a large number of pools can be treated quickly; and whether particular larvicide manufacturers might donate their products.

Cleaning trash out of pools. Organic materials rotting in the water support high numbers of bacteria, protozoa, and other small organisms that serve as food for mosquito larvae. Putrid conditions are particularly favorable for *Cx. quinquefasciatus,* and trash of any kind can provide *Anopheles* larvae refuge from predators. The sooner trash is removed from a pool, the sooner the organic loading will dissipate and the carrying capacity for mosquito larvae decline.

Systematic records**.** Systematic data about the condition of inspected pools are essential for a well organized program. A form should be completed at every swimming pool inspection. It can be simple, specifying whether or not the pool is properly maintained, whether fish are already in the pool, whether fish were introduced at the time of inspection, whether there are mosquito larvae in the pool, and whether the pool was treated with a larvicide at the time of inspection. A standard number of dips should be taken at a subsample of pools to identify species of mosquito larvae and estimate their numbers. During the early months of a fish introduction program, pools should be checked about six weeks after the introductions to confirm that the introductions are successful.

Supervision and training of volunteers. Non-profit organizations can offer exceptional flexibility for providing resources and other forms of assistance after a disaster. However, careful supervision and training of volunteers was essential because volunteer turnover was often high, most volunteers had no experience with this kind of work, and the calamitous conditions after Katrina hindered orderly operations. The devastating conditions after Hurricane Katrina could distract people with the best of intentions from the focus that the work required. Volunteer roles should be clearly defined, and volunteers should be told what is expected of them down to procedural details. The general practice was to have a Mosquito Control staff person working directly alongside volunteers at all times.

Organizational self-sufficiency. While Mosquito Control was fortunate to receive valuable assistance from state and federal sources, and coordination with agencies at all levels was necessary and beneficial, we were impressed with the importance of functioning in the aftermath of disaster without too much dependence. For example, measures to compel property owners to maintain their swimming pools – which can draw on authority beyond a mosquito control agency's immediate domain – could well be a part of mosquito control operations under normal circumstances. However, during the chaotic conditions that prevailed in New Orleans for more than a year after Katrina, coordinating with enforcement agencies to compel property owners to maintain their pools or demolish the pools was not a viable option because many homeowners were out of the city and relevant agencies were overburdened with their own post-Katrina priorities. We found it most effective to focus on getting fish into as many pools as possible as rapidly as possible, leaving organizationally more complex tasks for later.

Many of the above considerations will function at a higher standard after disaster if they are part of mosquito control operations before the disaster. In some instances, they can be built into routine mosquito control operations for unmaintained pools in a way that can be scaled up when necessary. In other instances, they may not be appropriate for routine operations, but there can be some kind of preparation beforehand, such as a “dry run” or review of preparedness.

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Credits

Gerald Marten is an Adjunct Senior Fellow at the East-West Center in Honolulu. He collected information about the fish introduction program during a series of visits to New Orleans, contributed to design and management of the research program, conducted statistical analyses of swimming pool inspection records, prepared figures and tables, and wrote this report. The other authors are New Orleans Mosquito Control staff. Cynthia Harrison and Mieu Nguyen participated in the fish introductions, contributed to data compilations, conducted the species identifications and counts of larval samples in Appendix 4 and Appendix 5, and did the field and laboratory work for the research program, including swimming pool experiments with bleach and VectoLex and collecting all the data in Appendix 1. Cynthia Harrison took the swimming pool photos in Figure 4 and Figures 8-13. Stephen Sackett was in charge of the fish introduction program. Gregory Thompson managed the collection and tabulation of records for fish introductions and swimming pool inspections. He was also responsible for many aspects of fish introduction operations, including the use of Pictometry images to locate swimming pools, compilation of swimming pool address lists, and fish transport to the pools. Michael Carroll was New Orleans Mosquito, Termite & Rodent Control Board Director at the time of the fish introductions, and Claudia Riegel was Assistant Director.

Appendix 1. Research program data. Variable codes are defined in Table 2.[1] Data collected by Cynthia Harrison and Mieu Nguyen.

#	MON	DAY	YR	PIN	OAK	MLE	STI	TB	WOO	GRA	ALG	PLB	PLO	LO	GLB	BLB	BRW	GRW	WSM	PH
1	5	25	2007	0	0	2	0	0	0	0	2	2	0	0	0	0	0	0	0	6.6
2	5	25	2007	0	0	0	0	3	3	0	0	0	0	3	0	0	2	0	2	8.5
3	5	25	2007	0	2	0	0	1	0	0	0	0	2	0	0	0	1	0	2	8
4	5	25	2007	0	0	0	0	1	0	1	2	0	0	3	0	0	2	0	3	7.5
5	5	25	2007	2	0	0	0	0	0	0	2	2	0	0	0	0	0	2	0	9
6	5	25	2007	0	0	0	2	1	0	0	2	0	0	2	0	0	0	2	0	7.5
7	5	25	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6
8	6	10	2007	0	0	2	0	0	0	0	2	1	0	0	0	0	1	0	0	nd
9	6	13	2007	0	0	0	0	1	3	0	0	0	0	3	0	0	2	0	0	nd
10	6	13	2007	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	6
11	6	13	2007	0	2	0	0	1	0	0	2	0	0	1	0	0	1	0	0	nd
12	6	13	2007	0	2	0	0	0	0	0	1	2	0	0	0	0	0	1	2	nd
13	6	14	2007	0	0	0	0	1	0	1	2	0	0	3	0	0	1	0	0	nd
14	6	14	2007	0	0	2	1	0	0	0	1	0	0	0	0	0	0	1	0	nd
15	6	15	2007	2	0	0	0	0	0	0	0	0	1	0	0	2	2	0	0	nd
16	6	15	2007	0	2	0	0	0	0	0	0	2	0	0	0	0	0	1	2	6.5
17	6	15	2007	0	0	2	2	0	0	0	1	0	0	0	0	0	0	1	0	6
18	6	18	2007	0	2	0	0	0	0	0	0	2	0	0	0	0	0	1	0	nd
19	6	19	2007	0	2	0	2	0	0	0	1	2	2	0	0	0	3	0	2	7.5
20	6	19	2007	0	0	0	2	1	0	0	1	0	0	2	0	0	0	1	0	nd
21	6	20	2007	0	0	0	0	1	0	0	1	1	0	0	0	0	1	0	0	7
22	6	20	2007	2	0	0	0	1	0	0	2	2	2	0	0	0	0	2	0	7
23	6	20	2007	2	0	0	0	0	0	2	0	2	0	0	0	1	0	1	0	6.5
24	6	23	2007	0	0	2	0	0	0	0	0	0	0	1	1	0	0	1	3	7.5
25	6	25	2007	0	0	0	0	0	0	2	0	0	0	1	1	0	0	1	0	nd
26	7	3	2007	0	0	2	0	0	0	0	1	0	0	3	0	0	0	1	0	7.5
27	7	6	2007	0	0	0	0	0	0	2	0	0	0	1	1	0	0	0	0	nd
28	7	18	2007	0	3	0	0	0	0	0	0	2	0	0	0	0	0	2	2	7.5
29	7	19	2007	0	0	2	0	2	0	0	1	0	2	0	0	0	0	2	0	6
30	7	19	2007	0	0	2	0	0	0	2	1	0	0	0	0	0	2	0	0	6
31	7	19	2007	0	0	0	2	0	0	1	2	2	0	0	0	1	0	2	0	7
32	7	20	2007	0	0	2	0	0	0	0	2	2	0	0	0	0	0	1	0	7.5
33	7	20	2007	2	0	0	0	1	0	0	0	2	2	0	0	0	1	0	0	7.5
34	7	20	2007	0	2	0	0	1	0	0	2	0	0	1	0	0	1	0	0	6.5
35	7	20	2007	2	0	0	0	0	0	0	1	2	0	0	0	2	0	1	0	7.5
36	7	20	2007	0	0	0	2	1	0	0	1	0	0	2	0	0	0	1	0	6.5
37	7	20	2007	0	0	0	2	1	0	0	0	0	1	0	0	0	3	0	0	6.5
38	7	20	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6
39	7	21	2007	0	0	0	0	0	0	2	2	0	0	0	1	0	0	1	0	6
40	8	2	2007	0	2	0	0	0	0	0	1	2	0	0	0	0	2	0	0	6
41	8	2	2007	0	0	0	2	0	0	0	2	2	0	0	0	0	1	0	0	7.5
42	8	8	2007	2	0	0	2	0	0	0	0	2	0	0	0	0	2	0	0	7.5
43	8	8	2007	0	0	2	2	0	1	0	0	1	0	0	1	0	2	0	0	6
44	8	8	2007	0	0	0	0	0	0	0	1	2	0	0	2	0	0	2	0	7.3
45	8	8	2007	2	0	2	0	0	0	0	1	0	2	0	0	0	0	1	0	8.2
46	8	13	2007	0	0	2	0	0	0	0	0	2	0	0	0	0	3	0	0	8
47	8	13	2007	0	0	2	2	0	0	0	1	0	0	0	0	0	0	1	0	7.5

48	8	13	2007	0	0	0	2	0	0	0	0	2	0	0	0	0	2	0	0	8.5
49	8	23	2007	2	0	0	2	1	0	0	0	1	0	0	0	0	1	0	0	nd
50	8	24	2007	2	0	0	2	1	0	0	0	1	0	0	0	0	0	1	0	nd
51	8	27	2007	0	0	3	0	0	0	0	0	0	2	0	1	0	0	1	0	nd
52	8	27	2007	0	0	3	0	0	0	0	1	0	0	0	0	0	0	1	0	nd
53	8	29	2007	0	0	2	0	0	0	0	2	1	0	0	0	0	1	0	0	8
54	8	29	2007	0	0	0	0	1	0	0	1	2	0	2	0	0	0	1	0	7
55	8	29	2007	2	0	0	0	1	0	0	0	2	2	0	0	0	0	2	0	6.5
56	8	29	2007	0	2	0	0	1	0	0	0	1	0	0	0	0	0	2	0	8
57	8	29	2007	2	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	8
58	8	29	2007	0	0	0	2	1	0	0	1	0	2	0	0	0	0	2	0	9
59	8	29	2007	0	0	0	2	1	0	0	0	2	0	0	0	0	0	1	0	9
60	8	29	2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	nd
61	8	30	2007	0	0	2	2	0	0	0	0	2	2	0	0	0	1	0	0	8
62	8	30	2007	0	0	0	0	1	0	0	1	0	0	3	2	0	0	1	0	8
63	8	30	2007	2	2	0	2	1	0	0	0	3	0	0	0	0	1	0	0	nd
64	8	30	2007	0	0	0	0	1	0	0	2	0	0	3	0	0	1	0	0	7.5
65	8	30	2007	2	0	0	0	0	0	2	0	1	0	0	0	1	3	0	0	8.5
66	8	31	2007	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	8.5
67	9	5	2007	0	0	0	2	1	0	0	0	0	0	2	0	0	0	2	2	6.5
68	9	6	2007	2	0	0	2	1	0	0	0	2	0	0	0	0	1	0	0	nd
69	9	6	2007	0	0	2	2	0	0	0	1	2	0	0	1	0	0	1	0	7
70	9	11	2007	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1	0	8
71	9	11	2007	0	0	2	0	0	0	0	1	0	0	3	0	0	0	1	0	7
72	9	11	2007	0	0	3	2	1	0	0	0	0	0	2	0	0	0	2	2	6.5
73	9	12	2007	0	0	0	2	0	0	0	1	2	0	0	0	0	0	1	0	6.5
74	9	12	2007	2	2	0	0	0	0	0	2	2	0	0	0	0	0	1	0	8
75	9	17	2007	0	0	0	0	1	0	0	1	1	0	0	0	0	2	0	0	8
76	9	17	2007	0	0	0	0	0	2	0	0	2	0	0	0	0	0	1	0	9
77	9	18	2007	0	0	2	0	0	0	0	0	2	0	0	0	0	0	1	0	7.5
78	9	18	2007	2	0	2	0	0	0	0	0	0	2	0	0	0	2	0	0	9
79	9	18	2007	0	0	0	2	0	0	0	0	2	0	0	0	0	0	2	0	9
80	9	23	2007	0	0	0	0	1	0	0	1	1	0	0	0	0	3	0	0	7
81	10	1	2007	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	7
82	10	1	2007	2	0	0	2	0	0	2	1	1	0	0	0	1	0	2	0	9
83	10	2	2007	0	0	3	0	0	0	0	2	1	0	0	0	0	1	0	0	8.5
84	10	2	2007	0	0	0	0	1	0	0	1	2	0	2	0	0	1	0	0	7.8
85	10	2	2007	0	0	0	0	0	0	0	1	0	0	0	1	0	0	2	0	7
86	10	2	2007	1	0	0	0	1	0	0	1	0	2	0	0	0	0	1	0	7.5
87	10	2	2007	2	0	0	2	0	0	0	0	1	0	0	0	0	0	2	0	6.8
88	10	2	2007	2	0	0	0	1	0	0	0	2	2	0	0	0	0	2	0	9
89	10	2	2007	0	2	0	0	2	0	0	0	2	2	0	0	0	1	0	0	8.5
90	10	2	2007	0	0	0	0	2	0	0	0	0	0	3	0	0	2	0	0	8.5
91	10	2	2007	0	0	2	0	0	0	0	1	0	1	3	0	0	0	1	0	8.5
92	10	2	2007	2	0	0	0	0	0	0	0	0	2	0	0	2	0	1	0	8.8
93	10	2	2007	0	0	0	2	1	0	0	0	0	2	0	0	0	1	0	0	7.8
94	10	2	2007	0	0	2	0	1	0	0	0	1	0	3	0	0	1	0	0	7.5
95	10	3	2007	0	0	0	0	1	0	0	1	0	0	0	3	2	0	2	0	8
96	10	9	2007	0	0	0	0	0	0	0	1	2	0	0	0	0	0	1	0	6.5
97	10	9	2007	0	0	2	2	1	0	0	0	2	0	0	0	0	0	1	0	7.5
98	10	10	2007	0	0	0	0	0	0	0	1	2	2	0	0	0	0	1	0	6
99	10	10	2007	0	0	3	0	0	0	0	0	0	2	2	0	0	2	0	0	9

