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Vincent Shane Hesting for the Master of Science

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The fish assemblage of 155 ha Turkey Creek Cove, Melvern Lake, Osage County, Kansas, was sampled with three gear types once a month during 1992. Detrended canonical correspondence analysis illustrated a significant depth and habitat heterogeneity gradient throughout the year, as well as for the non-spawn season (August - February), which separated inshore from offshore fishes. Age 0 and fishes mature at small size, e.g., brook silverside (Labidesthes sicculus), occupied diverse inshore habitats; larger species occupied deeper, less diverse habitat offshore. No individual gear type effectively characterized the cove assemblage, supporting the use of multiple gear types when sampling reservoir fisheries.

Environmental Correlates of Cove Fish Assemblage Structure in Melvern Lake, Kansas

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Vincent Shane Hesting

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Approved by Committee Member

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PREFACE

I have organized my thesis according to the Guide for Authors given for the Transactions of the American Fisheries Society because I intend to submit my manuscript to that journal for publication.

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INTRODUCTION

Only a small proportion of reservoir fish studies has examined environmental variables influencing fisheries (Jenkins 1968, 1970; Aggus and Lewis 1977; Jenkins and Morais 1971; Matthews et al. 1985; Matthews et al. 1989; Gelwick and Matthews 1990), and even fewer have addressed mechanisms structuring reservoir fish assemblages (Summerfelt 1971; Vondracek et al. 1989; Paller et al. 1992). Much of our knowledge of reservoir fish ecology has been extrapolated from studies in rivers or natural lakes.

Rivers are highly fluctuating lotic environments susceptible to drought and flood, whereas natural lakes are lentic systems having lower water exchange rates and various other contrasts with reservoirs (Wetzel 1990). Reservoirs are recent hybrids of lotic and lentic systems, with upper reaches being more riverine and lower reaches more lacustrine. Correlates of riverine fish assemblage structure include stream width, depth, current velocity, turbidity, amount of run habitat, substrate, cover, Ph, mean annual runoff, mean annual growing season, discharge, land character of ecoregion/geography, water temperature, stream gradient, shoreline vegetation, stream order, water clarity, dissolved oxygen, position along the stream's length, altitude, fish migration, and season (Hawkes et al. 1986; Larson et al. 1986; Meffe and Sheldon 1988; Ibarra and Stewart 1989; Lyons 1989; Rahel and Hubert 1991; Meador and

Matthews 1992; Edds 1993). Fish assemblages in natural lakes have been interpreted as functions of water chemistry, nutrient gradients, maximum depth, surface area, habitat heterogeneity, presence or absence of an inlet/outlet, postglacial colonization, and behavioral adaptations, as well as complex combinations of these variables (Gascon and Leggett 1977; Werner et al. 1978; Tonn and Magnuson 1982; Rahel 1984; Stang and Hubert 1984; Magnuson et al. 1985; Robinson and Tonn 1989; Hinch et al. 1991; Benson and Magnuson 1992; Graham 1993).

Given the prominence of reservoirs as important sport and commercial fishing resources, it is important for managers to understand the environmental factors associated with reservoir fish assemblage structure. The purpose of my study was to model the fish assemblage of a midwestern United States reservoir cove to identify environmental correlates of fish assemblage structure. Specific objectives were to investigate: 1) physicochemical factors associated with variation in fish assemblage structure; 2) zonation of cove fishes; 3) effects of collection method; and 4) seasonality in cove fish assemblage structure, including habitat relationships between age 0 and adults.