100	10	10	2007	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	8.5
101	10	15	2007	0	0	2	0	0	0	0	0	1	0	0	0	0	0	1	0	6
102	10	15	2007	0	0	2	2	0	1	0	0	1	0	0	1	0	3	0	0	8.5
103	10	17	2007	0	0	0	0	0	0	2	1	1	1	0	0	0	0	1	0	6.5
104	10	17	2007	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	8.5
105	10	17	2007	0	0	2	0	0	0	0	0	0	1	2	0	0	0	1	0	8.5
106	10	17	2007	0	0	2	2	1	0	0	0	2	0	0	0	0	0	1	0	8.5
107	10	17	2007	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	9
108	10	26	2007	0	0	0	2	0	0	0	1	1	0	0	0	0	1	0	0	7
109	10	26	2007	0	2	0	0	0	0	0	0	2	0	0	0	0	2	0	0	6.5
110	10	26	2007	0	0	2	0	0	1	2	1	0	0	0	0	0	0	2	0	6.3
111	10	26	2007	0	0	2	0	0	1	2	0	1	0	0	1	0	0	1	0	8.8
112	10	26	2007	2	0	2	0	0	0	0	0	0	2	0	0	0	1	0	0	7
113	10	31	2007	0	0	0	2	0	0	0	1	1	0	0	0	0	1	0	0	nd
114	11	2	2007	0	0	0	2	0	0	0	1	1	0	0	0	0	1	0	0	7.5
115	11	2	2007	0	3	0	0	0	0	0	0	2	0	0	0	0	2	0	0	6.8
116	11	2	2007	0	0	2	0	0	1	2	1	0	0	0	0	0	0	2	0	8
117	11	2	2007	0	0	2	0	0	1	2	0	1	0	0	1	0	0	1	0	7.5
118	11	2	2007	2	0	2	0	0	0	0	0	1	0	0	0	0	2	0	0	8.8
119	11	9	2007	0	0	0	3	0	0	0	1	1	0	0	0	0	1	0	0	6
120	11	9	2007	0	2	0	0	0	0	0	0	2	0	0	0	0	3	0	0	6
121	11	9	2007	0	0	2	0	0	1	2	1	0	0	0	0	0	0	2	0	6.8
122	11	9	2007	0	0	2	0	0	1	2	0	1	0	0	0	0	0	1	0	6
123	11	9	2007	2	0	2	0	0	0	0	0	1	0	0	1	0	2	0	0	7.5
124	11	12	2007	0	0	0	0	0	0	2	0	1	1	0	0	0	0	1	0	7
125	11	12	2007	0	0	2	0	0	0	0	1	0	2	0	0	0	1	0	0	6.5
126	11	12	2007	0	0	0	0	0	0	0	1	2	0	0	0	0	0	1	0	6.5
127	11	12	2007	0	0	2	2	1	0	0	0	2	0	0	0	0	0	2	0	7
128	11	12	2007	0	0	3	0	0	0	0	0	0	1	2	0	0	1	0	0	6.5
129	11	12	2007	0	0	0	0	0	0	2	0	0	2	0	0	0	2	0	0	7.5
130	11	12	2007	0	0	2	1	1	0	0	0	2	0	0	0	0	0	1	0	6
131	11	12	2007	2	2	0	0	0	0	0	0	2	0	0	0	0	2	0	0	6
132	11	12	2007	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	8
133	11	12	2007	0	0	0	0	0	0	1	0	0	2	0	0	0	2	0	0	6.8
134	11	15	2007	0	0	0	0	1	0	0	0	2	0	0	0	0	1	0	0	5.8
135	11	15	2007	0	0	0	0	0	2	2	1	0	0	0	3	2	0	2	0	7.5
136	11	15	2007	2	0	0	2	2	0	0	0	2	1	0	0	0	2	0	0	7
137	11	15	2007	0	0	2	0	0	0	0	0	0	0	0	0	0	3	0	0	6
138	11	15	2007	0	0	2	0	0	0	0	1	0	2	2	0	0	0	1	0	8
139	11	15	2007	0	0	2	0	0	0	0	0	0	0	0	1	0	0	1	0	8.5
140	11	15	2007	0	0	2	2	0	2	0	0	0	2	0	0	0	1	0	0	6.5
141	11	15	2007	0	0	0	0	0	2	0	0	0	0	0	1	0	0	1	0	8.3
142	11	15	2007	0	0	0	2	1	0	0	0	0	0	2	0	0	0	1	0	7.5
143	11	15	2007	0	0	0	0	1	0	0	0	0	0	2	0	0	0	1	0	7.5
144	11	19	2007	0	0	2	0	0	0	0	1	2	0	0	0	0	1	0	0	6
145	11	19	2007	0	0	2	2	1	0	0	0	2	0	0	0	0	0	2	0	6.8
146	11	19	2007	0	0	0	0	0	0	2	0	0	2	0	0	0	0	1	0	6.5
147	11	19	2007	2	2	0	0	0	0	0	0	2	0	0	0	0	2	0	0	7
148	11	19	2007	0	0	2	2	1	0	0	0	0	2	0	0	0	0	2	0	6.8
149	11	19	2007	0	0	0	0	0	0	2	0	0	1	0	0	0	1	0	0	6
150	11	21	2007	0	0	0	0	2	0	0	0	0	0	0	3	2	0	1	0	7.5
151	11	21	2007	0	0	2	0	0	0	0	0	2	0	0	0	0	1	0	0	7

152	11	21	2007	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	7
153	11	21	2007	0	0	2	0	0	1	0	0	2	0	0	0	0	0	1	0	7
154	11	21	2007	0	0	2	0	0	0	0	0	2	0	0	1	0	0	1	0	9
155	11	21	2007	0	2	0	2	0	0	0	0	0	0	0	0	0	0	1	0	8.5
156	11	21	2007	0	0	0	0	0	2	0	0	0	2	0	0	0	0	1	0	6.7
157	11	21	2007	0	0	2	2	0	0	0	0	1	1	0	0	0	0	1	0	5
158	11	21	2007	0	0	0	0	1	0	0	0	1	0	3	0	0	0	1	0	9
159	11	21	2007	0	0	0	2	0	0	0	0	2	0	0	0	0	0	1	0	7.5
160	11	26	2007	0	0	0	2	0	0	0	1	2	0	0	0	0	0	0	0	6.5
161	11	26	2007	0	2	0	0	0	0	0	0	2	0	0	0	0	2	0	0	6.5
162	11	26	2007	0	0	2	0	0	1	1	1	0	0	0	0	0	0	2	0	6.5
163	11	26	2007	0	0	2	0	0	1	1	0	1	0	0	1	0	0	1	0	6.5
164	11	26	2007	2	0	2	0	0	0	0	0	0	2	0	0	0	0	1	0	7.5
165	11	27	2007	0	0	2	0	0	0	0	1	2	0	0	0	0	1	0	0	6
166	11	27	2007	0	0	2	2	1	0	0	0	2	0	0	0	0	0	2	0	8
167	11	27	2007	0	0	0	0	0	0	1	0	0	2	0	0	0	0	1	0	6.5
168	11	27	2007	2	2	0	0	0	0	0	0	2	0	0	0	0	2	0	0	7.5
169	11	27	2007	0	0	0	0	0	0	2	0	0	1	0	0	0	1	0	0	6.5
170	12	5	2007	0	0	2	0	0	0	0	0	2	0	0	0	0	0	1	0	6
171	12	5	2007	0	0	2	0	0	1	0	0	0	0	0	1	0	0	1	0	6
172	12	5	2007	0	2	0	2	0	0	0	0	0	0	0	0	0	2	0	0	6.5
173	12	5	2007	0	0	2	2	0	0	0	0	1	0	0	0	0	2	0	0	7.5
174	12	5	2007	0	0	0	2	0	0	0	0	2	0	0	0	0	0	1	0	7.5
175	12	12	2007	0	0	2	0	0	0	0	1	2	0	0	0	0	1	0	0	6.5
176	12	12	2007	0	0	2	2	1	0	0	0	2	0	0	0	0	0	1	0	8
177	12	12	2007	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	7.5
178	12	12	2007	2	2	0	0	0	0	0	0	2	0	0	0	0	2	0	0	7.5
179	12	12	2007	0	0	0	0	0	0	2	0	0	1	0	0	0	1	0	0	7.5
180	12	13	2007	0	0	2	0	0	0	0	2	2	0	0	0	0	1	0	0	7
181	12	13	2007	0	2	0	0	1	0	0	0	2	0	0	0	0	1	0	0	7.5
182	12	13	2007	2	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	6.5
183	12	15	2007	0	0	0	0	1	0	0	0	0	0	1	1	0	2	0	0	7.5
184	12	15	2007	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	6
185	12	15	2007	0	0	2	0	0	0	0	0	0	0	0	1	0	0	1	0	6
186	12	15	2007	0	0	0	0	0	2	0	0	1	2	0	0	0	0	1	0	7.5
187	12	15	2007	0	0	0	0	1	0	0	0	0	0	2	0	0	0	1	0	8
188	12	17	2007	0	0	0	0	0	0	2	0	2	2	0	0	0	0	1	0	7
189	12	17	2007	0	0	0	0	0	0	0	1	2	0	0	0	0	0	1	0	7.5
190	12	17	2007	0	0	2	0	0	0	0	0	0	2	2	0	0	1	0	0	7
191	12	17	2007	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7.5
192	12	17	2007	0	0	0	0	0	0	0	1	2	0	0	0	0	0	1	0	7.5
193	12	20	2007	0	0	2	2	0	0	0	0	2	1	0	0	0	2	0	0	7
194	12	20	2007	0	0	0	0	1	0	0	1	2	0	1	0	0	0	1	0	7.5
195	12	20	2007	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	6.5
196	12	20	2007	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	6.8
197	12	20	2007	2	0	0	0	1	0	0	0	2	1	0	0	0	0	1	0	6.5
198	12	20	2007	0	0	0	0	1	0	0	2	0	1	3	0	0	2	0	0	6
199	12	20	2007	2	0	0	2	0	0	1	0	1	1	0	0	1	0	2	0	6
200	12	20	2007	0	0	2	0	1	0	0	0	0	2	0	0	0	1	0	0	7.8
201	12	20	2007	0	0	2	2	0	0	0	0	0	0	0	0	0	1	0	0	7.5
202	12	21	2007	0	0	2	0	0	0	0	0	2	0	0	0	0	1	0	0	6.5
203	12	21	2007	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	0	6.5

204	12	21	2007	0	2	0	2	0	0	0	0	0	0	0	0	0	0	1	0	6
205	12	21	2007	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	6.5
206	12	26	2007	0	0	0	0	0	0	0	1	2	0	0	0	0	1	0	0	6
207	12	26	2007	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	7.5
208	12	26	2007	0	0	2	0	0	1	2	1	0	0	0	0	0	0	1	0	6
209	12	26	2007	0	0	2	0	0	1	2	0	0	0	0	0	0	0	1	0	7.5
210	12	26	2007	0	0	2	2	0	0	0	0	1	0	0	0	0	2	0	0	7.5
211	12	26	2007	2	0	2	0	0	0	0	0	0	2	0	0	0	0	1	0	7.5
212	12	28	2007	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	7.5
213	1	11	2008	0	0	0	0	0	0	2	0	1	1	0	0	0	0	1	0	6.5
214	1	11	2008	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	6
215	1	11	2008	0	0	2	0	0	0	0	0	0	2	2	0	0	1	0	0	6
216	1	11	2008	0	0	2	2	1	0	0	0	2	0	0	0	0	0	2	0	6
217	1	11	2008	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	6
218	1	28	2008	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	6
219	1	28	2008	0	0	0	2	0	0	0	2	2	0	0	0	0	0	1	0	6
220	1	28	2008	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	6
221	1	28	2008	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	6
222	1	28	2008	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	6.5
223	1	28	2008	0	0	2	0	0	0	0	1	0	0	0	0	0	0	1	0	6
224	1	28	2008	0	0	2	0	0	0	2	1	1	0	0	0	0	0	1	0	6
225	1	28	2008	0	0	2	0	0	0	0	1	0	0	0	0	0	0	1	0	6
226	1	28	2008	0	0	2	0	0	1	2	0	1	0	0	1	0	0	1	0	7
227	1	28	2008	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	6
228	1	28	2008	2	0	0	0	0	0	2	0	0	2	0	0	0	0	1	0	6.5
229	1	28	2008	0	0	2	0	0	2	2	0	1	0	0	0	0	0	2	0	7
230	1	28	2008	0	0	2	0	0	0	0	1	1	0	0	0	0	1	0	0	6
231	1	29	2008	0	0	2	0	0	0	0	0	2	0	0	0	0	3	0	0	6
232	1	29	2008	0	0	2	0	0	2	0	1	0	0	0	0	0	0	1	0	6
233	1	29	2008	0	0	2	0	0	0	0	0	0	0	0	1	0	2	0	0	7
234	1	29	2008	0	2	0	0	0	0	0	0	1	0	0	0	0	0	1	0	7
235	1	29	2008	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	7
236	1	29	2008	0	0	2	0	0	0	0	1	0	0	0	0	0	0	1	0	6.5
237	1	29	2008	0	0	2	0	0	0	0	0	1	0	0	0	0	0	1	2	6
238	2	7	2008	0	0	0	0	0	0	2	0	0	1	0	0	0	0	1	0	6
239	2	7	2008	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	6.5
240	2	7	2008	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	6.5
241	2	7	2008	0	0	2	0	0	1	0	0	0	0	0	0	0	0	1	0	6.3
242	2	7	2008	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	6.3
243	2	13	2008	0	0	0	2	0	0	0	2	1	0	0	0	0	0	1	0	6.5
244	2	13	2008	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	6.3
245	2	13	2008	0	0	2	2	0	0	0	1	1	1	0	0	0	0	1	0	6.3
246	2	13	2008	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	6.3
247	2	13	2008	0	0	2	2	0	0	0	0	1	0	0	0	0	0	2	0	6
248	2	18	2008	0	0	0	0	1	0	0	1	1	0	0	0	0	2	0	0	6.5
249	2	18	2008	0	0	2	0	0	0	0	1	1	0	0	0	0	2	0	0	6.3
250	2	18	2008	0	0	2	2	1	0	0	0	0	1	0	1	0	2	0	0	6.5
251	2	18	2008	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	6.5
252	2	18	2008	0	0	2	2	1	0	0	2	0	1	1	0	0	0	2	0	6.5
253	2	21	2008	0	0	0	0	0	0	0	1	2	0	0	0	0	0	2	0	6.5
254	2	21	2008	0	0	2	2	0	1	0	0	1	1	0	0	0	2	0	0	6.5
255	2	21	2008	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	6.5

256	2	21	2008	0	0	2	2	0	0	0	0	1	0	0	0	0	0	2	0	6
257	2	21	2008	0	0	2	0	0	0	0	0	0	1	0	0	0	1	0	0	7.5
258	2	25	2008	0	0	2	2	0	0	0	2	1	0	0	0	0	1	0	0	6.3
259	2	25	2008	0	2	0	2	0	0	0	0	0	1	0	0	0	0	2	0	6.5
260	2	25	2008	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	8
261	3	20	2008	0	0	0	0	0	1	0	0	0	0	2	0	0	1	0	0	nd
262	3	20	2008	0	0	2	0	0	1	0	0	1	0	2	0	0	1	0	0	6.5
263	3	20	2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	7
264	3	20	2008	0	0	0	0	0	0	2	0	1	0	0	0	0	0	1	0	7.5
265	3	20	2008	0	0	2	0	0	0	0	0	1	0	0	0	0	0	2	0	6
266	3	20	2008	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	6
267	3	20	2008	0	0	0	0	0	0	1	0	1	0	0	0	0	2	0	0	7
268	3	20	2008	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	7.5
269	3	20	2008	0	0	0	0	0	0	0	1	0	0	0	0	1	0	2	0	8
270	3	20	2008	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	6
271	3	20	2008	0	2	0	0	0	0	0	0	1	1	0	0	0	0	2	0	7
272	3	20	2008	0	2	0	0	0	0	0	0	1	0	1	1	0	2	0	0	6
273	3	26	2008	0	0	2	0	0	0	0	1	0	0	2	0	0	0	1	0	8.5
274	3	26	2008	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	6.5
275	3	26	2008	0	0	0	0	0	0	1	0	1	0	0	0	0	2	0	0	8.5
276	3	26	2008	0	0	2	0	0	0	0	0	1	0	0	0	0	3	0	0	8.5
277	3	27	2008	0	0	2	0	0	1	0	0	1	0	0	0	0	2	0	0	7.5
278	3	31	2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6.5
279	3	31	2008	0	0	2	0	0	0	0	2	1	0	0	0	0	0	1	0	8
280	3	31	2008	0	0	2	2	0	0	0	1	1	1	0	0	0	0	2	0	6.5
281	3	31	2008	0	0	2	2	0	0	0	1	1	1	0	0	0	0	2	0	8
282	3	31	2008	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	6.5
283	4	3	2008	0	0	2	0	0	0	0	0	0	2	0	0	0	0	2	0	8
284	4	3	2008	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	6
285	4	3	2008	0	0	0	0	0	2	0	0	1	0	0	0	0	2	0	0	8
286	4	3	2008	0	0	2	0	0	0	0	0	1	0	0	0	0	0	2	0	6.5
287	4	3	2008	0	0	2	0	0	1	0	1	1	0	0	0	0	0	1	0	6.5
288	4	3	2008	0	0	0	2	0	0	0	3	1	1	0	0	0	1	0	0	8
289	4	7	2008	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	6.5
290	4	7	2008	0	0	0	1	0	0	0	1	1	0	0	0	0	0	2	0	7
291	4	7	2008	0	0	2	0	0	0	0	1	1	0	0	0	0	0	1	0	6.5
292	4	7	2008	0	0	2	0	0	0	0	0	1	0	0	0	0	0	1	0	7.5
293	4	11	2008	0	0	2	0	0	1	0	0	1	0	0	0	0	1	0	0	7.5
294	4	11	2008	0	0	2	2	0	0	0	2	0	0	0	0	0	0	2	0	6.5
295	4	11	2008	0	0	2	0	0	0	0	1	1	2	0	0	0	0	1	0	7.5
296	4	14	2008	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	6.5
297	4	14	2008	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	6.5
298	4	14	2008	0	0	2	0	0	0	0	1	1	1	0	0	0	1	0	0	6
299	4	24	2008	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0
300	4	21	2008	0	0	2	2	0	0	0	1	0	1	0	0	0	0	1	0	8.5
301	4	21	2008	0	0	2	0	0	0	0	0	0	1	0	0	0	1	0	0	6
302	4	21	2008	0	0	2	0	0	0	0	0	1		1	0	0	1	0	0	7.5
303	4	21	2008	0	0	0	0	0	0	0	2	1	0	0	0	0	0	2	0	6.5
304	4	21	2008	0	0	2	0	0	1	0	0	0	1	0	0	0	1	0	0	6.5
305	4	25	2008	0	0	2	0	0	1	0	0	1	1	0	0	0	2	0	0	6
306	4	25	2008	0	0	2	0	0	0	0	1	0	0	0	0	0	1	0	0	8
307	4	25	2008	0	0	0	0	0	0	0	1	1	1	0	0	0	0	2	0	6.5

308	4	30	2008	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	6
309	4	30	2008	0	0	2	0	0	0	0	1	1	0	0	0	0	0	2	0	6
310	4	30	2008	0	0	0	0	0	0	0	1	1	1	0	0	0	2	0	0	6
311	4	30	2008	0	0	2	2	0	0	0	2	1	0	0	0	0	0	2	0	6
312	4	30	2008	0	0	0	2	0	0	0	0	1	0	0	0	0	1	0	0	8
313	5	8	2008	2	0	0	0	2	0	0	3	1	1	1	0	0	1	0	1	8
314	5	12	2008	0	0	0	2	0	1	0	0	0	0	0	0	0	1	0	0	6
315	5	12	2008	0	0	2	0	0	1	0	0	0	0	0	0	0	2	0	0	7.5
316	5	12	2008	0	0	2	0	0	0	0	0	0	1	0	0	1	2	0	0	6
317	5	12	2008	0	0	2	0	0	1	0	3	0	1	0	0	0	0	1	0	6
318	5	12	2008	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	6
319	5	15	2008	0	0	0	0	0	1	0	2	1	1	0	0	0	0	1	0	8
320	5	15	2008	2	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	5
321	5	15	2008	0	0	0	0	0	0	2	0	0	1	0	0	0	0	2	0	8.5
322	5	15	2008	0	0	0	0	0	1	0	2	0	1	0	0	0	2	0	2	8.6
323	5	15	2008	0	0	2	0	1	0	0	1	0	1	0	0	0	0	2	0	8
324	5	20	2008	0	0	2	0	0	1	0	1	1	0	0	0	0	0	2	0	7
325	5	20	2008	0	0	2	0	0	0	0	1	1	0	0	0	0	0	2	0	6
326	5	20	2008	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	7.5
327	5	20	2008	0	0	0	0	0	1	0	2	1	0	1	0	0	0	2	0	6.5
328	5	20	2008	0	0	2	0	0	0	0	1	0	1	1	0	0	0	2	0	6.5
329	5	21	2008	0	0	2	0	0	0	0	1	1	1	0	0	0	2	0	0	6.5
330	5	27	2008	0	0	0	0	0	0	0	2	1	0	0	0	0	0	1	0	7.5
331	5	27	2008	0	0	2	0	0	0	1	0	1	0	0	0	0	0	1	0	8
332	5	27	2008	0	0	2	0	0	0	0	1	0	2	0	0	0	0	1	0	7.5
333	5	30	2008	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	6.5
334	5	30	2008	0	0	2	0	0	0	0	1	0	0	0	0	0	0	1	0	7
335	5	30	2008	0	0	0	0	0	0	0	2	1	1	0	0	0	0	2	0	6.5
336	5	30	2008	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1	0	8.5
337	5	30	2008	0	0	0	0	0	0	0	3	0	1	1	0	0	1	0	0	9
338	6	6	2008	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	6
339	6	6	2008	0	2	0	0	0	0	0	0	1	0	0	0	0	0	2	0	7.5
340	6	6	2008	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	7.5
341	6	6	2008	0	0	2	2	0	1	0	0	0	1	0	0	0	3	0	0	7.5
342	6	19	2008	0	0	0	2	0	0	0	3	1	0	0	0	0	1	0	0	6.5
343	6	20	2008	2	0	0	2	0	0	0	2	0	1	0	0	0	1	0	0	7
344	6	20	2008	0	0	0	0	0	0	2	0	1	0	0	0	0	0	1	0	6
345	6	20	2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	6
346	6	20	2008	0	0	2	0	0	0	0	2	0	1	0	0	0	0	1	0	6
347	6	20	2008	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	6.5
348	6	20	2008	0	0	2	2	0	0	2	1	2	0	0	0		1	0	0	7.5
349	6	20	2008	2	0	0	0	0	0	2	0	0	1	0	0	0	2	0	0	7
350	6	20	2008	0	0	2	0	0	0	0	2	0	1	0	0	0	0	2	0	6.5
351	6	20	2008	0	0	2	0	0	0	0	0	0	1	0	0	0	1	0	0	6
352	6	30	2008	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	6.2
353	6	30	2008	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	6
354	6	30	2008	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	6.5
355	6	30	2008	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	7.2
356	6	30	2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6
357	7	10	2008	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2	0	6.3
358	7	10	2008	0	0	0	0	0	0	0	1	0	0	1	0	0	2	0	0	6.3
359	7	28	2008	0	0	2	2	0	0	0	1	1	0	0	0	0	0	2	0	7.5

360	7	28	2008	0	0	2	0	0	0	0	1	0	1	0	0	0	0	2	0	7
361	8	12	2008	0	0	0	0	0	0	1	1	0	0	1	0	0	0	1	0	6.5
362	8	12	2008	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	6.5
363	8	12	2008	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	7.3
364	8	15	2008	0	0	0	0	0	1	0	3	0	0	2	0	0	2	0	0	6.2
365	8	15	2008	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	6.6
366	8	15	2008	0	0	0	0	1	0	0	1	0	0	0	0	0	2	0	0	7.8
367	8	21	2008	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	6
368	8	21	2008	0	0	2	0	0	0	0	0	1	0	0	0	0	1	0	0	8
369	8	25	2008	0	0	0	2	0	0	0	3	1	0	0	0	0	0	2	0	6.5
370	9	12	2008	0	0	2	2	0	0	0	0	1	0	0	0	0	0	2	0	6
371	9	12	2008	0	0	0	0	0	0	0	2	0	2	0	0	0	0	2	0	6
372	9	12	2008	0	0	2	0	0	0	0	2	0	2	0	0	0	0	2	0	6
373	9	19	2008	0	0	0	0	0	0	0	3	0	1	0	0	0	0	1	0	6.5
374	9	19	2008	0	0	0	0	0	2	0	2	1	1	0	0	0	0	1	0	6
375	9	19	2008	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	6
376	9	19	2008	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	0	7.5
377	9	19	2008	0	0	2	0	1	0	0	2	0	1	0	0	0	0	2	0	7.5
378	9	19	2008	0	0	0	0	0	0	1	0	0	1	0	0	0	0	2	0	7
379	9	30	2008	0	0	2	2	0	0	0	0	0	1	0	0	0	0	2	0	6
380	9	30	2008	0	0	0	2	0	0	0	3	0	1	0	0	0	0	2	0	6.5
381	9	30	2008	0	0	0	0	0	1	0	3	1	0	0	0	0	0	2	0	8
382	10	9	2008	0	0	2	0	0	0	0	0	2	2	0	0	0	1	0	0	6.5
383	10	12	2008	0	0	2	0	0	0	0	0	0	1	0	0	0	2	0	0	6
384	10	27	2008	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	6.5
385	11	12	2008	0	0	0	0	0	0	0	1	1	0	0	0	0	2	0	0	6
386	11	12	2008	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	6.5
387	11	12	2008	0	0	2	0	0	0	0	1	0	1	0	0	0	2	0	0	6
388	11	17	2008	0	0	2	2	0	0	0	3	0	1	1	0	0	0	1	0	6
389	11	17	2008	0	0	2	0	0	0	0	0	0	0	1	0	0	2	0	0	6
390	11	17	2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
391	11	17	2008	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2	0	6.5
392	11	21	2008	0	0	2	0	0	0	0	1	0	1	0	0	0	0	2	0	6
393	11	25	2008	0	0	2	0	0	0	0	2	1	1	0	0	0		0	0	6.5
394	11	25	2008	0	0	2	2	0	0	0	0	0	0	2	0	0		0	0	7
395	11	25	2008	0	0	1	0	1	0	0	2	0	0	2	0	0	0	2	0	7.5
396	11	26	2008	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	7.5
397	12	5	2008	0	0	2	0	1	0	0	1	1	0	0	1	0	1	0	0	6
398	12	5	2008	2	0	0	0	1	0	0	0	2	0	0	0	0	1	0	0	6
399	12	5	2008	0	0	2	0	0	0	0	1	0	2	0	0	0	0	2	0	6
400	12	5	2008	0	0	0	2	0	0	1	0	0	0	1	0	0	2	0	0	6.5
401	12	18	2008	0	0	2	0	0	0	0	2	0	1	1	0	0	0	2	0	6
402	12	18	2008	0	0	2	0	0	0	0	2	0	0	1		0	0	0	0	0
403	12	18	2008	0	0	0	2	0	1	0	1	0	2	0	0	0	0	2	0	6
404	12	18	2008	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	6
405	12	18	2008	0	0	0	2	0	0	0	2	1	0	0	0	0	0	1	0	6
406	12	18	2008	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	7.5
407	12	18	2008	0	0	0	2	0	0	0	1	0	1	0	0	0	0	2	0	6
408	1	5	2009	0	0	2	0	0	0	1	0	0	0	0	0	0	1	0	0	6
409	1	5	2009	0	0	0	2	0	0	0	2	0	1	0	0	0	0	2	0	6.5
410	1	5	2009	0	0	2	0	0	0	0	2	1	0	0	0	0	0	2	0	6
411	1	7	2009	0	0	2	2	0	0	0	1	1	1	0	0	0	2	0	0	6

412	1	7	2009	0	0	0	0	0	0	0	3	2	2	0	0	0	0	2	0	6
413	1	26	2009	0	0	2	2	0	0	0	0	nd	nd	nd	nd	nd	nd	0	0	6
414	2	12	2009	0	0	2	0	0	0	0	1	0	0	1	0	0	0	2	0	9
415	2	12	2009	0	0	0	0	0	1	0	2	1	0	0	0	0	0	1	0	6.5
416	2	12	2009	0	0	2	0	0	1	0	0	0	1	0	0	0	1	0	0	8
417	2	12	2009	0	0	2	0	0	0	0	1	0	1	0	0	0	0	0	0	8
418	2	16	2009	0	0	0	0	0	0	0	2	0	1	0	0	0	0	2	0	6
419	2	16	2009	0	0	2	0	0	0	0	1	1	1	0	0	0	0	0	0	7
420	2	16	2009	0	0	2	0	0	0	0	3	0	1	0	0	0	0	1	0	6
421	2	22	2009	0	0	2	0	0	0	0	2	0	1	0	0	0	0	2	0	6
422	3	5	2009	0	0	2	2	0	0	0	0	0	1	0	1	0	1	0	0	6
423	3	5	2009	0	0	2	2	0	0	0	1	2	0	0	0	0	1	0	0	7
424	3	5	2009	0	0	0	0	0	0	0	2	1	1	0	0	0	0	2	0	7
425	3	5	2009	0	0	0	0	0	0	1	0	1	0	0	0	0	2	0	0	7
426	3	30	2009	0	0	2	0	0	0	0	1	0	0	0	0	0	0	1	0	6.5
427	3	30	2009	0	0	0	0	0	0	0	1	1	1	0	0	0	0	2	0	7
428	3	30	2009	0	0	0	0	0	0	0	2	1	1	0	0	0	0	2	0	7
429	4	13	2009	0	0	2	0	0	0	1	0	0	1	0	0	0	2	0	0	6.5
430	4	13	2009	0	0	2	0	0	1	0	1	2	2	0	0	0	0	1	0	6.5
431	4	27	2009	0	0	0	0	0	0	1	0	0	0		0	0	2	0	0	7
432	5	12	2009	0	0	2	0	0	0	0	1	0	0	1	0	0	0	1	0	6.5
433	5	12	2009	2	0	2	0	0	0	0	0	1	0	0	0	0	0	2	0	6