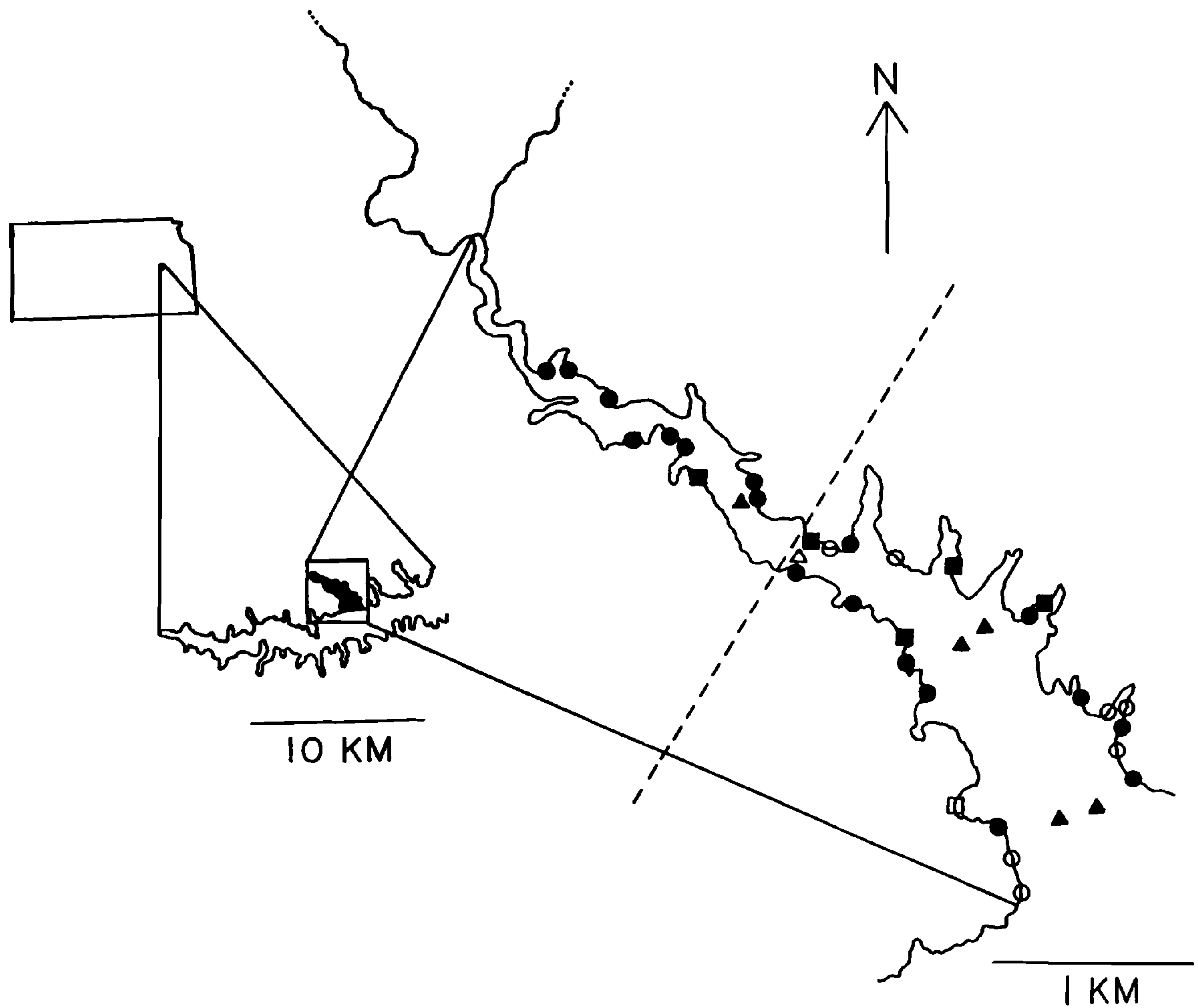
METHODS

Study Site

Melvern Lake (38°28' N, 95°53' W) is a 2,805 ha man-made impoundment of the Marais des Cygnes River in east-central Kansas. The dam closed in 1970, and the reservoir attained multipurpose pool of 316 m in April 1975, regulating 904 km^2 of drainage, with a maximum depth of 23 m (Mack Carlisle, U.S. Army Corps of Engineers Project Manager, pers. comm.). Using a cartometer, I measured a shoreline length of 163 km and calculated a shoreline development index (D_L) of 8.68 (Cole 1983). Much of the area surrounding the reservoir is pasture, and consists of a mixture of native grasses and herbaceous shrubs with tree foliage limited to tributary stream perimeters. A proportion of the flood plain and some upland areas are cultivated for agriculture, providing additional allochthonous input. Pennsylvanian and Quaternary sedimentary rock outcrops constitute the parent rock, which produces the substrate mixture of gravel, sand, silt, and clay along the river valley (Mac Carlisle, U.S. Army Corps of Engineers Project Manager, pers. comm.).

Turkey Creek Cove (Figure 1) is the largest cove in Melvern Lake, with a surface area of 155 ha, 18.9 km of shoreline, and a D_L of 4.28. From the upper portion of the cove to its mouth, conspicuous changes occur in physical habitat. At multipurpose pool, width ranges from 61 m in the upper reach to 914 m in the lower reach. Shoreline substrate

Figure 1. Study site at Turkey Creek Cove, Melvern Reservoir, Osage County, Kansas 1992. Sites above and below the dotted line represent upper and lower cove sites, respectively. Gill net, trap net, and seine haul sites are triangles, squares and circles, respectively. Sites sampled every month are closed; open symbols represent sites sampled only in January.


N
10 KM
1 KM

changes from mud/sand in the upper reach to a mix of gravel/rock/boulder toward the mouth; however, mud dominates the lower cove substrate from 4 m to maximum depth of 13 m. Throughout the year, the upper cove has more shoreline vegetation, including willows (*Salix* spp.), sedges (Cyperaceae), and smartweeds (*Polygonum* spp.), whereas the lower cove typically has more filamentous green algae (Chlorophyta) throughout the year. Turbidity generally decreases toward the mouth, though fetch and wave height increase. Numerous dead trees are inundated in the upper cove reach, but are absent from the lower cove.

Sampling

From January - December 1992, I sampled the ichthyofauna of Turkey Creek Cove monthly. All sampling occurred on two consecutive days each month, except in April, May, and December when harsh weather forced sampling to a third consecutive day (Table 1). Sample sites were chosen to represent the variety of habitats in Turkey Creek Cove (Figure 1).

Fishes were captured with five monofilament nylon experimental gill nets (38.1 x 1.8 m, with 12.7, 25.4, 38.1, 63.5, and 88.9 mm bar-mesh), five trap nets (1.2 x 1.8 m frame with 12.7 mm bar-mesh and 13.7 m leader), and 11-18 seine hauls with a bag seine (7.6 x 1.8 m with 6.4 mm bar-mesh and a 1.8 x 1.8 m with 6.4 mm bar-mesh bag).

Table 1. Sampling dates in Turkey Creek Cove, Melvern Reservoir, Osage County, Kansas, 1992.

Sampling Dates
19-20 January
15-16 February
12-13 March
11-13 April
10-12 May
9-10 June
21-22 July
18-19 August
26-27 September
24-25 October
21-22 November
17-19 December

Seining effort varied because of variation in habitat availability due to ice cover and summer inundation of shoreline, with 15 seine hauls in January - March, 18 in April - July, 14 in August - November, and 11 in December. Sampling occurred at 309 sites, with 184 seine hauls, 64 gill net nights, and 61 trap net nights.

Shoreline seining consisted of a single Swingle Sweep, in which the seine was stretched perpendicular to shore and an arcing sweep was made into shore (Swingle 1950). I set gill nets and traps one day and retrieved them the next morning, except during December when it was necessary to leave two traps and four gill nets set for two nights due to high waves, which prevented their retrieval, and during April when one trap was stolen. I divided the four lower cove gill nets into surface and bottom sets, whereas the upper cove gill net spanned the entire water column.

Each fish was identified to species and counted. Total length (mm) of all fishes was recorded, except for silversides (Atherinidae), darters (Percidae), and most small minnows (Cyprinidae). To facilitate analysis of ontogenetic differences in habitat use, age 0 and adults were entered into the data matrix as separate operational taxonomic units, with designations derived empirically from growth data for Missouri (Pflieger 1975).