#	SAL	CHL	NO3	NO2	OXY	NH3	TEM	SEC	BSW	WBO	DBE	DRA	WST	PUP	CXQ	CXS	AN	CXC	FISH
1	8.3	0	0	0	1	nd	1	2	1	0	1	0	0	0	0	0	0	0	0
2	1.2	0	0	0	0	nd	26	0.1	0	0	0	0	0	0	55	0	0	0	0
3	5.1	0	0	0	nd	nd	25	0.75	1	1	0	0	0	0	0	0	0	0	2
4	5.6	0	0	0	1.1	nd	23.4	0.75	1	1	0	0	0	0	0	0	0	0	2
5	7.8	0	0	0	6	0.8	25	0.62	0	0	0	0	0	0	0	0	0	0	0
6	6	0	0	0	0.37	nd	26	1.4	2	2	2	2	2	0	0	0	0	0	0
7	2.2	0	0	0	2	nd	22	nd	0	0	0	0	0	0	130	0	20	0	0
8	nd	nd	nd	nd	nd	0.3	nd	nd	1	0	1	0	0	0	0	0	0	0	0
9	nd	nd	nd	nd	nd	6	nd	nd	0	0	0	0	0	0	0	0	0	0	0
10	0.1	0	0.5	0.15	3	nd	32	0.8	0	0	0	0	0	0	0	0	0	0	0
11	nd	nd	nd	nd	3	0.3	nd	nd	1	1	0	0	0	0	0	0	0	0	3
12	nd	nd	nd	nd	nd	0	nd	nd	1	1	1	0	0	1500	4000	0	0	0	0
13	nd	nd	nd	nd	1.1	0.4	nd	nd	1	1	0	0	0	0	0	0	0	0	3
14	nd	nd	nd	nd	nd	nd	nd	nd	1	1	1	0	0	0	155	0	5	0	0
15	nd	nd	nd	nd	6	0.8	nd	nd	0	0	0	0	0	0	0	0	0	0	3
16	2.2	0.1	0.5	0.15	3	4	26.3	0.9	1	1	0	0	0	148	50	8	0	0	0
17	8.5	0.1	0.5	0.15	nd	11	32	nd	1	1	1	0	0	0	0	0	0	0	0
18	nd	nd	nd	nd	nd	0	nd	nd	1	1	1	0	0	4	98	0	0	0	0
19	8.3	0	0.5	0.15	6.8	0.6	30	1.25	0	0	0	0	0	0	0	0	0	0	0
20	nd	nd	nd	nd	5	3	nd	nd	2	2	2	2	2	0	0	0	0	0	2
21	6.4	0	0	0	4	0.3	26	1.7	1	0	0	1	0	0	0	0	0	0	0
22	4.3	0	0	0	5.2	0.4	26	0.45	0	0	1	0	0	0	0	0	0	0	3
23	1	0	0	0.1	3	0.3	29	1	1	0	0	1	1	0	0	0	0	0	0
24	0.5	0	0	0	7.1	0.3	32	nd	0	0	1	0	0	0	500	0	0	0	0
25	nd	nd	nd	nd	nd	nd	nd	nd	1	0	0	0	0	3	0	0	4	0	1
26	4.2	1	0	2	4.95	0.2	29.6	0.6	0	0	0	0	0	0	0	0	0	0	2
27	nd	nd	nd	nd	nd	nd	nd	nd	1	0	0	0	0	0	0	0	0	0	2
28	0.2	0	0.5	1	4.38	8	26.4	0.85	1	1	0	0	0	0	0	0	61	0	0
29	7.4	0	0	0.5	4.8	nd	30	1.6	1	0	0	0	1	0	0	0	0	0	0
30	0.1	0	0	0	6.2	0.1	31	0.75	0	0	0	0	0	0	0	0	0	0	2
31	6.5	0	0	0	8.03	0.2	29.3	1.3	1	0	0	1	0	0	0	0	0	0	3
32	7	0	0	0	7.16	0.2	28.8	2.1	1	0	1	0	0	0	0	0	0	0	0
33	3.9	0	0	0	5.51	0.3	27.3	0.4	0	0	1	0	0	0	0	0	0	0	3
34	3.9	0	0	0	1.5	0.2	28	1.2	1	1	0	0	0	0	0	0	0	0	3
35	6.6	0.1	0	0	5.7	0	28.4	0.75	0	0	0	0	0	0	0	0	0	0	3
36	4.7	0	0	0	2.23	2	28	0.8	2	2	2	2	2	0	0	0	0	0	2
37	0.3	0	0	0	6.74	0.2	28.9	0.6	0	1	1	0	0	0	0	0	0	0	0
38	1.6	0	0	0	0.28	3	26	1.3	0	0	0	0	0	0	0	0	0	0	0
39	0.3	0	0	0	6.72	nd	30.4	nd	1	0	0	0	0	0	0	0	0	0	3
40	1	0	5	1	2.86	0.5	26.8	0.85	1	1	0	0	0	0	0	0	10	0	0
41	5.1	0	0	0	2.5	0.1	29.6	1.8	0	0	0	0	0	0	0	0	0	0	0
42	5.3	0.1	0	0	2.46	0.3	31.4	2.2	0	2	0	2	2	3	0	0	27	0	0
43	9	0	0	0	3.4	0.3	31.7	1.15	0	2	0	0	0	0	0	0	0	0	0
44	4.2	0	0	0	6.3	0.2	35	1.6	0	0	0	0	0	0	0	0	0	0	0
45	6	0	0	0	3.9	0.3	34.8	0.75	0	1	0	0	0	0	0	0	0	0	0
46	0.3	0	0	0	5.31	0.1	33.7	1.3	1	1	0	0	0	0	0	0	0	0	0
47	1.1	0	0	0	1.99	0.1	31	nd	1	1	1	0	0	0	65	0	10	0	0
48	4.3	0	0	0	2.94	0.1	29	0.75	0	2	0	0	0	0	0	0	5	0	0

49	nd	nd	nd	nd	nd	nd	nd	nd	1	1	0	0	0	6	25	0	19	0	0
50	nd	nd	nd	nd	nd	nd	nd	nd	0	2	0	2	2	0	2	0	4	0	1
51	nd	nd	nd	nd	nd	nd	nd	nd	1	0	0	0	0	0	0	0	0	0	3
52	nd	nd	nd	nd	nd	nd	nd	nd	0	0	0	0	0	0	0	0	0	0	0
53	7.6	0	0	0	4.25	0.1	29.2	1.4	1	0	0	0	0	0	0	0	0	0	0
54	6.2	0	0	0	1.42	0	28.9	1.4	1	0	0	1	0	0	0	0	0	0	0
55	4.2	0	0	0	1.2	1	28	0.25	0	0	1	0	0	0	0	0	0	0	3
56	4.2	0	0	0	3.26	0	27.3	0.8	1	1	0	0	0	0	0	0	0	0	3
57	7.3	0.1	0	0	1.2	0.3	28	0.5	0	0	0	0	0	0	0	0	0	0	3
58	5.1	0	0	0	2	2	27.8	0.4	2	2	2	2	2	0	0	0		0	3
59	0.4	0	0	0	6.58	0.3	29.1	0.6	0	1	1	0	0	0	0	0	0	0	0
60	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0	0	0	0	0	0
61	8.1	0.1	0	0	0.25	0	27.9	0.6	0	0	0	0	0	0	0	0	0	0	0
62	0.7	0	0	0	0.2	0.1	27.2	nd	1	0	0	0	0	0	0	0	0	0	0
63	nd	nd	nd	nd	nd	nd	nd	nd	0	2	0	2	2	0	0	0	12	0	1
64	4.5	0	0	0	0.65	1	27	0.4	1	1	0	0	0	0	0	0	0	0	3
65	7.1	0.1	0	0	4.2	0.2	28.3	1	1	0	0	1	1	0	0	0	0	0	3
66	0.6	0	0.1	0	4.6	40	28.6	nd	0	0	0	0	0	0	0	0	0	0	0
67	0.3	0	0	0	0.19	3	27.9	nd	0	0	0	0	0	0	400	0	0	0	0
68	nd	nd	nd	nd	nd	nd	nd	nd	0	2	0	2	2	0	0	0	2	0	1
69	10.1	0	0	0	5.5	0.3	32.2	1.5	0	1	0	0	0	0	0	0	0	0	0
70	0.7	0	0	0	2.85	40	29.2	nd	0	0	0	0	0	0	0	0	0	0	0
71	3.9	0	0.5	0.1	3.9	0.1	29	0.6	0	0	0	0	0	0	0	0	0	0	3
72	0.3	0	0	0	0.3	0.2	29.7	nd	0	0	0	0	0	0	0	0	0	0	0
73	0.2	0	0	0	3.41	0	28.8	1.5	1	0	0	0	0	0	0	0	0	0	0
74	0.4	0	0	0	2.65	0.2	28	1.3	0	1	0	1	0	0	3	0	8	0	0
75	0.6	0	0	0	6.6	30	25.8	nd	0	0	0	0	0	0	0	0	0	0	0
76	4.5	0	0	0	8.37	0.1	27.5	1.5	0	0	0	0	0	0	0	0	0	0	0
77	0.3	0	0	0	10.11	0.2	28.9	0.9	1	1	0	0	0	0	0	0	0	0	0
78	6.5	0	0	0	1.15	0.2	26.9	0.1	0	1	0	0	0	0	1	0	5	0	0
79	3.7	0	0	0	6.5	0.4	26.4	0.6	0	1	0	0	0	0	0	0	0	0	0
80	0.6	0	0	0	5.95	40	27.8	nd	0	0	0	0	0	0	1	0	5	0	1
81	0.6	0	0	0	8.75	40	26.7	nd	0	0	0	0	0	0	0	0	0	0	1
82	6.3	0	0	0	6.35	0	27.5	0.85	1	0	0	1	1	0	0	0	0	0	3
83	7.6	0	0	0	8.34	0.3	27.2	1.75	1	0	0	0	0	0	0	0	0	0	0
84	5.9	0	0	0	2.61	0	25.1	1.75	1	1	0	0	0	0	0	0	0	0	0
85	0.3	0	0	0	4.35	0.1	24.6	0.8	0	0	0	0	0	0	0	0	0	0	3
86	0.1	0	0	0	3.61	0	25.9	0.9	0	0	1	0	0	0	0	0	0	0	2
87	5.5	0	0	0	3.53	0.2	27.2	1.8	0	2	0	2	2	2	0	0	1	0	2
88	4.2	0	0	0	0.6	0.8	24.9	0.15	0	0	1	0	0	0	0	0	0	0	3
89	0.3	0	0	0	5.33	4.3	25	0.55	1	1	0	0	0	0	0	0	0	0	3
90	4.4	0	0	0	0.12	1	25.3	0.6	1	1	0	0	0	0	0	0	0	0	3
91	3.8	0	0	0	4.39	0.1	26.1	0.8	0	0	0	0	0	0	0	0	0	0	2
92	7.3	0	0	0	1.34	1	27.1	0.4	0	0	0	0	0	0	0	0	0	0	3
93	5.5	0	0	0	0.3	2	26.2	0.35	2	2	2	2	2	0	0	0	0	0	2
94	0.3	0	0	0	0.58	2	24.8	nd	0	0	0	0	0	0	0	0	0	0	0
95	0.7	nd	nd	nd	0.2	0.1	27.2	nd	1	0	0	0	0	0	0	0	0	0	0
96	0.3	0	0	0	5.44	0.1	26.6	nd	0	0	0	1	0	0	0	0	0	1	1
97	0.3	0	0	0	8.74	0	27	0.4	0	1	1	0	0	0	0	0	2	2	0
98	4.5	0	0	0	6.2	0.1	27.8	1.2	1	0	0	1	0	0	0	0	0	0	0
99	4.9	0	0	0	4.53	0.1	30.1	1.3	0	1	0	0	0	0	0	0	0	0	2
100	7.7	0	0	0	3.45	0.1	27	1.4	0	0	0	0	0	30	0	0	0	80	0

101	0.6	0	0	0	7.7	5	24.9	0.5	1	0	0	0	0	0	0	0	0	0	1
102	9	0.5	0	0	5	0	25.7	1.2	0	1	0	0	0	0	0	0	0	0	1
103	4.5	0	0	0	5.34	0.2	24.8	1.2	0	0	0	0	0	0	0	0	0	0	0
104	0.4	0	0	0	6.6	0.1	24.8	0.7	0	0	0	1	0	0	0	0	0	0	1
105	5.2	0	0	0	5.2	0.2	25.3	1.3	0	0	0	0	0	0	0	0	0	0	2
106	0.7	0	0	0	8.5	0	25.2	0	0	1	1	0	0	0	0	0	1	0	2
107	8.2	0	0	0	4.15	0.2	25.8	1.3	0	0	0	0	0	0	0	0	0	0	0
108	0.1	0	0	0	13	0.2	19.9	1.9	1	0	0	0	0	0	0	0	0	0	0
109	0.3	0	0	0	0.45	1	19.1	0.55	1	1	0	0	0	315	1000	0	0	0	0
110	0.1	0	0	0	7.4	0.3	21.5	1.5	0	0	0	1	0	0	0	0	0	0	3
111	5.4	0	0	0	6.75	0.2	20.3	1	0	0	0	0	0	0	0	0	0	0	0
112	0.1	0	0	0	0	2	20.9	0.7	0	1	0	0	0	0	60	0	0	8	0
113	nd	nd	nd	nd	nd	nd	nd	nd	1	0	0	0	0	0	0	0	0	0	0
114	0.1	0.1	0	0	14.75	0	19.4	1.9	1	0	0	0	0	0	0	0	0	0	0
115	0.4	0	0	0	4.3	0.8	23.7	0.4	0	1	0	0	0	0	0	0	0	0	1
116	5.6	0.1	0	0	4.54	0.2	23.3	1.7	0	0	0	1	0	0	0	0	0	0	3
117	5.5	0	0	0	8.8	0.2	21.7	2	0	0	0	0	0	0	0	0	0	0	1
118	5.8	1.5	0	0	16	0.9	23.4	0.55	1	1	0	0	0	0	500	0	0	0	0
119	0.1	0	0	0	10.8	0	20.7	1.9	1	0	0	0	0	0	0	0	0	0	0
120	0.4	0	0	0	6.6	1	17.8	0.45	1	1	0	0	0	0	0	0	0	0	1
121	5.6	0	0	0	7.4	0.2	18.7	1.5	0	0	0	1	0	0	0	0	0	0	3
122	5.6	0	0	0	9.7	0.3	18.9	6	0	0	0	0	0	0	0	0	0	0	2
123	4.4	0	0	0	5.59	0.8	21	0.7	0	1	0	0	0	0	0	0	3	0	0
124	6.9	0	0	0	10.65	6	20.8	nd	0	0	0	0	0	0	0	0	4	0	0
125	0.1	0	0	0	8.29	0	19.9	1	1	0	0	0	0	0	0	0	0	0	0
126	0.2	0	0	0	7.89	0	20.4	1.4	0	0	0	1	0	0	0	0	0	0	1
127	4.7	0	0	0	0.45	4	18.5	0.25	1	0	0	0	0	0	1000	0	0	0	0
128	4.8	0	0	0	7.9	0	19.9	1.5	0	0	0	0	0	0	0	0	0	0	3
129	6.4	0	0	0	8.49	0.1	19.3	0.8	1	0	1	0	0	0	0	0	0	0	3
130	0.3	0	0	0	11.41	0.1	21.6	0.4	0	1	1	0	0	0	0	0	0	0	1
131	0.3	0	0	0	2.97	0	18.7	1.1	0	0	0	1	0	0	0	0	0	0	0
132	6.9	0	0	0	7.36	0.1	21.5	nd	0	0	0	0	0	0	85	0	7	0	0
133	4.7	0	0	0	3.44	0.1	17.5	nd	0	0	0	0	0	0	34	0	6	0	0
134	0.5	0	0	0	9.4	40	20.3	0.5	0	0	0	0	0	0	0	0	0	0	1
135	0.5	0	0	0	2.6	0	18	0.5	1	0	0	0	0	0	0	0	0	0	0
136	5	0	0	0	7.5	0.3	21.4	2.2	0	2	0	2	2	0	0	0	0	0	2
137	0.2	0	0	0	5.47	0.1	19.1	1	0	0	0	0	0	0	400	0	0	100	0
138	3.2	0	0	0	8.3	0.1	20.5	1.25	0	0	0	0	0	0	0	0	0	0	3
139	0.3	0	0	0	7.77	0.1	20.2	0.45	0	0	0	1	0	0	0	0	0	0	3
140	8.8	0	0	0	4.97	0.1	19.8	1.1	0	1	0	0	0	0	0	0	0	0	2
141	3.8	0	0	0	5.88	0.1	24.7	1.7	0	0	0	0	0	0	0	0	0	0	0
142	0.3	0	0	0	0.65	1	17.9	nd	0	0	0	0	0	0	0	0	0	0	0
143	4.6	0	0	0	3.3	0.4	17.9	0.7	0	1	0	1	0	0	200	0	80	20	0
144	0.1	0	0	0	10.37	0	19.4	1	1	0	0	0	0	0	0	0	0	0	0
145	4.6	0	0	0	0.75	4	17.3	0.25	1	1	0	0	0	0	0	0	0	0	1
146	6.1	0	0	0	9.64	0.2	19.6	0.65	1	0	1	0	0	0	0	0	0	0	3
147	0.3	0	0	0	4.57	0.1	18.6	1.7	0	0	0	1	0	0	0	0	0	0	1
148	4.6	0	0	0	0.75	4	17.3	0.25	1	1	0	0	0	0	0	0	0	0	1
149	4.6	0	0	0	6.78	0	17.6	nd	0	0	0	0	0	0	0	0	10	0	0
150	0.6	0	0	0	9.8	0.1	20.9	nd	1	0	0	0	0	0	0	0	0	0	0
151	0.3	0	0	0	7.7	0	21.5	1.1	1	1	0	0	0	0	0	0	0	0	0
152	2	0	0	0	4.3	1	18	1	0	0	0	0	0	0	0	0	0	0	1

153	0.2	0	0	0	6.58	0	17.8	nd	1	1	0	0	0	0	0	0	0	0	0
154	3.8	0	0	0	12	0	20	nd	0	0	0	1	0	0	0	0	0	0	3
155	4.7	0	0	0	6.9	0	17	0.95	0	0	0	0	0	0	0	0	0	0	3
156	4	0	0	0	9.8	0.1	21.7	nd	0	0	0	0	0	0	0	0	0	0	1
157	0.2	0	0	0	12.5	0.2	20.1	1.5	0	0	0	0	0	0	0	0	0	0	0
158	0.6	0	0	0	7.92	0.1	23.6	0.65	0	1	0	1	0	1	0	0	3	2	0
159	3.5	0	0	0	0.24	3	18.5	nd	0	1	0	0	0	27	407	0	32	6	0
160	0.1	0	0	0	8.7	0	16.7	nd	1	0	0	0	0	0	0	0	0	0	0
161	0.4	0	0	0	3.4	1	16.6	0.3	1	1	0	0	0	1	190	0	0	0	1
162	5.3	0	0	0	7.9	0	18.4	1.3	0	0	0	1	0	0	0	0	0	0	3
163	5.3	0	0	0	9.82	0	17.6	1.5	0	0	0	0	0	0	0	0	0	0	1
164	5.9	0	0	0	4.92	0	16.3	nd	0	1	0	0	0	0	10	0	10	0	0
165	0.1	0	0	0	11.31	0	15.1	1	1	0	0	0	0	0	0	0	0	0	0
166	8.6	0	0	0	0.48	3	15.5	0.3	1	1	0	0	0	0	0	0	0	0	1
167	5.9	0	0	0	9.2	0.3	16.7	0.7	1	0	1	0	0	0	0	0	0	0	3
168	0.3	0	0	0	7.78	1	14	1	0	1	0	1	0	0	0	0	0	0	1
169	4.5	0	0	0	6.45	0	14.2	nd	0	0	0	1	0	7	0	0	5	0	0
170	0.2	0	0	0	5.7	0.1	18.7	1.25	0	1	0	0	0	0	0	0	0	0	0
171	0.2	0	0	0	8.6	0.1	16.8	nd	1	1	0	0	0	0	0	0	0	0	1
172	4.1	0	0	0	12.5	0.1	19.3	1	0	0	0	0	0	0	0	0	0	0	3
173	3.3	0	0	0	27	6	18.1	1	0	1	0	0	0	0	0	0	0	0	1
174	0.2	0	0	0	6.75	0.1	17.2	1	0	1	0	0	0	0	0	0	0	0	0
175	0.2	0	0	0	6.75	0	19.9	0.9	0	1	0	0	0	0	0	0	0	0	0
176	4.6	0	0	0	0.45	0.8	17	0.54	1	1	0	0	0	0	0	0	0	0	3
177	6.2	0	0	0	12.4	0.2	17.7	0.75	1	0	1	0	0	0	0	0	0	0	3
178	0.3	0	0	0	9.8	0.2	19.5	1.25	0	0	0	1	0	0	0	0	0	0	1
179	4.4	0	0	0	9.75	0.1	19.9	nd	0	0	0	0	0	0	0	0	0	0	0
180	2.2	0	0	0	6.35	1	17.9	1.5	1	0	1	0	0	0	0	0	0	0	0
181	2.2	0	0	0	5.6	0.3	17.5	0.6	1	1	0	0	0	0	0	0	0	0	3
182	4.4	0	0	0	5.25	1	17.8	0.1	0	0	0	0	0	0	0	0	0	0	3
183	0.5	0	0	0	12.75	0.1	19.6	0.75	1	0	0	0	0	0	0	0	0	0	0
184	0.2	0	0	0	9.31	0.1	11.1	1	0	0	0	0	0	0	0	0	0	0	2
185	3	0	0	0	11.04	0.3	11.7	0.75	0	0	0	1	0	0	0	0	0	0	3
186	3.8	0	0	0	0.43	0	21.8	nd	0	0	0	0	0	0	0	0	0	0	1
187	4.4	0	0	0	7.8	0.2	20.4	2	0	1	0	1	0	0	20	0	5	0	0
188	4.2	0	0	0	4.25	1	16.4	nd	0	0	0	0	0	0	0	0	0	0	0
189	2.2	0	0	0	6.25	0.1	17.8	nd	0	0	0	1	0	0	0	0	0	0	2
190	4.4	0	0	0	4.35	0.3	17.4	1.5	1	0	0	0	0	0	0	0	0	0	2
191	6.5	0	0	0	7.5	0.1	18.8	nd	0	0	0	0	0	0	0	0	0	0	0
192	2.2	0	0	0	6.25	0.1	17.8	nd	0	0	0	1	0	0	0	0	0	0	2
193	6.8	0	0	0	6.4	0	14.3	1	0	0	0	0	0	0	0	0	0	0	0
194	2.2	0	0	0	6.35	0.1	16.4	1.75	1	0	0	1	0	0	0	0	0	0	0
195	0.2	0	0	0	7.88	0.1	16.5	nd	0	0	0	0	0	0	0	0	0	0	3
196	0.1	0	0	0	5.25	0.1	16	0.9	0	0	0	0	0	0	0	0	0	0	2
197	4.2	0	0	0	6.25	0.1	16.5	1	0	1	1	0	0	0	0	0	0	0	3
198	2.2	0	0	0	6.75	0	16.8	0.25	1	1	0	0	0	0	0	0	0	0	2
199	6.2	0	0	0	8.33	0.3	16.1	0.87	1	0	0	1	1	0	0	0	0	0	1
200	4.2	0	0	0	5.45	0.2	17	0.4	2	2	2	2	2	0	0	0	0	0	3
201	2.2	0	0	0	8.74	0.1	15.8	nd	1	1	1	0	0	0	0	0	0	0	0
202	0.2	0	0	0	6.5	0.1	16.7	1.25	1	1	0	0	0	0	0	0	0	0	0
203	0.3	0	0	0	8.4	0.1	17.8	nd	1	1	0	0	0	0	0	0	0	0	1
204	4.2	0	0	0	11.75	0.1	17.5	1	0	0	0	0	0	0	0	0	0	0	3

205	0.3	0	0	0	5.45	0.1	15.6	1	0	1	0	0	0	0	0	0	0	0	0
206	1.1	0	0	0	7.8	0.1	16.7	nd	1	0	0	0	0	0	0	0	0	0	0
207	0.3	0	0	0	9.34	1	16.7	0.25	1	1	0	0	0	0	1800	0	0	0	1
208	5.5	0	0	0	11.5	0.1	16.1	nd	0	0	0	1	0	0	0	0	0	0	3
209	0.2	0	0	0	6.4	0.1	16.7	nd	0	0	0	0	0	0	0	0	0	0	1
210	3.3	0	0	0	0.25	0.4	15.8	nd	0	1	0	0	0	0	0	0	0	0	0
211	4.3	0	0	0	4.75	0.1	16.7	nd	0	1	0	0	0	0	0	0	0	0	1
212	0.2	0	0	0	8.46	1	11.5	0.25	1	1	0	0	0	135	4	0	0	0	0
213	5.1	0	0	0	10.29	1	12	1.5	0	0	0	0	0	0	0	0	2	0	0
214	0.2	0	0	0	11	0.1	16.2	nd	0	0	0	1	0	0	0	0	0	0	2
215	3.2	0	0	0	11.95	0.1	15.8	1.5	0	0	0	0	0	0	0	0	0	0	2
216	0.3	0	0	0	10.25	0.1	13.7	0.55	0	1	1	0	0	0	0	0	0	0	2
217	nd	0	0	0	11.75	0.1	16.4	nd	0	0	0	0	0	6	0	0	0	0	0
218	0.2	0	0	0	4.79	0.1	16	1.25	0	1	0	0	0	0	0	0	0	0	1
219	0.2	0	0	0	7.52	0	11.2	1.75	0	1	0	0	0	0	0	0	0	0	0
220	0.3	0	0	0	9.77	0.1	9.4	0.9	1	1	0	0	0	0	0	0	0	0	0
221	0.2	0	0	0	5.23	1	14.9	0.75	1	1	0	0	0	2	1	0	0	0	1
222	4	0	0	0	8.88	0.4	13.1	1	1	1	0	0	0	12	90	1	1	0	1
223	0.1	0	0	0	9.5	0	10.8	1.25	0	0	1	0	0	0	0	0	0	0	1
224	4.9	0	0	0	9.86	0	11.8	1.1	0	0	0	1	0	0	0	0	0	0	1
225	4.2	0	0	0	8.92	0	11.7	0.8	1	0	1	0	0	0	0	0	0	0	1
226	4.5	0	0	0	9.75	0	11.2	1	0	0	0	0	0	0	0	0	0	0	1
227	0.2	0	0	0	4.35	0.2	11.5	1.75	0	0	0	0	0	0	0	0	0	0	1
228	5.1	0	0	0	8.9	0.1	13.2	1.3	0	1	0	1	0	1	0	158	13	0	0
229	4.2	0	0	0	8.75	0.2	11.5	0.35	0	0	0	1	0	0	0	0	0	0	0
230	3.9	0	0	0	8.75	0.1	14	1	0	1	0	1	0	0	0	0	0	0	0
231	0.2	0	0	0	10.98	0	14.7	1.2	1	1	0	0	0	0	0	0	0	0	0
232	0.2	0	0	0	8.35	0	10.5	0.7	1	1	0	0	0	0	0	0	0	0	1
233	2.5	0	0	0	8.75	0.1	12.7	0.6	0	0	0	1	0	0	0	0	0	0	2
234	3.6	0	0	0	9.75	0	10.2	1	0	0	0	0	0	0	0	0	0	0	3
235	0.1	0	0	0	9.8	0	14.9	9	0	0	0	0	0	0	0	0	0	0	1
236	0.2	0	0	0	10.2	0.4	12.9	1.6	0	1	0	0	0	0	0	0	0	0	1
237	3.2	0	0	0	0.77	6	13.7	0.4	0	1	0	0	0	0	0	0	0	0	0
238	0.3	0.1	0	0	18.8	10	17.2	0.9	0	0	0	0	0	0	0	0	0	0	1
239	4	0	0	0	17.7	0.1	16.3	1.7	0	0	0	1	0	0	0	0	0	0	3
240	2.3	0	0	0	4.6	0	16.7	1.2	0	0	0	0	0	0	0	0	0	0	3
241	6.9	0	0	0	8.9	0.3	17.8	1.25	0	0	1	0	0	0	0	0	0	0	2
242	0.2	0	0	0	3.5	0.1	14	nd	0	0	0	1	0	1	0	0	0	0	0
243	0.1	0	0	0	10.32	0	14	2	0	0	1	0	0	0	0	0	0	0	0
244	4	0	0	0	5.36	0.1	17.6	1.1	0	1	0	0	0	0	0	0	0	0	1
245	5.4	0	0	0	10.32	1	16	0.75	1	0	1	0	0	0	0	0	0	0	3
246	2	0	0	0	8.34	0	13.9	1.6	0	1	0	0	0	0	0	0	0	0	1
247	2.9	0	0	0	8.29	0.1	13.4	0.8	1	1	0	1	0	1	0	37	32	0	0
248	0.2	0	0	0	10.45	0.2	19.6	0.75	1	0	0	0	0	0	0	0	0	0	0
249	0.2	0	0	0	10.43	0.1	15.5	1	0	1	0	0	0	0	0	0	0	0	1
250	2.4	0	0	0	9.85	0.2	16.1	0.7	0	0	0	0	0	0	0	0	0	0	2
251	0.2	0	0	0	10.3	0	16	1	0	0	0	0	0	0	0	0	0	0	1
252	3.1	0	0	0	9.7	0.2	18.1	0.75	1	0	0	0	0	1	0	0	9	0	0
253	0.1	0	0	0	5.5	0	18.9	1.25	1	1	0	0	0	0	0	0	0	0	0
254	0.1	0	0	0	6.75	0.3	16.5	0.75	0	0	0	0	0	0	0	0	0	0	1
255	3.1	0	0	0	10.25	0.1	14.8	1.1	0	0	0	0	0	0	0	0	0	0	3
256	0.1	0	0	0	10.23	0.3	19.2	1.75	1	1	0	0	0	0	0	0	0	0	1

257	3.1	0.1	0	0	5.2	1	15.8	0.4	0	1	0	0	0	0	0	0	0	0	1
258	5.7	0	0	0	nd	0	19.3	2	1	0	1	0	0	0	0	0	0	0	0
259	2.7	0	0	0	10.29	0.1	16	1.1	0	0	0	0	0	0	0	0	0	0	3
260	5.4	0	0	0	0.17	0.1	19.3	1.1	0	0	0	0	0	0	0	0	0	0	3
261	nd	nd	nd	nd	nd	nd	nd	nd	0	0	0	0	0	0	0	0	0	0	0
262	1.6	0	0	0	4.6	0.1	18.9	1.25	2	0	0	0	0	0	0	0	0	0	0
263	3.6	0	0	0	8.45	0	20.6	1.9	1	0	0	1	0	1	0	0	1	0	0
264	0.1	0.2	0	0	7.3	0.1	20.8	1.25	0	0	0	0	0	0	0	0	0	0	3
265	0.1	0	0	0	8.2	0	17.9	1.25	0	0	0	0	0	17	0	0	1	0	0
266	0.1	0	0	0	6.8	0	18.5	1	0	0	0	0	0	0	0	0	0	0	3
267	2.3	0	0	0	0.5	0.4	17.8	0.25	0	0	0	0	0	0	0	0	0	0	3
268	5.4	0	0	0	2.6	0.3	19.5	1.4	0	0	0	0	0	0	0	0	0	0	3
269	4.4	0	0	0	6	0.1	19.2	0.9	0	0	0	0	0	0	0	0	0	0	0
270	2.9	0	0	0	8.37	0.1	19	1.5	0	0	0	0	0	0	0	0	0	0	0
271	3.4	0	0	0	2.64	0.2	18.3	1.4	0	0	0	0	2	0	0	0	0	0	3
272	0.1	0	0	0	3.38	0	16.8	0.75	0	0	0	0	0	2	0	0	0	0	1
273	0.2	0	0	0	6.46	0	23.7	1	0	1		1	0	0	0	0	0	0	0
274	0.2	0	0	0	8.98	0	19.2	1.1	0	0	0	0	0	0	0	0	0	0	1
275	5.5	0	0	0	5.22	0.2	20.6	1.4	0	0	0	0	0	0	0	0	0	0	3
276	0	0	0	0	7.22	0	20	1.5	0	0	0	0	0	0	0	0	0	0	1
277	0.1	0	0	0	4.29	0.1	20.9	0.9	0	1	0	0	0	0	0	0	3	0	0
278	0.2	0	0	0	8.34	0	22.8	0.65	1	0	1	0	0	0	0	0	0	0	0
279	0.3	0	2	0	11.25	0.1	21.9	0.5	1	0	0	0	0	0	0	0	0	0	2
280	0.1	0	0	0	9.16	0.1	23.4	1.8	0	0	0	0	0	0	0	0	0	0	3
281	1.2	0	0	0	8.23	0.1	23	1.8	1	0	1	0	0	0	0	0	0	0	0
282	0.2	0	1	0	17.54	0.6	17.9	0.5	0	0	0	0	0	0	0	0	7	0	0
283	1.5	0	0	0	4.7	0	24.7	1	1	0	0	1	0	0	0	0	0	0	0
284	0.1	0	0	0	7.8	0.1	25.9	1.3	0	0	0	0	0	0	0	0	0	0	1
285	5.1	0	0.5	0	5.51	0.4	25.5	1.5	0	0	0	0	0	0	0	0	0	0	3
286	2.2	0	0	0	8.67	0.1	24.8	1.5	0	0	0	0	0	0	0	0	0	0	1
287	0.1	0	0	0	6.11	0	23.4	0.65	0	1	0	0	0	0	0	0	0	0	0
288	2.5	0	0	0	6.1	1	30.2		0	0	0	0	0	0	0	0	0	0	0
289	0.2	0	0	0	7.3	0.1	23.9	1.5	1	1	1	0	0	0	0	0	0	0	0
290	0.2	0	0.5	0	7.7	1	21.8	0.5	1	0	0	0	0	0	0	0	0	0	1
291	2.3	0	0	0	6.57	0.1	23.1	1.8	0	0	0	0	0	0	0	0	0	0	3
292	1.4	0	0	0	7.07	0.1	23.5	1.7	1	0	0	0	0	0	0	0	0	0	2
293	4.7	0	0	0	5.34	0.4	24.8	2.2	2	0	0	0	0	0	0	0	1	0	0
294	0.1	0	0	0	9.57	0.1	24.3	1	0	0	0	0	0	0	0	0	0	0	1
295	0.2	0	0	0	5.28	0.1	24.1	1	2	0	0	0	0	0	0	0	0	0	3
296	0.2	0	0	0	6.93	0.1	21.2	1.25	2	0	0	0	0	0	0	0	0	0	0
297	0.2	0	0	0	8.82	0.4	17.7	0.4	0	0	0	0	0	0	0	0	0	0	1
298	2.4	0	0	0	7.93	0.1	19.9	1.5	0	0	0	0	0	0	0	0	0	0	3
299	1.1	0	0	0	7.62	0.1	18.4	1.2	1	1	0	0	0	0	0	0	0	0	1
300	1.4	0	0	0	5.28	0.2	23.4	1	1	1	0	0	0	0	0	0	0	0	0
301	0.1	0	0	0	8.89	0	20.9	1.3	0	0	0	0	0	0	0	0	0	0	1
302	5.2	0	0	0	5.12	0.1	22.5	1	0	0	0	0	0	0	0	0	0	0	3
303	2.7	0	0	0	5.9	0.3	23.6	1.5	0	0	0	0	0	0	0	0	0	0	2
304	0.1	0	0	0	5.92	0.1	20.9	0.6	0	0	0	0	0	0	0	0	0	0	0
305	0.3	0	0	0	4.35	2	27.7	nd	1	1	0	0	0	0	0	0	0	0	1
306	4.3	0	0	0	7.95	0.4	25.7	1.3	0	0	0	0	0	0	0	0	0	0	3
307	4.1	0	0	6	7.23	0.6	25.1	1.5	0	0	0	0	0	0	0	0	0	0	1
308	0.2	0	0	0	6.35	0.4	24.7	1.2	1	0	1	0	1	0	0	0	0	0	0