A set of 31 environmental variables was measured at each site yielding fish. I measured depth (m) with a meter stick at shallow areas and with a Hydrolab Surveyor II at deeper sites. To assess water quality, I surveyed specific conductivity (micromhos cm^{-1}), dissolved oxygen (ppm), Ph, and water temperature (°C) with the Hydrolab, except at nine sites in March and November when the battery malfunctioned; on these occasions I utilized data from the nearest site before malfunction. From water samples collected with hand-held jars at the surface and with a Van Dorn sampler at bottom gill nets, I determined phenolphthalein alkalinity (ppm) and total alkalinity (ppm) (Lind 1979), and used a Hach turbidity meter to assess turbidity (FTU). I surveyed transparency (m) with a Secchi disc, and maximum wave height (m) with a meter stick by noting the distance between the lowest trough and highest crest for 30 seconds. I collected substrate samples with a 15.2 x 15.2 cm Ponar dredge at trap sites, by net weights at gill net sites, and by hand in shallow areas. Substrate was described according to a modified Wentworth scale (Cummins 1962; Hynes 1970) by visually estimating percent mud (< 0.0625 mm), sand (0.0625 to < 2 mm), gravel (2 to < 16 mm), rock/cobble (16 to < 256 mm), and boulder (≥ 256 mm). As a measure of habitat heterogeneity, I recorded the number of substrate types at each site, and estimated percent detritus from substrate samples. I noted the number of littoral vegetation types, and estimated percent of the water column occupied by vegetation and structure, including filamentous algae, inundated vegetation, and dead or dying trees. To assess weather-related and water level fluctuation influences on the community, I obtained eight environmental variables from the U.S. Army Corps of Engineers Project Office at Melvern Lake, including mean air temperature for seven days prior to sampling, total discharge for seven days prior to sampling, wind velocity during day of sampling, mean wind velocity for seven days prior to sampling, total precipitation for seven days prior to sampling, reservoir surface elevation on day of sampling, drop/rise in reservoir elevation since last sampling, and mean reservoir surface elevation for month prior to sampling. I recorded barometric pressure from National Weather Service records for the city of Emporia, Kansas, 64 km west of the cove, between 1300 and 1530 hours the first day of sampling, and determined longitudinal position of each site from the upper end to the mouth from a scaled grid placed over a map of the cove.

Analyses

I examined species-environment relationships with detrended canonical correspondence analysis (DCCA) from CANOCO software (ter Braak 1986, 1988). This direct multivariate gradient analysis method constrains ordination axes to be linear combinations of supplied environmental variables; thus, DCCA produces community ordinations with an environmental basis. Resulting ordination diagrams represent sites and species with points, and environmental variables with vectors (arrows); trajectory and length of arrows portray direction and magnitude of correlations. Accordingly, axes can be interpreted directly from the pattern of assemblage variation along environmental gradients. Eigenvalues measure the separation of species distributions along canonical axes; the greater the eigenvalue, the more important the axis is in explaining species distributions.

I arcsine square root transformed species proportions in each sample to approximate more closely a normal distribution (Zar 1996). Detrending by fourth-order polynomials with downweighting of rare species, I analyzed all collections and each collection method to assess effects of longitudinal zonation (upper cove vs. lower cove), and season (spawn in March - July vs. non-spawn in August - February) on assemblage structure. I used Monte Carlo tests (ter Braak 1986; 1988) to test significance of each ordination, as well as significance of individual canonical axes. I calculated appropriate probabilities for simultaneous tests in correlation analyses by the sequential Bonferroni technique (Rice 1989), consulting statistical tables (Zar 1996) for critical correlation coefficients.

RESULTS

All Samples

I captured fish in 217 of the 309 samples (108 seine hauls, 53 gill nets, 56 traps). The total catch represented 10 families comprised of 27 species, 35 operational taxonomic units (age 0 and adults) and 4938 individuals (Table 2; Appendix 1).

The overall ordination and first canonical axis (DCCA 1) (Figure 2) were significant (Monte Carlo test, $P < 0.001$ and $P = 0.02$ respectively); DCCA 2 was not significant ($P = 0.07$). DCCA 1 spanned 4.4 SD, one complete turnover of species (Hill 1979). The species-environment correlation for DCCA 1, the extent to which species data were explained by environmental data, was 0.84.

Samples clustered along a strong inshore/offshore gradient with corresponding high/low habitat heterogeneity (Figure 2). Longitudinal position was not significantly correlated with DCCA 1 (Table 3). Significant positive correlations with DCCA 1, associated with offshore areas and low habitat heterogeneity, in order of decreasing scores, were depth, percent mud substrate, Secchi depth transparency, and maximum wave height. Significant negative correlations, associated with inshore areas and high habitat heterogeneity, occurred with habitat heterogeneity factors, including number of substrate types, number of littoral vegetation types, percent sand substrate, percent detritus,

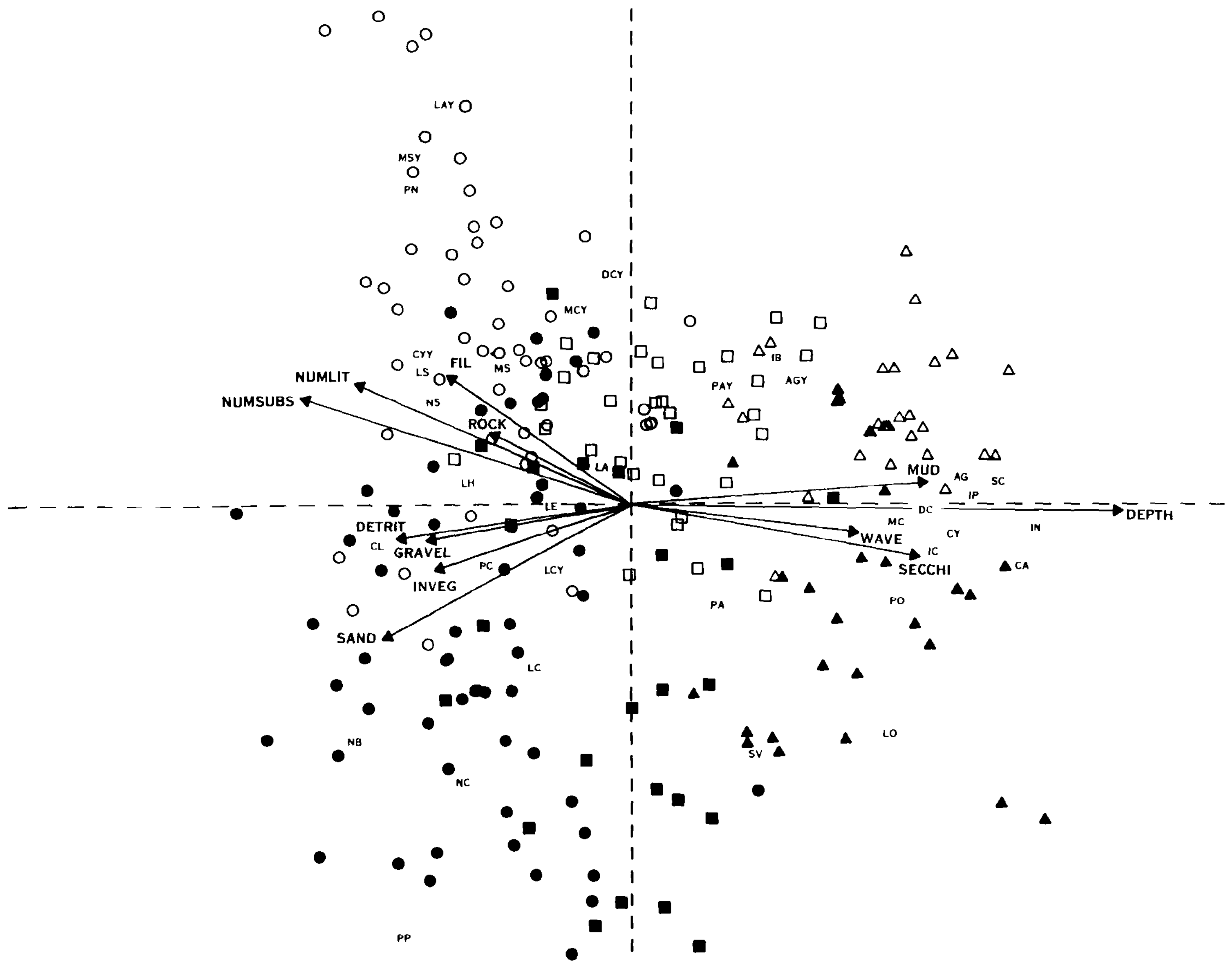
Table 2. Summation of catch by gear type in Turkey Creek Cove, Melvern Lake, Osage County, Kansas, January - December 1992.