309	0.2	0	0	0	8.16	0.2	22.3	0.4	0	0	0	1	0	0	0	0	0	0	1
310	2.3	0	0	0	4.8	0.4	24.1	1.6	0	0	0	0	0	0	0	0	0	0	3
311	1.1	0	0	0	7.24	0.2	24.2	1.5	0	0	0	1	0	0	0	0	0	0	3
312	2.5	0	0	0	6.1	1	30.2		0	0	0	0	0	0	0	0	0	0	0
313	3.6	0	0	0	7.44	0.8	23.9		0	0	0	0	0	0	0	0	0	0	0
314	0.1	0	0	0	4.58	0	25.6	1.9	1	0	0	0	0	0	0	0	0	0	0
315	3.6	0	0	0	5.99	1	23.2	0.2	0	1	0	0	0	0	0	0	0	0	3
316	5	0	0	0	4.59	1	24.4	1	1	0	1	0	0	0	0	0	0	0	3
317	0.3	0	0	0	1.44	0.1	21.4	0.3	0	0	0	0	0	0	0	0	0	0	1
318	2.5	0	0	0	2.63	0	24.3	0.8	1	1	0	1	0	0	0	0	7	0	0
319	0.2	0	0	0	6.92	0	26.8	1.89	1	1	0	0	0	0	0	0	0	0	0
320	0.2	0	0	0	6.51	0.3	27.6	0.8	1	0	0	0	0	0	0	0	0	0	1
321	2.1	0	0	0	6.49	0.3	28.2	0.4	0	0	0	0	0	0	0	0	0	0	2
322	5.2	0	0	0	3.49	1	29.4	0	1	1	0	0	0	0	0	0	0	0	0
323	3.2	0	0	0	2.4	0.3	26.6	1.1	1	0	1	0	0	0	0	0	0	0	0
324	1.3	0	0	0	7	0.3	26.3	0.5	1	1	0	0	0	0	0	0	0	0	0
325	0.1	0	0	0	6.23	0.1	25.6	1.98	0	0	0	0	0	0	0	0	0	0	2
326	4.8	0	0	0	6.2	0.6	27	0.6	0	0	0	0	0	0	0	0	0	0	3
327	2.3	0	0	0	9.15	0.1	26.5	1.9	0	0	0	0	0	0	0	0	0	0	3
328	0.1	0	0	0	1.76	0.3	23.7	0.25	0	0	0	0	0	0	0	0	0	0	0
329	0.2	0	0	0	8.46	0.1	22.4	1.2	1	1	0	0	0	50	350	0	0	0	0
330	4.9	0	0	0	8.15	0.1	29	2	1	0	0	0	0	0	0	0	0	0	0
331	2.2	0	0	0	3.98	0.1	27	1.5	0	0	0	0	0	0	0	0	0	0	3
332	4.4	0	0	0	4.73	0	27.6	1.1	0	0	0	0	0	0	0	0	0	0	3
333	0.1	0.1	0	0	3.26	0	29.6	1.4	0	1	0	0	1	0	0	0	0	0	0
334	0.3	0	0	0	1.52	7	28.8	nd	0	0	0	0	0	0	0	0	0	0	0
335	1.8	0	0	0	3.15	0.3	28.8	0.8	0	0	0	0	0	0	0	0	0	0	3
336	0.9	0.1	0	0	4.71	0.1	29.1	1.25	0	0	0	0	0	0	0	0	0	0	2
337	4.5	0	0	0	1.1	6	27.5	0.4	1	1	0	0	0	0	0	0	0	0	0
338	0.2	0	0	0	5.11	10	29.9	1	0	0	3	0	0	0	0	0	0	0	2
339	1.5	0	0	0	4.95	0.4	28.8	0.55	0	0	0	0	0	0	0	0	0	0	3
340	5.1	0	nd	nd	3.07	1	29.7	1.2	0	0	0	0	0	0	0	0	0	0	3
341	0.2	0	0	0	0.49	1	26		0	0	0	0	0	0	0	0	0	0	0
342	4.8	0	0	0	2.4	2	26.7	0.4	0	1	0	0	0	0	0	0	0	0	0
343	2.9	0	0	0	5.09	0	30.2	1.9	2	0	0	0	0	0	0	0	1	0	0
344	0.1	0	0	0	5.86	0	30.6	1.25	0	0	0	0	0	0	0	0	0	0	3
345	0.1	0	0	0	7.69	0.1	26.9	1.1	0	0	0	0	0	0	0	0	0	0	2
346	0.3	0	0.5	0	7.36	8	30.6	1	0	0	0	0	0	0	0	0	0	0	0
347	0.2	0	0	0	5.1	0.2	31	2	1	0	0	0	0	0	0	0	0	0	0
348	3.3	0	0	0	6.51	0.8	29	2	0	0	0	0	0	0	0	0	0	0	3
349	1.8	0	0	0	1.69	0.4	29.5	0.3	0	0	0	0	0	0	0	0	0	0	3
350	2.8	0	0	0	2.21	0.8	29.3	0.5	0	0	0	0	0	0	0	0	0	0	2
351	0.1	0	0	0	3.78	0.1	27.9	0.8	0	0	0	0	0	0	0	0	0	0	0
352	0.1	0	0	0	9.7	0	29.8	0.9	1	0	0	0	0	0	0	0	0	0	0
353	0.3	0	0.5	0	7.36	8	30.6	1	0	0	0	0	0	0	0	0	0	0	0
354	1.6	0	0	0	0.96	0.4	28.8	0.6	0	0	0	0	0	0	0	0	0	0	3
355	0.9	0.1	0	0	3.35	0	29.4	1.1	0	0	0	0	0	0	0	0	0	0	2
356	5.1	0	0	0	0.35	nd	25.8	nd	0	0	0	0	0	0	0	0	0	0	0
357	0.2	0	0	0	10.7	0	33.5	0.5	0	0	0	0	0	0	0	0	0	0	3
358	0.2	0	0	0	10.09	0	31.4	1	0	0	0	0	0	0	0	0	0	0	1
359	0.2	0	0	0	4.35	0.3	23.4	0.8	1	0	0	0	0	0	0	0	0	0	3
360	0.2	0	0	0	9.18	0.7	29.7	1.1	0	0	0	0	0	0	0	0	0	0	3

361	1.8	0	0	0	5.6	0.1	28	0.5	0	0	0	0	0	0	0	0	0	0	2
362	0.1	0	0	0	5.55	0.1	26.6	nd	0	0	0	0	0	0	0	0	0	0	1
363	2.4	0	0	0	6.86	0.1	27.6	0.5	0	0	0	0	0	0	0	0	0	0	1
364	0.1	0	0	0	1.5	0	28.1	1.3	0	0	0	0	0	0	0	0	0	0	0
365	0.1	0	0	0	8.82	0.1	29.5	0.7	0	0	0	0	0	0	0	0	0	0	3
366	2.5	0	0	0	4.97	0	28.1	1.1	0	0	0	0	0	0	0	0	0	0	1
367	2.4	0	0	0	0.43	0.1	31.2	nd	1	0	0	0	0	0	0	0	0	0	2
368	2.1	0	0	0	0.26	1	26.2	nd	0	0	0	0	0	0	0	0	0	0	0
369	2.4	0	0	0	7.9	0.1	27.9	1.9	1	0	1	0	0	0	0	0	0	0	0
370	0.1	0	0	0	6.34	4	27.8	0.5	0	0	0	0	0	0	0	0	0	0	2
371	2.4	0	0	0	6.9	0.3	27.8	1.7	0	0	0	1	0	0	0	0	0	0	2
372	1	0	0	0	4.13	0.3	27.3	0.6	0	0	0	0	0	0	0	0	0	0	1
373	2.1	0	0	0	4.69	0.2	26.7	1.8	1	0	0	0		0	0	0	0	0	0
374	0.1	0	0	0	6.94	0.2	26.3	1.2	0	0	0	0	0	0	0	0	0	0	3
375	0.2	0	0	0	8.27	2	25.9	1.25	0	0	0	0	0	0	0	0	0	0	1
376	0.3	0	0	0	4.33	0.1	25.9	0.3	0	0	0	0	0	0	0	0	0	0	3
377	0.2	0	0	0	4.81	1	26.5	0.5	2	0	0	0		0	0	0	0	0	3
378	0.1	0	0	0	11.9	0.1	25.2		0	0	0	0	0	0	0	0	0	0	0
379	0.2	0	0	0	8.75	0.1	26.3	1.2	1	0	0	0	0	0	0	0	0	0	1
380	1	0	0	0	8.94	0.4	26	1.3	0	0	0	0	0	0	0	0	0	0	2
381	0.6	0	0	0	9.84	0.3	26.3	0.26	0	0	0	0	0	0	0	0	0	0	3
382	0.2	0	0	0	6.5	0.3	24.3	0.9	0	0	0	0	0	0	0	0	0	0	3
383	1.8	0	0	0	7.4	1	21.7	0.6	0	0	0	0	0	0	0	0	0	0	3
384	3	0	0	0	8.15	0.4	21	1.1	0	0	0	0	0	0	0	0	0	0	3
385	0.1	0	0	0	8.2	1	18.6	0.6	0	0	0	0	0	0	0	0	0	0	3
386	0.1	0	0	0	5.93	1	18.7	0	0	0	0	0	0	0	0	0	0	0	1
387	2.2	0	0	0	8.94	1	18.5	1.1	0	0	0	0	0	2	0	0	0	0	0
388	0.1	0	0	0	10.3	0.1	15	0	0	1	0	0	0	0	0	0	0	0	0
389	0.2	0	0	0	6.98	0.1	14	1.3	0	0	0	0	0	0	0	0	0	0	2
390	0	0	0	0	0	0	0		0	0	0	0	0		0	0	0	0	0
391	2.4	0	0	0	4.9	0.4	16.1	0.5	0	1	0	0	0	0	0	0	3	0	3
392	0.2	0	0	0	9.85	0.3	14.9	0.7	0	1	0	0	0	0	0	0	0	0	2
393	4.4	0	0	0	6.66	0.2	15.2	2	1	0	1	0	0	0	0	0	0	0	0
394	1.9	0	0	0	8.44	0.3	13.3	2.5	0	0	0	0	0	0	0	0	0	0	2
395	0.2	0	0	0	9.85	0.3	15.7	1	0	0	0	0	0	0	0	0	0	0	3
396	0.2	0	0	0	9.85	0	15.7	1	0	0	0	0	0	0	0	0	0	0	0
397	0.2	0	0	0	7	2.5	12.4		0	0	0	0	0	0	0	0	0	0	2
398	0.2	0	0	0	6	0.1	16.9	1.4	0	0	0	1	0	1	0	0	7	0	1
399	1.1	0	0	0	6.2	0.1	13.9	0.8	0	0	0	0	1	5	0	0	50	0	1
400	0.2	0	0	0	10.14	0.2	13.1	0	0	0	0	1	0	0	0	0	0	0	0
401	0.7	0	0	0	8.75	0.2	18.3	0.85	0	0	0	0	0	0	0	0	0	0	0
402	1.8	0	0	0	4.21	0.2	15.8		0	0	0	0	0	0	5	0	0	0	
403	2.2	0	0	0	7.7	0	18.1	0.5	0	0	0	0	0	0	0	0	0	0	0
404	0.2	0	0	0	8.92	0	18	0	0	0	0	0	0	0	0	0	0	0	2
405	1	0	0	0	4.55	0.1	19	2	0	0	0	0	0	0	0	0	0	0	3
406	2.3	0	0	0	8.66	0.3	16.9	0	0	0	0	0	0	0	0	0	0	0	3
407	0.2	0	0	0	8.44	0	18.9	0	0	0	0	0	0	0	0	0	0	0	0
408	0.1	0	0	0	5.91	0.2	19	2	1	1	0	0	1	0	0	0	0	0	0
409	1	0	0	0	4.55	0.1	19	2	0	0	0	0	0	0	0	0	0	0	3
410	0.6	0	0	0	7.92	0.2	17	0	0	0	0	0	0	0	0	0	0	0	3
411	0.1	0	0	0	7	0.4	16.7	0.5	0	0	0	0	0	0	0	0	0	0	3
412	0.1	0	0	0	8.5	0.2	16.2	1.2	0	0	0	0	0	0	nd	nd	nd	nd	3

413	0.2	0	0	0	13.9	2	12.5	0.5	0	0	0	0	0	6	38	0	18	0	2
414	1.6	0	0	0	3.55	0	14.9	0.5	0	0	1	0	0	0	0	0	0	0	3
415	3.3	0	0	0	6.2	0.3	14.1	0.5	0	0	0	0	0	0	0	0	0	0	3
416	0.2	0	0	0	7.4	0.3	15.5	1.5	0	0	0	0	0	0	0	0	0	0	3
417	2	0	0	0	7.8	0.2	14.1	1.5	1	1	1	0	0	1	0	0	0	0	0
418	0.2	0	0	0	12.84	nd	18.2	1.84	1	0	0	0	0	0	0	0	0	0	0
419	0.1	0	0	0	8.33	nd	16.4	1.6	0	0	0	0	0	0	0	0	0	0	3
420	2	0	0	0	12.29	nd	17.6	1.5	0	0	0	0	0	0	0	0	3	0	3
421	0.2	0	0	0	8.26	nd	12.2	0.5	0	0	0	0	0	0	60	0	40	0	0
422	0.1	0	0	0	0	nd	26.2	0	0	0	0	0	0	0	0	0	0	0	1
423	0.2	0	0	0	6.78	nd	18	nd	0	0	0	0	0	0	0	0	0	0	3
424	1	0	0	0	6.82	nd	17.1	1	0	0	0	0	0	0	0	0	0	0	2
425	0.2	0	0	0	12.6	nd	15.9	0	0	0	0	0	0	0	0	0	0	0	0
426	0.1	0	0	0	6.7	nd	20.4	0.8	1	0	0	0	0	0	0	0	0	0	0
427	0.2	0	0	0	7.9	nd	21.8	1.2	0	0	0	0	0	0	0	0	0	0	3
428	0.5	0	0	0	6.9	nd	20.6	2	0	0	0	0	0	0	0	0	0	0	3
429	0.2	0	0	0	6.78	nd	22.4	0.5	0	0	0	0	0	0	0	0	0	0	3
430	0.1	0	0	0	7.95	nd	24	1.5	0	0	0	0	0	0	0	0	0	0	3
431	0.1	0	0	0	7.49	nd	24	1.3	0	0	0	0	0	0	0	0	0	0	3
432	2.5	0	0	0	7.49	nd	25.4	0.9	0	0	0	0	0	0	0	0	0	0	1
433	0.2	0	0	0	7.13	nd	25.6	nd	0	0	0	1	0	0	0	0	0	0	0

1. nd = no data.

Appendix 2. Spearman rank correlations between fish abundance, abundance of mosquito larvae and pupae, and the physical, chemical, and biological variables. Based on the data in Appendix 1. N = 433. The top number in each cell of the table is the Spearman correlation coefficient. The number beneath the correlation coefficient is the level of significance (two-tailed test). Asterisks indicate $P<.05$. (Appendix 3 provides the Spearman correlation coefficients among all physical, chemical, and biological variables listed in Table 2.)

	Fish abundance	Culex quinquefasciatus	Culex salinarius	Culex coronator	Anopheles	Pupae
Fish abundance	1.000	-.223*	-.072	-.122*	-.222*	-.180*
	.	.000	.134	.011	.000	.000
Culex quinquefasciatus	-.223*	1.000	.149*	.223*	.370*	.339*
	.000	.	.002	.000	.000	.000
Culex salinarius	-.072	.149*	1.000	-.013	.203*	.353*
	.134	.002	.	.783	.000	.000
Culex coronator	-.122*	.223*	-.013	1.000	.175*	.167*
	.011	.000	.783	.	.000	.000
Anopheles	-.222*	.370*	.203*	.175*	1.000	.370*
	.000	.000	.000	.000	.	.000
Pupae	-.180*	.339*	.353*	.167*	.370*	1.000
	.000	.000	.000	.000	.000	.
Time	.192*	-.193*	-.029	-.107*	-.115*	-.038
	.000	.000	.546	.026	.017	.426
Leaves	-.014	-.029	-.040	-.023	-.055	-.088
	.769	.552	.405	.632	.254	.067
Sticks	-.112*	.003	.006	.007	.095*	.004
	.020	.951	.905	.877	.050	.936
Tree branches	.022	.047	-.044	.070	.091	-.034
	.647	.332	.359	.145	.060	.486
Wood	-.021	-.079	-.036	-.051	-.088	-.075
	.669	.101	.459	.293	.068	.120
Grass	.139*	-.090	.038	-.053	.023	-.021
	.004	.062	.426	.273	.632	.663
Pine leaves	.033	.101*	.051	.013	.212*	.061
	.496	.036	.294	.785	.000	.205
Oak leaves	.021	.210*	.137*	.017	.051	.238*
	.662	.000	.004	.724	.291	.000
Algal mats	.039	-.122*	-.084	-.092	-.146*	-.142*
	.415	.011	.082	.057	.002	.003
Plastic bags	-.083	-.024	.007	.025	.034	.035
	.086	.619	.882	.610	.479	.475
Plastic	.148*	-.070	-.001	-.047	-.013	-.028
	.002	.146	.977	.336	.790	.566
Large items	-.012	.034	-.039	.049	-.032	-.009
	.798	.478	.417	.307	.511	.845
Glass bottles	-.009	-.041	-.027	-.038	-.039	-.002
	.854	.391	.583	.436	.422	.961
Bleach bottle	.077	-.053	-.018	-.025	-.064	-.049
	.112	.274	.713	.602	.189	.308

Brown	-.071	.072	-.020	-.033	.006	.059
	.139	.137	.679	.492	.894	.222
Green	.112*	-.073	.026	.000	.007	-.054
	.020	.130	.583	.998	.887	.264
Smell	-.113*	.197*	.118*	-.025	-.018	.059
	.018	.000	.014	.602	.713	.219
pH	.001	.045	-.059	.074	.019	-.079
	.982	.364	.231	.134	.699	.110
Salinity	.079	.013	.063	-.009	.110*	-.004
	.109	.791	.199	.856	.026	.943
T- Chlorine	.021	.037	.098*	-.030	-.029	.044
	.677	.456	.046	.542	.553	.375
Nitrate	-.093	-.001	.117*	-.027	.080	.009
	.061	.988	.018	.592	.106	.856
Nitrite	-.093	.011	.136*	-.023	.053	.022
	.059	.817	.006	.636	.284	.661
Oxygen	.060	-.120*	.043	-.083	-.022	.009
	.226	.014	.389	.091	.658	.853
Ammonia	.088	.143*	.035	.006	.000	-.002
	.081	.005	.494	.903	.999	.962
Temperature	-.049	-.060	-.095	.021	-.061	-.172*
	.325	.224	.054	.670	.219	.000
Secchi	-.122*	-.164*	.002	-.057	-.009	.006
	.023	.002	.976	.284	.864	.910
Back swimmer	-.204*	.067	.082	-.095*	-.033	.093
	.000	.162	.089	.048	.500	.053
Water boatman	-.187*	.224*	.145*	.096*	.240*	.171*
	.000	.000	.002	.046	.000	.000
Diving beetle	-.006	.030	-.035	.002	-.036	-.015
	.904	.532	.468	.961	.453	.761
Dragonfly nymphs	.027	-.024	.095*	.085	.186*	.115*
	.577	.615	.049	.076	.000	.017
Water strider	.038	-.031	-.023	-.032	.131*	.060
	.431	.525	.641	.508	.007	.213

Appendix 3. Spearman rank correlations among variables measured in the research program. Based on the data in Appendix 1. N = 433. The top number in each cell of the table is the Spearman correlation coefficient. The number beneath the correlation coefficient is the level of significance (two-tailed test). Asterisks indicate P<.05. (Correlations involving mosquito larvae and fish are shown in Appendix 2.)

	Time	Leaves	Sticks	Tree branches	Wood	Grass	Pine leaves	Oak leaves	Algal mats	Plastic bags	Plastic objects
Time	1.000	.126*	-.090	-.321*	.039	-.052	-.214*	-.205*	.195*	-.201*	.151*
	.	.009	.061	.000	.416	.281	.000	.000	.000	.000	.002
Leaves	.126*	1.000	.012	-.188*	.119*	-.103*	-.159*	-.286*	-.063	-.103*	.060
	.009	.	.801	.000	.013	.032	.001	.000	.192	.032	.217
Sticks	-.090	.012	1.000	.126*	-.082	-.128*	.010	-.054	.001	.157*	-.013

	.061	.801	.	.009	.090	.008	.828	.259	.990	.001	.785
Tree branches	-.321*	-.188*	.126*	1.000	-.124*	-.143*	.119*	.006	-.030	.086	-.007
	.000	.000	.009	.	.010	.003	.013	.905	.532	.074	.888
Wood	.039	.119*	-.082	-.124*	1.000	.137*	-.121*	-.116*	-.052	-.051	-.017
	.416	.013	.090	.010	.	.004	.012	.016	.283	.292	.721
Grass	-.052	-.103*	-.128*	-.143*	.137*	1.000	.017	-.121*	-.113*	-.077	.010
	.281	.032	.008	.003	.004	.	.725	.012	.019	.112	.841
Pine leaves	-.214*	-.159*	.010	.119*	-.121*	.017	1.000	.060	-.137*	.177*	.125*
	.000	.001	.828	.013	.012	.725	.	.212	.004	.000	.009
Oak leaves	-.205*	-.286*	-.054	.006	-.116*	-.121*	.060	1.000	-.175*	.132*	-.116*
	.000	.000	.259	.905	.016	.012	.212	.	.000	.006	.016
Algal mats	.195*	-.063	.001	-.030	-.052	-.113*	-.137*	-.175*	1.000	.006	.051
	.000	.192	.990	.532	.283	.019	.004	.000	.	.905	.292
Plastic bags	-.201*	-.103*	.157*	.086	-.051	-.077	.177*	.132*	.006	1.000	-.196*
	.000	.032	.001	.074	.292	.112	.000	.006	.905	.	.000
Plastic objects	.151*	.060	-.013	-.007	-.017	.010	.125*	-.116*	.051	-.196*	1.000
	.002	.217	.785	.888	.721	.841	.009	.016	.292	.000	.
Large items	-.099*	-.028	-.059	.305*	-.020	-.043	-.112*	-.064	.094	-.256*	-.072
	.039	.561	.222	.000	.679	.378	.020	.184	.051	.000	.138
Glass bottles	-.163*	.081	-.039	.024	.149*	.117*	-.059	-.055	-.109*	-.061	-.124*
	.001	.093	.420	.618	.002	.015	.219	.255	.024	.203	.010
Bleach bottles	-.154*	-.140*	-.005	-.009	-.023	.163*	.294*	-.058	-.021	-.014	-.013
	.001	.004	.921	.852	.628	.001	.000	.231	.663	.774	.781
Brown water	-.036	.017	.002	.041	.005	-.048	.084	.164*	-.230*	.035	-.009
	.460	.720	.973	.401	.911	.318	.083	.001	.000	.471	.848
Green water	.089	-.025	.055	-.006	.005	.041	-.050	-.120*	.208*	-.044	.041
	.066	.610	.252	.902	.916	.393	.296	.013	.000	.358	.395
Foul smell	-.165*	-.076	-.005	.132*	.016	-.034	-.017	.174*	.004	-.001	-.005
	.001	.114	.920	.006	.735	.484	.726	.000	.940	.976	.912
pH	-.315*	-.136*	.004	.231*	.029	.018	.145*	.073	-.087	.098*	-.004
	.000	.006	.938	.000	.559	.718	.003	.137	.076	.046	.928
Salinity	-.404*	-.088	.053	.129*	.032	.151*	.180*	.070	-.053	.054	.131*
	.000	.075	.286	.009	.516	.002	.000	.155	.286	.273	.008
Total chlorine	-.141*	-.033	.029	-.062	-.008	.098*	.141*	-.023	-.032	.045	-.071
	.004	.498	.551	.211	.874	.046	.004	.639	.512	.368	.151
Nitrate	-.110*	-.016	-.010	-.047	-.025	-.072	-.059	.139*	.044	.039	-.068
	.026	.750	.832	.339	.610	.145	.232	.005	.376	.426	.170
Nitrite	-.225*	-.006	-.016	-.025	-.062	-.018	-.001	.170*	.027	.054	-.006
	.000	.897	.744	.608	.213	.720	.992	.001	.583	.274	.897
Oxygen	.243*	.124*	.007	-.224*	.001	.089	-.149*	-.052	.019	-.013	-.055
	.000	.012	.890	.000	.978	.069	.002	.294	.698	.794	.269
Ammonia	-.060	-.016	.046	.221*	-.082	-.048	.082	.043	-.065	.027	.081
	.234	.753	.359	.000	.103	.342	.105	.398	.196	.587	.110
Temperature	-.197*	-.153*	.030	.109*	-.036	-.031	.106*	-.065	.199*	.039	.012
	.000	.002	.547	.026	.466	.526	.032	.189	.000	.427	.814
Secchi disk	.008	.029	.025	-.222*	.056	.003	-.076	-.068	.141*	.122*	-.092
	.878	.589	.647	.000	.293	.957	.154	.205	.008	.023	.086
Back	-.216*	.010	.080	.166*	-.072	-.055	-.092	.065	.110*	.046	-.039

swimmer	.000	.842	.095	.001	.136	.254	.055	.176	.022	.340	.420
Water boatman	-.286*	.023	.221*	.244*	-.018	-.186*	.124*	.188*	-.146*	.143*	-.085
	.000	.628	.000	.000	.713	.000	.010	.000	.002	.003	.078
Diving beetle	-.175*	.038	.164*	.197*	-.113*	-.076	.023	-.065	.054	.002	.092
	.000	.427	.001	.000	.019	.115	.632	.180	.264	.962	.056
Dragonfly nymphs	-.177*	-.105*	.065	.123*	-.015	.131*	.275*	.008	-.031	.098*	-.099*
	.000	.030	.179	.010	.758	.006	.000	.867	.518	.043	.041
Water strider	-.156*	-.109*	.206*	.211*	-.086	.061	.280*	.001	-.055	.015	.043
	.001	.024	.000	.000	.075	.205	.000	.978	.254	.753	.379

	Large items	Glass bottles	Bleach bottle	Brown water	Green water	Foul smell	pH	Salinity	Total chlorine	Nitrate	Nitrite
Time	-.099*	-.163*	-.154*	-.036	.089	-.165*	-.315*	-.404*	-.141*	-.110*	-.225*
	.039	.001	.001	.460	.066	.001	.000	.000	.004	.026	.000
Leaves	-.028	.081	-.140*	.017	-.025	-.076	-.136*	-.088	-.033	-.016	-.006
	.561	.093	.004	.720	.610	.114	.006	.075	.498	.750	.897
Sticks	-.059	-.039	-.005	.002	.055	-.005	.004	.053	.029	-.010	-.016
	.222	.420	.921	.973	.252	.920	.938	.286	.551	.832	.744
Tree branches	.305*	.024	-.009	.041	-.006	.132*	.231*	.129*	-.062	-.047	-.025
	.000	.618	.852	.401	.902	.006	.000	.009	.211	.339	.608
Wood	-.020	.149*	-.023	.005	.005	.016	.029	.032	-.008	-.025	-.062
	.679	.002	.628	.911	.916	.735	.559	.516	.874	.610	.213
Grass	-.043	.117*	.163*	-.048	.041	-.034	.018	.151*	.098*	-.072	-.018
	.378	.015	.001	.318	.393	.484	.718	.002	.046	.145	.720
Pine leaves	-.112*	-.059	.294*	.084	-.050	-.017	.145*	.180*	.141*	-.059	-.001
	.020	.219	.000	.083	.296	.726	.003	.000	.004	.232	.992
Oak leaves	-.064	-.055	-.058	.164*	-.120*	.174*	.073	.070	-.023	.139*	.170*
	.184	.255	.231	.001	.013	.000	.137	.155	.639	.005	.001
Algal mats	.094	-.109*	-.021	-.230*	.208*	.004	-.087	-.053	-.032	.044	.027
	.051	.024	.663	.000	.000	.940	.076	.286	.512	.376	.583
Plastic bags	-.256*	-.061	-.014	.035	-.044	-.001	.098*	.054	.045	.039	.054
	.000	.203	.774	.471	.358	.976	.046	.273	.368	.426	.274
Plastic objects	-.072	-.124*	-.013	-.009	.041	-.005	-.004	.131*	-.071	-.068	-.006
	.138	.010	.781	.848	.395	.912	.928	.008	.151	.170	.897
Large items	1.000	.040	-.074	.039	-.083	.189*	.118*	.062	-.043	-.030	.034
	.	.409	.124	.416	.086	.000	.017	.214	.385	.550	.498
Glass bottles	.040	1.000	.116*	-.035	.008	.002	.070	.059	-.006	-.049	-.043
	.409	.	.016	.469	.868	.965	.158	.231	.906	.323	.382
Bleach bottle	-.074	.116*	1.000	-.047	.092	-.034	.118*	.166*	.174*	-.033	.058
	.124	.016	.	.330	.056	.487	.017	.001	.000	.509	.245
Brown water	.039	-.035	-.047	1.000	-.841*	.026	.002	-.033	.011	-.026	-.053
	.416	.469	.330	.	.000	.596	.973	.504	.825	.601	.285
Green water	-.083	.008	.092	-.841*	1.000	-.023	-.008	.014	-.051	.044	.077
	.086	.868	.056	.000	.	.637	.875	.772	.304	.375	.119
Foul smell	.189*	.002	-.034	.026	-.023	1.000	.085	.062	.029	.195*	.228*
	.000	.965	.487	.596	.637	.	.085	.208	.562	.000	.000
pH	.118*	.070	.118*	.002	-.008	.085	1.000	.381*	.144*	-.012	-.052
	.017	.158	.017	.973	.875	.085	.	.000	.003	.808	.292
Salinity	.062	.059	.166*	-.033	.014	.062	.381*	1.000	.119*	-.012	.071