Family and scientific name	Number in Seine haul/Gill net/Trap net Adult	Age 0	Total
Lepisosteidae			
Lepisosteus osseus	0/5/0	0	5
Clupeidae			
Dorosoma cepedianum	3/123/12	120/172/3	433
Cyprinidae			
**Cyprinella lutrensis*			307
Cyprinus carpio	0/16/1	2/0/0	19
**Notemigonus crysoleucas*			1
**Notropis buchanani*			540
**Notropis stramineus*			1
**Pimephales notatus*			50
Catostomidae			
Carpiodes carpio	0/8/3	0	11
Ictiobus bubalus	0/1/0	0	1
Ictiobus cyprinellus	0/25/0	0	25
Ictiobus niger	0/13/0	0	13
Ictaluridae			
Ictalurus punctatus	1/179/3	0	183
Pylodictis olivaris	0/3/0	0	3
Atherinidae			
**Labidesthes sicculus*			180
Moronidae			
Morone chrysops	1/48/3	5/4/9	70
Centrarchidae			
Lepomis cyanellus	0/0/4	1/0/0	5
Lepomis humilis	4/0/8	0	12
Lepomis macrochirus	5/0/76	6/0/7	94
Lepomis megalotis	2/0/10	0	12
Micropterus salmoides	0/0/1	11/0/11	23
Pomoxis annularis	12/260/1098	50/78/1348	2846
Percidae			
**Percina caprodes*			9
**Percina phoxocephala*			3
Stizostedion canadense	0/25/0	0	25
Stizostedion vitreum	0/3/1	0	4
Sciaenidae			
Aplodinotus grunniens	0/37/12	1/4/9	63

* = caught only in seine hauls

Figure 2. DCCA ordination of all samples, superimposing species (Table 2) and significant environmental vectors for Turkey Creek Cove, Melvern Lake, Osage County, Kansas 1992; seine hauls, trap nets, and gill nets are represented by circles, squares, and triangles, respectively. Open symbols are non-spawn; closed are spawn samples. Significant environmental vectors are given as arrows: **Depth** = water depth, **NUMSUBS** = number of substrate types, **MUD** = percent mud, **SECCHI** = Secchi depth transparency, **NUMLIT** = number of littoral vegetation types, **SAND** = percent sand, **DETRIT** = percent detritus, **WAVE** = maximum wave height, **GRAVEL** = percent gravel, **INVEG** = percent inundated vegetation, **FIL** = percent filamentous algae, and **ROCK** = percent rock/cobble. Species, in order of initial capture, are given as abbreviations: **IC** = Ictiobus cyprinellus, **IN** = Ictiobus niger, **LA** = Lepomis macrochirus, **PN** = Pimephales notatus, **LS** = Labidesthes sicculus, **CY** = Cyprinus carpio, **IP** = Ictalurus punctatus, **PO** = Pylodictis olivaris, **AG** = Aplodinotus grunniens, **NB** = Notropis buchanani, **DC** = Dorosoma cepedianum, **NC** = Notemigonus crysoleucas, **LC** = Lepomis cyanellus, **MS** = Micropterus salmoides, **PC** = Percina caprodes, **LE** = Lepomis megalotis, **LO** = Lepisosteus osseus, **LH** =

Lepomis humilis, **CL** = Cyprinella lutrensis, **CA** = Carpiodes carpio, **NS** = Notropis stramineus, **SC** = Stizostedion canadense, **PP** = Percina phoxocephala, **IB** = Ictiobus bubalus, **SV** = Stizostedion vitreum, **MC** = Morone chrysops, **PA** = Pomoxis annularis, **LAY** = Lepomis macrochirus age 0, **CYY** = Cyprinus carpio age 0, **AGY** = Aplodinotus grunniens age 0, **DCY** = Dorosoma cepedianum age 0, **LCY** = Lepomis cyanellus age 0, **MSY** = Micropterus salmoides age 0, **MCY** = Morone chrysops age 0, and **PAY** = Pomoxis annularis age 0.



NUMSUBS
NUMLIT
FIL
ROCK
DETRIT
GRAVEL
INVEG
SAND
MUD
DEPTH
WAVE
SECCHI
LAY
MSY
PN
DCY
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Table 3. Significant intraset correlation coefficients (ter Braak 1986, 1988) between environmental variables and DCCA 1 for all samples (n=217) and non-spawn (n=110) in Turkey Creek Cove, Melvern Lake, Osage County, Kansas, January - December 1992. Eigenvalues in parentheses; sum of all canonical eigenvalues for all samples = 2.099; non-spawn = 2.864. Sequential Bonferroni criterion for significance is $P < 0.001$, ns = not significant.

	All (0.608)	Non-spawn (0.702)
Water Quality		
depth	.799	-.661
Secchi transparency	.466	-.389
maximum wave height	.369	ns
conductivity	ns	ns
dissolved oxygen	ns	ns
pH	ns	ns
turbidity	ns	ns
total alkalinity	ns	ns
phenolphthalein alkalinity	ns	ns
water temperature	ns	ns
Substrate		
%mud	.478	ns
%sand	-.409	ns
%gravel	-.338	ns
%rock/cobble	-.230	ns
%boulder	ns	ns
no. of substrate types	-.542	.311
%detritus	-.382	.415
Vegetation		
%inundated vegetation	-.324	ns
%filamentous vegetation	-.304	ns
no. of littoral vegetation types	-.454	.486
%structure	ns	ns

Table 3 cont.

Longitudinal Position	ns	ns
Weather and Water Level Fluctuation		
surface elevation day of sampling	ns	-.326
mean air temperature day of sampling	ns	ns
wind velocity day of sampling	ns	ns
mean wind velocity for 7 days prior	ns	ns
total precipitation for 7 days prior	ns	ns
barometric pressure day of sampling	ns	ns
total discharge for 7 days prior	ns	ns
drop/rise elevation since last sample	ns	ns
mean surface elevation for month prior	ns	ns

percent gravel substrate, percent inundated vegetation, percent filamentous algae, and percent rock/cobble substrate (Figure 2).

Fishes with highest scores on DCCA 1, in order of decreasing ordination scores, were black buffalo (Ictiobus niger), river carpsucker (Carpiodes carpio), sauger (Stizostedion canadense), channel catfish (Ictalurus punctatus), freshwater drum (Aplodinotus grunniens), common carp (Cyprinus carpio), bigmouth buffalo (Ictiobus cyprinellus), gizzard shad (Dorosoma cepedianum), flathead catfish (Pylodictis olivaris), white bass (Morone chrysops), and longnose gar (Lepisosteus osseus) (Figure 2). The distribution of these large adults corresponded with deeper, offshore, homogeneous habitat. Fishes having intermediate scores were freshwater drum age 0, smallmouth buffalo (Ictiobus bubalus), walleye (Stizostedion vitreum), white crappie (Pomoxis annularis) age 0, white crappie, gizzard shad age 0, and bluegill (Lepomis macrochirus) (Figure 2). These fishes were distributed between inshore and offshore habitats. Taxa scoring low on DCCA 1 included ghost shiner (Notropis buchanani), red shiner (Cyprinella lutrensis), slenderhead darter (Percina phoxocephala), largemouth bass (Micropterus salmoides) age 0, bluntnose minnow (Pimephales notatus), common carp age 0, sand shiner (Notropis stramineus), brook silverside (Labidesthes sicculus), bluegill age 0, golden shiner (Notemigonus crysoleucas), orangespotted sunfish (Lepomis humilis), logperch (Percina caprodes), largemouth bass, green sunfish (Lepomis cyanellus), longear sunfish (Lepomis megalotis), green sunfish age 0, and white bass age 0 (Figure 2). These age 0 and mature at small size fishes were typically found in inshore areas with greater habitat heterogeneity, exemplified by more substrate types, filamentous algae, inundated vegetation, and detritus.

Collection Method and Seasonality

Clustering of each collection method (gear type) was evident in the overall ordination (Figure 2). However, analyses of patterns within each method were not significant, with overall ordination P-values of 0.26, 0.08, and 0.18 and DCCA 1 P-values of 0.28, 0.34, and 0.97 for seine hauls, gill nets, and trap nets, respectively. In addition, no surface/benthic clusters were evident among gill nets.

Clusters of spawn and non-spawn samples (Figure 2) were analyzed separately. The spawning season overall ordination and DCCA 1 were not significant, $P = 0.20$ and $P = 0.09$, respectively. However, the non-spawn overall ordination and DCCA 1 were significant, $P = 0.002$ and $P < 0.001$, respectively; DCCA 2 was not significant, $P = 0.54$. The species-environment correlation was 0.90. Significant positive environmental correlations with DCCA 1 were with number of littoral vegetation types, percent detritus, and number of substrate types, while significant negative correlations were with depth, Secchi depth transparency, and reservoir surface elevation the day of sampling (Table 3). As in the overall ordination of all samples, the non-spawn DCCA 1 represented a habitat heterogeneity and inshore/offshore depth gradient. Fishes with highest scores on DCCA 1 were red shiner, largemouth bass age 0, bluntnose minnow, orangespotted sunfish, brook silverside, and bluegill age 0, fishes commonly found in more diverse inshore habitat. Species with lowest scores on DCCA 1 were flathead catfish, black buffalo, channel catfish, sauger, river carpsucker, freshwater drum, gizzard shad, bigmouth buffalo, freshwater drum age 0, walleye, smallmouth buffalo, common carp, and white bass; these larger, piscivorous, planktivorous, or omnivorous fishes were commonly found in deeper, offshore, homogeneous habitats.

DISCUSSION

Moyle and Cech (1996) described three distinct warm-water reservoir fish zones as inshore, open-water, and deepwater benthic, but noted zonation is less conspicuous in reservoirs than in lotic systems because reservoir fishes are at more liberty to move among areas than are fishes inhabiting a stream gradient. Zonation of reservoir fishes has been explained, in part, by abiotic factors, including reservoir morphology and fluctuations in water level and water chemistry parameters (Jenkins 1968, 1970; Jenkins and Morais 1971; Il'ina 1974; Paxton et al. 1981; Day et al. 1983; Paller et al. 1992). My study illustrates, during one year and one season, cove fish assemblages organized along a horizontal and vertical, but not longitudinal, gradient of inshore/offshore habitats. Inshore areas in Turkey Creek Cove were shallow and had greater substrate and vegetation heterogeneity, whereas offshore habitats were much deeper and more homogeneous, with greater water transparency over predominantly mud substrate.

DCCA 1 demonstrated the importance of depth in segregating large adults from age 0 and forage fishes, including adult *Lepomis* species. Depth was also the most important environmental variable explaining adult and forage fish catch rate in Lake Carl Blackwell, an Oklahoma reservoir, because depth influenced organic content, hydrogen-ion concentration, and particle size of substrate;

substrate is a major regulator of macrobenthos abundance (Summerfelt 1971). Large and small brown trout segregated according to pelagic and epibenthic habitats, respectively, in Lake Tesse, a southern Norway reservoir (Hesthagen et al. 1995). Jackson and Harvey (1989) reported depth to be one of the most important determinants of fish community structure in natural lakes. Werner et al. (1977) concluded that depth differences influenced the fish community of two small, natural Michigan lakes, noting adult centrarchids such as bluegill, green sunfish, longear sunfish, pumpkinseed (Lepomis gibbosus), and black crappie (Pomoxis nigromaculatus) were more common residents of the littoral zone.