	.214	.231	.001	.504	.772	.208	.000	.	.016	.810	.150
Total chlorine	-.043	-.006	.174*	.011	-.051	.029	.144*	.119*	1.000	.089	.187*
	.385	.906	.000	.825	.304	.562	.003	.016	.	.072	.000
Nitrate	-.030	-.049	-.033	-.026	.044	.195*	-.012	-.012	.089	1.000	.549*
	.550	.323	.509	.601	.375	.000	.808	.810	.072	.	.000
Nitrite	.034	-.043	.058	-.053	.077	.228*	-.052	.071	.187*	.549*	1.000
	.498	.382	.245	.285	.119	.000	.292	.150	.000	.000	.
Oxygen	-.156*	.029	-.089	-.056	.062	-.164*	-.270*	-.224*	-.082	-.025	-.116*
	.002	.553	.072	.258	.210	.001	.000	.000	.096	.613	.019
Ammonia	.001	-.078	.000	.121*	-.038	.153*	.086	.179*	-.004	.203*	.142*
	.981	.121	.999	.016	.457	.002	.092	.000	.941	.000	.005
Temperature	.047	.005	.105*	-.057	.102*	.143*	.267*	.115*	.155*	.177*	.205*
	.343	.920	.034	.252	.037	.004	.000	.019	.002	.000	.000
Secchi disk	-.043	-.021	-.073	-.078	-.026	-.121*	-.071	.044	.011	-.063	-.004
	.419	.701	.175	.146	.630	.024	.187	.414	.834	.239	.934
Back swimmer	.040	.001	.114*	.026	-.050	.036	.040	.067	-.018	.044	.078
	.402	.984	.018	.587	.302	.458	.420	.177	.709	.377	.115
Water boatman	.034	-.071	-.115*	.156*	-.141*	.081	.115*	.091	.058	.002	.030
	.486	.144	.017	.001	.003	.093	.020	.065	.240	.966	.546
Diving beetle	-.037	-.072	-.027	-.135*	.079	.015	.052	.139*	-.038	-.024	-.011
	.441	.138	.575	.005	.101	.754	.294	.005	.444	.630	.823
Dragonfly nymphs	.029	-.013	.103*	-.056	.081	-.075	.039	.165*	.018	-.076	-.026
	.551	.796	.033	.244	.091	.121	.432	.001	.720	.124	.604
Water strider	.001	-.064	.184*	-.004	.038	-.043	.025	.147*	.125*	-.040	.107*
	.990	.187	.000	.940	.437	.378	.616	.003	.011	.415	.030

	Oxygen	Ammonia	Temperature	Secchi disk	Back swimmer	Water boatman	Diving beetle	Dragonfly nymphs	Water strider
Time	.243*	-.060	-.197*	.008	-.216*	-.286*	-.175*	-.177*	-.156*
	.000	.234	.000	.878	.000	.000	.000	.000	.001
Leaves	.124*	-.016	-.153*	.029	.010	.023	.038	-.105*	-.109*
	.012	.753	.002	.589	.842	.628	.427	.030	.024
Sticks	.007	.046	.030	.025	.080	.221*	.164*	.065	.206*
	.890	.359	.547	.647	.095	.000	.001	.179	.000
Tree branches	-.224*	.221*	.109*	-.222*	.166*	.244*	.197*	.123*	.211*
	.000	.000	.026	.000	.001	.000	.000	.010	.000
Wood	.001	-.082	-.036	.056	-.072	-.018	-.113*	-.015	-.086
	.978	.103	.466	.293	.136	.713	.019	.758	.075
Grass	.089	-.048	-.031	.003	-.055	-.186*	-.076	.131*	.061
	.069	.342	.526	.957	.254	.000	.115	.006	.205
Pine leaves	-.149*	.082	.106*	-.076	-.092	.124*	.023	.275*	.280*
	.002	.105	.032	.154	.055	.010	.632	.000	.000
Oak leaves	-.052	.043	-.065	-.068	.065	.188*	-.065	.008	.001
	.294	.398	.189	.205	.176	.000	.180	.867	.978
Algal mats	.019	-.065	.199*	.141*	.110*	-.146*	.054	-.031	-.055
	.698	.196	.000	.008	.022	.002	.264	.518	.254
Plastic bags	-.013	.027	.039	.122*	.046	.143*	.002	.098*	.015
	.794	.587	.427	.023	.340	.003	.962	.043	.753
Plastic	-.055	.081	.012	-.092	-.039	-.085	.092	-.099*	.043

objects	.269	.110	.814	.086	.420	.078	.056	.041	.379
Large items	-.156*	.001	.047	-.043	.040	.034	-.037	.029	.001
	.002	.981	.343	.419	.402	.486	.441	.551	.990
Glass bottles	.029	-.078	.005	-.021	.001	-.071	-.072	-.013	-.064
	.553	.121	.920	.701	.984	.144	.138	.796	.187
Bleach bottle	-.089	.000	.105*	-.073	.114*	-.115*	-.027	.103*	.184*
	.072	.999	.034	.175	.018	.017	.575	.033	.000
Brown water	-.056	.121*	-.057	-.078	.026	.156*	-.135*	-.056	-.004
	.258	.016	.252	.146	.587	.001	.005	.244	.940
Green water	.062	-.038	.102*	-.026	-.050	-.141*	.079	.081	.038
	.210	.457	.037	.630	.302	.003	.101	.091	.437
Foul smell	-.164*	.153*	.143*	-.121*	.036	.081	.015	-.075	-.043
	.001	.002	.004	.024	.458	.093	.754	.121	.378
pH	-.270*	.086	.267*	-.071	.040	.115*	.052	.039	.025
	.000	.092	.000	.187	.420	.020	.294	.432	.616
Salinity	-.224*	.179*	.115*	.044	.067	.091	.139*	.165*	.147*
	.000	.000	.019	.414	.177	.065	.005	.001	.003
Total chlorine	-.082	-.004	.155*	.011	-.018	.058	-.038	.018	.125*
	.096	.941	.002	.834	.709	.240	.444	.720	.011
Nitrate	-.025	.203*	.177*	-.063	.044	.002	-.024	-.076	-.040
	.613	.000	.000	.239	.377	.966	.630	.124	.415
Nitrite	-.116*	.142*	.205*	-.004	.078	.030	-.011	-.026	.107*
	.019	.005	.000	.934	.115	.546	.823	.604	.030
Oxygen	1.000	-.224*	-.391*	.134*	-.063	-.170*	.014	.010	-.158*
	.	.000	.000	.012	.204	.001	.784	.841	.001
Ammonia	-.224*	1.000	.157*	-.299*	.014	.102*	.024	-.072	.087
	.000	.	.002	.000	.780	.044	.633	.156	.087
Temperature	-.391*	.157*	1.000	.044	.058	-.058	.020	-.058	.105*
	.000	.002	.	.416	.243	.239	.685	.236	.034
Secchi disk	.134*	-.299*	.044	1.000	.030	-.173*	-.057	.092	.065
	.012	.000	.416	.	.580	.001	.287	.084	.227
Back swimmer	-.063	.014	.058	.030	1.000	.272*	.262*	.010	.167*
	.204	.780	.243	.580	.	.000	.000	.829	.000
Water boatman	-.170*	.102*	-.058	-.173*	.272*	1.000	.134*	.124*	.254*
	.001	.044	.239	.001	.000	.	.005	.010	.000
Diving beetle	.014	.024	.020	-.057	.262*	.134*	1.000	.005	.168*
	.784	.633	.685	.287	.000	.005	.	.912	.000
Dragonfly nymphs	.010	-.072	-.058	.092	.010	.124*	.005	1.000	.428*
	.841	.156	.236	.084	.829	.010	.912	.	.000
Water strider	-.158*	.087	.105*	.065	.167*	.254*	.168*	.428*	1.000
	.001	.087	.034	.227	.000	.000	.000	.000	.

Appendix 4. Number of mosquito larvae counted in samples (eight dips) from swimming pools that *did not contain fish but contained larvae.* Based on species identifications and counts by Cynthia Harrison and Mieu Nguyen.

Culiseta inornata

Jan. 2006	6, 7, 11, 30, 30, 47, 200
Feb. 2006	2, 2, 3, 3, 3, 4, 4,10, 13, 19, 20, 32
Mar. 2006	2, 3, 4, 6, 10, 11, 13
Apr. 2006	1
Nov. 2006	7
Dec.2006	1, 2, 2, 4, 4, 5, 6, 6, 7, 8, 10, 11, 12, 54, 100, 220
Jan. 2007	1, 1, 2, 2, 2, 3, 5, 6, 7, 9, 10, 11, 146
Feb. 2007	1, 11, 12
Mar. 2007	1, 2, 2, 2, 3, 3, 5, 6, 7, 8, 9, 11, 12, 43
May. 2007	6
Nov. 2007	1, 2, 6, 8, 23, 41
Jan. 2008	6, 9, 9, 104
Feb. 2008	2, 13
Mar.2008	2, 4, 6, 11, 21

Culex quinquefasciatus

Feb.2006	4
Mar.2006	4, 5, 6, 6, 12, 13, 18
Apr.2006	1, 2, 3, 4, 4, 4, 5, 11, 16, 18, 25, 27, 28, 33
Jun.2006	17 , 50
Aug.2006	2, 5, 5, 11, 25
Oct.2006	3, 5, 5, 10, 25 , 30, 136
Nov.2006	2, 2, 3, 4, 9, 10, 21, 30, 32, 36, 40, 72, 90
Dec.2006	1,1, 2, 2, 2, 2, 4, 4, 6, 7, 15, 34, 42, 54, 90, 100, 300
Jan.2007	1, 1, 2, 8, 30, 32, 40, 76, 80, 85, 90, 95, 100, 170, 280
Feb.2007	1, 3, 4, 7, 10, 150
Mar.2007	5, 5, 6, 7, 11, 11, 200
Apr.2007	2, 4, 4, 4, 7, 10, 10, 12, 18, 22, 32, 148
May.2007	2, 4, 4, 5, 7, 10, 11, 13, 15, 45, 200
Jun.2007	1, 45, 250
Jul.2007	35, 150
Aug. 2007	4
Sep.2007	1, 25, 69, 200, 400
Oct.2007	7, 10, 30, 60, 100, 100, 2000
Nov.2007	4, 50, 71, 215, 230, 411, 500
Jan. 2008	24, 60, 95, 100,110, 125, 400
Feb. 2008	37, 200, 300, 460
Mar.2008	1,2, 5, 7, 87, 91, 190, 680
Apr.2008	16, 75, 104
May. 2008	352
Sept. 2008	164
Oct. 2008	1, 2000
Nov. 2008	104

Feb. 2009	60
Apr. 2009	10, 500

Culex coronator

Apr. 2006	2,
Oct. 2006	30
Jan. 2007	1, 8
July. 2007	14
Sept. 2007	3, 28
Oct. 2007	9, 10, 14, 50
Nov. 2007	1, 2, 3, 3, 5, 12, 21, 30, 34, 75
Jan. 2008	7, 16, 64, 66
July. 2008	300
Aug. 2008	800
Sept. 2008	14, 800
Oct. 2008	10
Nov. 2008	3

Culex salinarius

Jan. 2006	1, 7
Mar. 2006	1, 1, 1, 5, 7, 8, 8, 11
Apr. 2006	1, 1
Aug. 2006	6, 11
Oct. 2006	20
Nov. 2006	1, 1, 1, 3, 4, 7, 7, 13
Dec. 2006	7, 18
Jan. 2007	1, 1, 4, 5, 13, 30
Feb. 2007	1, 2, 15
Apr. 2007	3, 6, 7, 16, 16
May. 2007	3, 14
Nov. 2007	2, 6, 7, 10
Jan. 2008	2, 2, 7, 14, 158
Feb. 2008	2, 12, 23, 37
Mar. 2008	4, 4
Apr. 2008	3, 507
July. 2008	1,4
Feb. 2009	1

Culex restuans

Jan. 2006	26
Mar. 2006	1, 3, 4
Nov. 2006	1, 2, 3
Dec. 2006	1, 1, 2, 4, 6, 7, 9, 30
Jan. 2007	1, 1, 1, 2, 2, 2, 2, 3, 6, 13
Feb. 2007	3, 5
May. 2007	1, 1, 3
Oct. 2007	600
Dec. 2007	1, 8, 30

Jan. 2008	2, 5, 10
Feb. 2008	4, 10, 180
Mar. 2008	2, 7
Apr. 2008	2
Nov. 2008	4

Culex erraticus

July. 2007	7,50
Aug. 2007	50, 150
Sept. 2007	7, 10
Oct. 2007	5, 8
Nov. 2007	1
July. 2008	2, 19

Culex nigripalpus

Nov. 2006	3
Dec. 2006	1
Nov. 2007	6

Anopheles

Apr.2006	1
Aug.2006	2
Oct.2006	5, 10
Nov.2006	1, 1, 3, 3
Dec.2006	1, 1, 3, 5
Jan.2007	2, 2, 2, 2, 4
Feb.2007	1
Mar.2007	2, 4
Apr.2007	1, 1, 2, 5, 8, 16
May. 2007	1, 2, 9
Jun.2006	2 , 8
Jul.2007	4, 31
Aug.2007	14 , 20, 20, 21
Sep.2007	2, 3 , 5 , 5, 5
Oct.2007	1, 1, 1, 3, 3, 4, 5, 8, 9
Nov.2007	2, 2, 2, 2, 3, 3, 5, 6, 7, 8, 15, 16, 21, 46
Jan.2008	4, 4, 13, 49
Feb.2008	1, 2, 8, 8, 9, 12, 32, 47, 49
Mar. 2008	1, 2, 9, 10, 15, 22, 58
May. 2008	3, 3 , 5, 6, 20
Jun. 2008	5
Jul. 2008	1, 2, 4, 6, 7, 80
Aug. 2008	10,
Oct. 2008	2, 2
Nov. 2008	10, 19

Appendix 5. Number of mosquito larvae counted in samples (eight dips) from swimming pools that *contained both fish and larvae.* Based on species identifications and counts by Cynthia Harrison and Mieu Nguyen.

Culiseta inornata

Oct. 2007	1
Jan. 2008	2

Culex quinquefasciatus

Nov.2007	190
Dec.2007	4,1800
Jan. 2008	1,90
Dec. 2008	10
Jan. 2009	30

Culex salinarius

Jan. 2008	1

Anopheles

Jul.2007	3
Oct.2007	2
Nov. 2008	3,2
Dec. 2008	7,50
Jan. 2009	18
Feb. 2009	3,30