Habitat heterogeneity was inversely proportional to depth in Turkey Creek Cove, and was also a major component of DCCA 1. Stang and Hubert (1984) found plant cover and substrate were correlated with fish distribution in Clear Lake, Iowa. The importance of littoral vegetation in reducing age 0 and small fish depredation has been documented both in natural lakes (Werner et al. 1978) and reservoirs (O'Brien 1990). Macrophytic vegetation, with the exception of filamentous algae, was nonexistent in Turkey Creek Cove, but inshore areas typically had diverse substratum, and most smaller fishes were assembled at the shallow end of the DCCA 1 gradient. It has been suggested that in the absence of vegetation, littoral zone fishes aggregate over substrate (Aboul Hosn and Downing 1994), or use interstices between rocky substrates (Beauchamp et al. 1994) to avoid predation. Secchi depth transparency increased toward deeper, offshore areas of Turkey Creek Cove, areas where larger, piscivorous and planktivorous fishes predominated and smaller fishes were absent. This is consistent with the observations of Rodriguez and Lewis (1997), who found water transparency alone was a very good predictor of species composition in tropical, Orinoco River floodplain lakes of Venezuela, where visually oriented predator abundance was reduced in more shallow, turbid areas.

Gear selectivity is an important consideration in sampling design (Hamley 1975; Matthews 1986; Henderson and Nepszy 1992; Spangler and Collins 1992; Weaver et al. 1993; Post et al. 1995). Water depth dictated the use of different methods to sample the fish assemblages throughout Turkey Creek Cove (e.g., seine hauls could not be performed in depths > 1.5 m). Variation in the catch by different gear (Table 2), coupled with the lack of significant ordinations within each method, demonstrates the need to employ various gear types when sampling reservoir fish assemblages to be able to interpret environmental gradients structuring fish assemblages in such heterogeneous habitats (even in reservoir habitats that may seem homogeneous).

Analysis of seasonality suggests age 0, forage, and adult fishes in Turkey Creek Cove nonrandomly dispersed along the inshore/offshore depth gradient from August to February, after being more evenly distributed during the March to July spawn. This pattern may be due to differences in habitat availability throughout the year. Gelwick and Matthews (1990) reported that littoral zone fish assemblages in Lake Texoma, an Oklahoma-Texas reservoir, changed more within than among seasons and habitat types due to effects of fluctuation in water level and physicochemical factors. Non-spawn dispersal may have also played a role, as age 0 have been known to leave spawning grounds to inhabit pelagic zones, and then return to littoral areas after three to seven weeks of age (Post et al. 1995). Older age 0 fishes typically utilize inshore habitats with higher productivity (Thornton et al. 1990).

The utility of the current model for other areas of Melvern Lake and other reservoirs remains untested. A twelve-month study does not enable investigation of year-to-year variation, and may be incapable of distinguishing the effects of climate, such as the mid-latitude cyclone, on fish assemblage structure; Mandrak (1995) reported significant correlations between climate and regional species richness in Ontario, Canada lakes. Similarly, a cove may not accurately represent an entire reservoir fish assemblage, as coves have been described as refuges and nursery areas often containing more littoral zone habitat and age 0 fishes per area than the reservoir as a whole (Beckman and Elrod 1971; Thornton et al. 1990). Reservoir age must also be considered when comparing fish communities. After filling, available littoral zone habitat in a new reservoir often degrades due to inundation, water level fluctuation, and wave action; and native riverine fishes decline, with larger, non-native, generalist fishes typical of lentic systems dominating (Paller et al. 1992). Moyle and Cech (1996) pointed out that most warm-water reservoirs exhibit similar fish faunas because reservoir environments are selective in similar ways (ecotypes), and often the same preferred gamefishes are stocked. However, different reservoirs may have different habitats available to fishes and disparate physicochemical regimes, thus compromising comparisons.

Substrate characteristics, vegetation, and macrobenthos are influenced by water depth, and more study is needed of the relationships between these resources and the fishes using them (Summerfelt 1971; Werner et al. 1978; Hesthagen et al. 1995). Future studies should also address environmental correlates of diel and nocturnal fish activity; temporal feeding and movement in fishes is well documented in natural lakes (Emery 1973; Helfman 1978, 1981; Stang and Hubert 1984; Beauchamp et al. 1994), but not in reservoirs (Matthews 1986). Additional research should integrate biotic factors, as well, if fish communities are to be completely understood (Dunson and Travis 1991). Much of the variation in fish community structure of natural lakes can ultimately be explained by adaptations for coexistence fishes have before they colonize a lake (Keast 1978). As Gelwick and Matthews (1990) pointed out, no species evolved to live in reservoirs, because reservoirs are products of human activity and short-lived on a geologic time-scale. Therefore, adaptation is at the center of reservoir community structure. The ability to adapt to fluctuating water level, habitat availability, predator densities, water temperatures, and a range of water quality variables is key to successful existence in a reservoir. Interspecific interactions were beyond the scope of my study, but predation, competition, and resource partitioning, in conjunction with the abiotic environment, are important factors structuring natural lake fish communities (Moyle 1973; Gascon and Leggett 1977; Hall and Werner 1977; MacLean and Magnuson 1977; Werner et al. 1977; Keast 1978; Hinch et al. 1991; Pierce et al. 1994). A merging of biotic and abiotic information is needed to generate further hypotheses about the mechanisms structuring reservoir fish assemblages.

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Appendix 1. Fishes collected in Turkey Creek Cove, Melvern Lake, Osage County, Kansas, January-December 1992. Gear type (G = gill net, T = trap net, S = seine), followed by vertical position (B = bottom, S = surface), (U = upper, L = lower) cove position, and sample number (e.g., gill net on bottom in lower cove for sample 29 = GBL029) are given first, followed by the number of individuals captured of the following taxa, ordered according to initial inclusion in the species data matrix: Ictiobus cyprinellus, Ictiobus niger, Lepomis macrochirus, Pimephales notatus, Labidesthes sicculus, Cyprinus carpio, Ictalurus punctatus, Pylodictis olivaris, Aplodinotus grunniens, Notropis buchanani, Dorosoma cepedianum, Notemigonus crysoleucas, Lepomis cyanellus, Micropterus salmoides, Percina caprodes, Lepomis megalotis, Lepisosteus osseus, Lepomis humilis, Cyprinella lutrensis, Carpiodes carpio, Notropis stramineus, Stizostedion canadense, Percina phoxocephala, Ictiobus bubalus, Stizostedion vitreum, Morone chrysops, Pomoxis annularis, Lepomis macrochirus age 0, Cyprinus carpio age 0, Aplodinotus grunniens age 0, Dorosoma cepedianum age 0, Lepomis cyanellus age 0, Micropterus salmoides age 0, Morone chrysops age 0, and Pomoxis annularis age 0.

<u>January</u>

GBL001 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

TL002 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2
0 0 0 0 0 0 0 0

TL003 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

TL004 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL005 0 0 0 0 33 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0

SL006 0 0 1 2 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL007 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 7 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL008 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL009 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

<u>February</u>

GBU010 1 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0
0 0 0 0 0 0 0 0

GBL011 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

GBL012 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 1
0 0 0 0 0 0 0 0

TU013 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6
0 0 0 0 0 0 0 0

TL014 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 3
0 0 0 0 0 0 0 0

TL015 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

TL016 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

TL017 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4
0 0 0 0 0 0 0 0

SU018 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SU019 0 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SU020 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SU021 0 0 0 0 18 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0

SL022 0 0 0 4 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL023 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL024 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL025 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL026 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

<u>March</u>

GBU027 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 8 4
0 0 0 0 0 0 0 0

GSL028 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 1 0 0 3 0 4 0 0 0 5 3
0 0 0 0 0 0 0 0

GBL029 0 0 0 0 0 2 4 0 0 0 1 0 0 0 0 0 0 0 0 1 0 4 0 0 0 3
13 0 0 0 0 0 0 0 0

GSL030 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 2 4
0 0 0 0 0 0 0 0

GBL031 0 1 0 0 0 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

TU032 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

TL033 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

TL034 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2
0 0 0 0 0 0 0 0

TL035 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

TL036 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

SU037 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL038 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

SL039 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

SL040 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

April

GBU041 2 1 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 7

0 0 0 0 0 0 0 0

GSL042 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 5

0 0 0 0 0 0 0 0

GBL043 1 0 0 0 0 0 9 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1 0 0 1 1 8

0 0 0 0 0 0 0 0

GSL044 2 0 0 0 0 1 0 0 1 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4

0 0 0 0 0 0 0 0

GBL045 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

TU046 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5

0 0 0 0 0 0 0 0

TL047 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

29 0 0 0 0 0 0 0 0

TL048 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

TL049 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1

0 0 0 0 0 0 0 0

SU050 0 0 0 0 0 0 0 0 0 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

SU051 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

SU052 0 0 0 0 0 0 0 0 0 4 1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SU053 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL054 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL055 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 4 0 0 0 1 0 0 0 0
0 0 0 0 0 0 0 0

SL056 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

SL057 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL058 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

SL059 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

<u>May</u>

GBU060 4 2 0 0 0 0 6 0 0 0 7 0 0 0 0 0 4 0 0 0 0 1 0 0 0 1
11 0 0 0 0 0 0 0 0

GSL061 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
17 0 0 0 0 0 0 0 0

GBL062 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

GSL063 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0
11 0 0 0 0 0 0 0 0

GBL064 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

TU065 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
70 0 0 0 0 0 0 0 0

TL066 0 0 0 0 0 0 0 0 0 0 9 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

TL067 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
31 0 0 0 0 0 0 0 0

TL068 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
19 0 0 0 0 0 0 0 0

SU069 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

SU070 0 0 0 0 8 0 0 0 0 1 0 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

SU071 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SU072 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 0

SU073 0 0 0 0 2 0 0 0 0 2 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL074 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL075 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL076 0 0 1 0 1 0 0 0 0 2 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL077 0 0 0 0 1 0 0 0 0 24 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0

SL078 0 0 0 0 0 0 0 0 0 9 0 0 0 0 0 0 0 0 10 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0

SL079 0 0 0 0 1 0 0 0 0 3 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL080 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL081 0 0 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL082 0 0 0 0 1 0 0 0 0 19 0 0 0 0 0 0 0 0 27 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0

<u>June</u>

GBU083 3 0 0 0 0 0 16 0 0 0 23 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2
19 0 0 0 0 0 0 0 0

GSL084 2 0 0 0 0 0 17 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
27 0 0 0 0 0 0 0 0

GBL085 0 1 0 0 0 1 3 0 1 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

GSL086 0 0 0 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 0 0 0 1 0 0 0 1
12 0 0 0 0 0 0 0 0

GBL087 0 0 0 0 0 0 5 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

TU088 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4

0 0 0 0 0 0 0 0

TL089 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 2 0 0 0 0 0 1 0 1

0 0 0 0 0 0 0 0

TL090 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0 2 0 1 0 0 0 0 0 0 0 0

17 0 0 0 0 0 0 0 0

TL091 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 1 0 2 0 0 0 0 0 0 0 0 6

0 0 0 0 0 0 0 0

TL092 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

27 0 0 0 0 0 0 0 0

SU093 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2

0 0 0 0 0 0 0 0

SU094 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1

0 0 0 0 0 0 0 0

SU095 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 1

0 0 0 0 0 0 0 0

SU096 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

SU097 0 0 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

SU098 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

SU099 0 0 0 1 0 0 0 0 0 55 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0

SL100 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
      0 0 0 0 0 0 0 0

SL101 0 0 0 8 0 0 0 0 0 185 0 0 0 0 1 0 0 0 103 0 0 0 1 0 0
      0 0 0 0 0 0 0 0 0 0

SL102 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
      0 0 0 0 0 0 0 0

SL103 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 4 0 0 0 0 0 0 1 0
      0 0 0 0 0 0 0 0

SL104 0 0 0 0 0 0 0 0 0 9 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
      0 0 0 0 0 0 0 0

SL105 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0
      0 0 0 0 0 0 0 0

SL106 0 0 0 0 0 0 0 0 0 30 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
      0 0 0 0 0 0 0 0 0

SL107 0 0 0 0 0 0 0 0 0 94 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
      0 0 0 0 0 0 0 0 0

SL108 0 0 0 0 0 0 0 0 0 36 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0
      0 0 0 0 0 0 0 0 0

SL109 0 0 0 0 0 0 0 0 0 14 0 0 0 0 0 0 0 0 1 0 0 0 1 0 0 0
      0 0 0 0 0 0 0 0 0

<u>July</u>

GBU110 0 2 0 0 0 3 12 0 4 0 6 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0
       10 0 0 0 1 0 0 0 0

GSL111 1 0 0 0 0 0 6 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3
       0 0 0 1 0 0 0 0

GBL112 0 2 0 0 0 0 5 0 5 0 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

GSL113 3 0 0 0 0 0 6 0 2 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
33 0 0 0 0 0 0 0 0

GBL114 0 0 0 0 0 0 5 0 0 0 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

TU115 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
15 0 0 0 0 0 0 0 5

TL116 0 0 2 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
24 0 0 0 0 0 0 1 39

TL117 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 0
37 0 0 0 0 0 0 0 3

TL118 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 0
88 0 0 0 0 0 0 0 0

TL119 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
24 0 0 0 0 0 0 0 6

SU120 0 0 0 0 20 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 2 0 0 12 0 1 0 3

SU121 0 0 1 0 17 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 1 1 0 0 0 0 2 2

SU122 0 0 0 0 27 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 4 0 0

SL123 0 0 0 2 7 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL124 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL125 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 1 0 0 0 0 0

SL126 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 1 0 0 0 0 0 0

SL127 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 2 0 0 2 0

SL128 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 3 0 1 1 0

SL129 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 10 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0

SL130 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

SL131 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 22 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0 0

<u>August</u>

GBU132 1 0 0 0 0 0 10 0 4 0 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2

9 0 0 0 0 0 0 0 0

GSL133 0 0 0 0 0 0 5 0 3 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4

0 0 0 0 0 0 0 0

GBL134 0 0 0 0 0 0 7 2 6 0 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3

0 0 0 0 0 0 0 0

GSL135 0 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1

10 0 0 0 0 0 0 0 0

GBL136 0 0 0 0 0 1 2 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1

0 0 0 0 0 0 0 0

TU137 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4

0 0 0 0 0 0 0 3

TL138 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 1 1

0 0 0 3 0 3 4 1

TL139 0 0 8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6

1 0 2 0 0 0 0 1

TL140 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

16 0 0 0 0 0 0 0 0

TL141 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 4

1 0 1 0 0 0 0 10

SU142 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

1 0 0 0 0 0 0 0

SU143 0 0 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

SL144 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

SL145 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

1 0 0 0 0 0 0 0

SL146 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 10 0 0 0 0 0 0 0

0 1 0 0 11 0 0 0 0

SL147 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 1 0 0

SL148 0 0 0 4 8 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 1 0 2 0 0

SL149 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 2 0 0 0 0

SL150 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 10 0 0 0 0

SL151 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

September

GBU152 0 1 0 0 0 1 8 0 3 0 1 0 0 0 0 0 0 0 0 1 0 2 0 0 0 10
8 0 0 0 108 0 0 2 3

GSL153 2 0 0 0 0 1 19 0 0 0 21 0 0 0 0 0 0 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0

GBL154 0 0 0 0 0 0 3 0 0 0 21 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 2 0 0 0 0

GSL155 1 0 0 0 0 0 1 0 1 0 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
16 0 0 0 33 0 0 0 0

GBL156 0 0 0 0 0 1 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 2 0 0 0 0 0

TU157 0 0 5 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3
0 0 1 0 0 0 0 89

TL158 0 0 3 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0 6
0 0 0 0 0 3 0 3

TL159 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
48 3 0 0 0 0 0 0 28

TL160 0 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
44 1 0 2 0 0 0 1 16

TL161 0 0 4 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
51 0 0 1 0 0 2 0 10

SU162 0 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SU163 0 0 0 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 2 0 0 0 0

SL164 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 0

SL165 0 0 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 0

SL166 0 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL167 0 0 0 0 3 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL168 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5 0 0 0 0 0 0 0 0
0 0 0 73 0 0 0 0

SL169 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

<u>October</u>

GBU170 0 0 0 0 0 0 5 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 2
0 0 0 1 0 0 2 14

GSL171 0 0 0 0 0 0 4 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 3

GBL172 0 1 0 0 0 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 0 0 0 2

GSL173 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 3

GBL174 0 1 0 0 0 0 3 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 0 0 0 0

TU175 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 2

TL176 0 0 4 0 0 0 0 0 0 0 0 0 1 1 0 1 0 0 0 0 0 0 0 0 0 0 3
0 0 0 0 0 0 1 15

TL177 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
29 0 0 0 0 0 0 0 108

TL178 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 8
1 0 0 0 0 0 0 58

TL179 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
38 0 0 0 0 0 0 0 0

SU180 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SU181 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 1 0 0

SL182 0 0 0 2 0 0 0 0 0 0 0 0 0 0 3 0 0 0 0 0 1 0 0 0 0 0 0
0 0 0 0 0 0 0 0

SL183 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 1 0 0 0 0

SL184 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 40 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0

SL185 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0

<u>November</u>

GBU186 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 2 0 0 0 1 1
0 0 0 0 0 0 0 1

GSL187 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 4
0 0 0 1 0 0 0 22

GBL188 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0
0 0 0 0 0 0 0 0

GSL189 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 6
0 0 0 3 0 0 0 14

TU190 0 0 1 0 0 0 1 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 1 0 0 0 0 0

TL191 0 0 2 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0
13 0 0 0 0 0 0 0 245

TL192 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
73 0 0 0 0 0 0 0 430

TL193 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2
83 0 0 0 0 0 0 0 33

TL194 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
42 0 0 0 0 0 0 0 149

SU195 0 0 0 0 0 0 0 0 0 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 5

SU196 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1
0 0 0 0 0 0 0 18

SU197 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 2

SU198 0 0 1 2 1 0 0 0 0 1 0 0 0 0 0 0 0 0 4 0 0 0 0 0 0 0 0

0 0 0 0 0 1 0 1

SL199 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 1 0 0 0 0

SL200 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

SL201 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 2

SL202 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

SL203 0 0 0 0 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

<u>December</u>

GBU204 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 1

GSL205 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 9 0 0 0 10

GBL206 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0

0 0 0 0 0 0 0 1

GSL207 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 13 0 0 0 4

GBL208 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

0 0 0 0 0 0 0 0

TU209 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6

0 0 0 0 0 0 0 15

TL210 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0
24 0 0 0 0 0 0 0 16

TL211 0 0 0 0 0 0 0 0 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
112 0 0 0 0 0 0 2 1

TL212 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
46 0 0 0 0 0 0 0 51

TL213 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
16 0 0 1 0 0 0 0 11

SU214 0 0 0 0 3 0 0 0 0 5 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 6

SU215 0 0 0 0 1 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 8

SU216 0 0 0 1 1 0 0 0 0 10 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 3

SL217 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0